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Note:
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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Write in 335
Calling in an outside expert to solve a problem is a popular business technique. As it turns out, the same technique may apply to bioremediation of petroleum contaminated soils. What is the difference between bio-stimulation and bioaugmentation? Bio-stimulation uses only the microbes that already live in the contaminated site, whereas bioaugmentation involves the importation of “outsider” microbes known to be expert degraders of the target contaminant.

Over the last few years, there has been a continuing controversy regarding the ability of indigenous microorganisms to degrade hydrocarbon-based contamination in soils vs. the need to augment soils with selected microorganisms to promote degradation. Although many case studies are available about both approaches, there has been little effort to distinguish the metabolic differences of indigenous bacteria compared to selected bacteria with regard to their ability to degrade a particular type of chemical contamination. In addition, the influence of other non-biological (abiotic) forces, such as volatilization, can have a tremendous impact on the outcome of a bioremediation project—and, in many cases, may be the primary mechanism for contaminant removal. Unless mass balance experiments are performed in bench scale to determine the abiotic contribution to contaminant removal, it is impossible to determine the degree of effectiveness of a bioremediation system with respect to other abiotic forces and mechanisms.

Accordingly, there is some question whether or not the actual removal of contamination is due to biotic or abiotic forces. If a site was continually monitored for the presence of hydrocarbon degraders, and if the levels of hydrocarbon degrading bacteria increased over time, it can be reasonably assumed that biological forces contributed to the removal of contamination from the site. Conversely, if monitoring the site for hydrocarbon degrading bacteria did not indicate the presence of significant quantities of hydrocarbon degraders, it can be reasonably assumed that abiotic forces were the predominant mechanism for hydrocarbon removal.

Although biological monitoring alone will not yield proper determination of mass balance of contaminant degradation, it is an indicator of relative biological activity—which can indicate if a site is responding positively to biological treatment.

**Biological monitoring of contaminated soils**

Although it is well known that bacteria in general have a wide range of ability to degrade different carbon sources, including hydrocarbon materials, it must be recognized that not all bacteria are capable of metabolizing petroleum hydrocarbons.

In fact, indigenous bacteria may not be able to degrade hydrocarbon materials. Selected microorganisms that have the capacity to degrade hydrocarbon materials perform at much higher rates than indigenous microorganisms.

Speciation of indigenous bacteria isolated from a contaminated soil site has been performed to determine if any of these organisms are pathogens to humans, animals or plants.

**Bacteria isolation and identification**

Isolation of heterogeneous bacteria from soils is generally accomplished using standard methods such as the dilution plating technique. This technique is basically a method where the soil is washed with sterile buffered saline and the resulting supernatant fluid is used to streak enriched media agar plates at various concentrations.

The agar plates are incubated at 22°C and visually examined daily to determine if microorganisms are present. Bacterial colonies are generally visible after 24 to 48 hours, and the resultant concentration in the soil is determined by comparing the growth of bacteria on the agar plates at different dilution levels. The bacteria isolated with this general methodology are considered to be the heterogeneous population of indigenous bacteria.

Michael Barnhart is president and CEO and James Hyzy, Ph.D., is assistant director of research and development for Waste Stream Technology, Inc., Buffalo, N.Y.
The existence of a particular microorganism in a soil environment can be due to many factors—including the presence of hydrocarbon contamination.

**Isolating volatile organic degraders**

In order to determine if a particular bacteria has the capacity to degrade a target substrate, a method to isolate the organism with a sole carbon source contaminant, such as gasoline, must be used.

There are a number of different methods to accomplish this objective. One is the jar system.

The jar system reveals whether a particular bacteria can degrade a volatile organic compound on a minimal media agar plate. The jar system consists of a one-gallon glass jar with a tight fitting lid, preferably with a Teflon liner—into which a small vial of the target volatile compound is placed.

Placing the volatile compound into a sealed jar creates a saturated atmosphere. Indigenous bacterial soil isolates are streaked onto a minimal media agar and placed into the jar system. This determines if any isolate can degrade a single carbon source at the concentration contained in the saturated atmosphere. Concentrations typically exceed 1,500 ppm. Although the jar system is sealed to prevent the volatilization of the compound from the jar, there is sufficient oxygen in the jar to support bacterial growth for the incubation period.

The response level and subsequent growth of the microorganisms in the jar system indicates the relative ability to degrade the volatile compound.

To demonstrate the ability of indigenous bacteria to degrade a volatile compound, a typical gasoline contaminated site was selected. Soil samples were taken to determine the baseline population of indigenous microorganisms. The indigenous population was incubated on an enriched media agar plate. Based on differences in colony morphology, six distinct bacterial types were identified. Each distinct colony form was further characterized by taking an aseptic loop of each type and incubating it separately on enriched media. A pure isolate may then be gram stained and specified.

**Finding contaminant degrading capability**

At this point, the indigenous population of bacteria at the site has been counted, isolated and speciated. Speciation is essential in order to ensure the soil contains no plant, animal or human pathogens.

The six bacteria which were isolated from this soil are:

- Comamonas testosteroni
- Pseudomonas sp.
- Alcaligenes faecalis, type II
- Acinetobacter johnsonii, genospecies 7
- Pseudomonas corrugata (a potential plant pathogen)
- Psychrobacter immobili

The determination of which bacteria metabolize the gasoline is accomplished with the jar system. The results of the jar analysis are compared to selected bacterial strains with well-characterized gasoline degrading capability. The jar system can only accommodate three petri dishes at one time. Due to the diverse population of indigenous bacteria isolated from the site, a hex plate is used for incubation in the jar system. A hex plate is a minimal media agar plate which has been divided into six zones where individual bacterial strains are streaked. This hex plate is used in situations where incubation of individual petri dishes

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How to shop for a consultant

Consider a number of factors before choosing a firm

By Stephen Testa

Choosing an environmental consulting firm is a lot like shopping for a sofa—it’s a decision that will have to cushion you for a long, long time. Environmental consulting is a professional service industry which, in fact, incorporates many specialists—including environmental engineers, geologists, hydrogeologists, chemists, toxicologists and industrial hygienists. The range of consulting services includes preliminary assessments, subsurface geologic and hydrogeologic investigations, design and implementation of remedial programs, operation and maintenance of remediation systems, environmental engineering, costing and regulatory interfacing, reporting and litigation support. The consultant is also often asked to be part of the decision-making process in matters of waste minimization and the appropriateness of remedial options.

Regardless of the company, the environmental experience of most consulting firms does not exceed 10 to 15 years. With the enactment of RCRA (Resource Conservation and Recovery Act) in 1976 and CERCLA (Comprehensive Environmental Response, Compensation and Liability Act) in 1980, many environmental consulting firms spun off established geotechnical firms to capture a share of the new market created by these regulations. Firms with more than 10 years experience were primarily geotechnical and engineering firms in which the conduct of environmental services made up a small portion of their overall service. Most firms, however, are no older than about eight years, with the enactment of underground storage tank regulations in 1984.

Environmental consulting firms vary significantly in both experience and size. Many firms claim to be able to do it all—however, in reality, a

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Stephen Testa is president of Applied Environmental Services, Inc., Laguna Hills, Calif.
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particular firm is most likely to be very strong in one or a few specific areas, adequate in a few others, and downright incompetent in all the rest. This is more evident in small to mid-size firms, which have difficulty supporting a diversity of high-priced specialists on a full-time basis. Some firms compensate for such deficiencies by hiring associates or specialists, by establishing team agreements with other firms, or by hiring subcontractors.

The quality of technical and management services doesn't necessarily vary in relation to the size of the firms. Large firms often offer their services nationally, even internationally, and typically maintain several offices. Such firms have the advantage of being able to exchange personnel from one office to another to meet particular project commitments. Such firms are usually in a better position to commit more human resources within a time constraint, and are well suited for long projects that are multi-disciplinary and require strong financial underpinning. Small to mid-size firms, however, can also provide certain advantages, including personalized service, accountability, competitive billing rates and specialized services. In theory, the quality of the technical services being performed should not vary regardless of a company’s size. In practice, this is not always the case and the pendulum swings both ways.

What makes a firm qualified to provide services regardless of size can be evaluated in several ways. A firm’s qualifications and experience are most often demonstrated by their Statement of Qualifications. Most firms maintain such a statement. It is a common means to promote the firm’s services and contains information about the firm’s overall capabilities and experience. It generally includes discussion of the firm’s expertise, list of previous clients, brief project descriptions, client reference list, resumes of key staff, summary of overall human resources capabilities and standard schedule of fees.

Occasionally, a listing of the firm’s publications is included to demonstrate standing in the professional community and provide technical credibility.

The list of clients for whom the firm has provided services should reflect a wide range of services for a wide range of clients. A hydrogeologic consulting firm that solely conducts phase I preliminary site assessments for property transfers may be too restricted in its services to address all a client’s needs—assessment, remediation, regulatory interfacing and potential litigation.

Firms whose experience encompasses a wide range of clients, such as municipalities, petrochemical and other industrial properties and landfills, for example, usually provide a broader base and elicit a higher degree of confidence. Whether the firm has served a variety of industries, including industrial, commercial, financial and legal, should also be considered. Project descriptions should be formatted to illustrate the diversity of the firm’s activities.

However, many firms may maintain several Statements of Qualifications that focus on specific capabilities and services unique to the firm or to promote an area of expertise where the firm is particularly strong. The firm should be able to demonstrate experience on several projects similar to what the potential client needs.

Another means to document the suitability of a firm for performance of a particular service is a reference list. A firm’s reputation and level of respectability is based primarily upon past performance, their ability to maintain long-term clients, or repeated

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services to clients over time. The reference list should contain names of client representatives who can be contacted. It should also contain professional contacts outside the typical consultant-client relationship.

Regulatory agency contacts can be invaluable to establish whether a firm is viewed favorably, based on past performance or expertise. Some regulatory agencies even maintain lists of firms they perceive to be well qualified. However, these lists are rarely complete or up-to-date, so the absence of a firm on the list does not necessarily mean that firm is unqualified. Contacts within professional associations or the academic community may also provide a sense of the professionalism of a firm.

A potential client should not feel awkward to inquire about the personnel who would be assigned to their project. All professional and technical staff to be assigned to a project should work under a licensed or registered professional—such as a registered geologist, certified engineer, certified engineering geologist, certified industrial hygienist. In some states, registration or licensing may be limited for some specialties, so it is a good idea to contact the appropriate state agency to find out what is required by law.

Most important, identify who would be accountable for the overall project. This person should not only fulfill the managerial and technical needs, but also be prepared to present the client’s position to the regulatory agencies and provide potential litigation support in the form of technical assistance and expert testimony.

The firm’s management style is particularly important when the scope of work for a project is not clearly defined and is expected to evolve. How a firm handles potential cost overruns is certainly a matter of concern. The firm should not necessarily have the lowest billing rates, but rather comparable rates. More important are experience, qualifications and references.

It is important that a strong business relationship be established quickly, so the consultant can be of value throughout all phases of the project. When more than one site or project is anticipated, the development of the relationship becomes even more important. The client must feel comfortable conducting open discussions with the lead consultant not only about technical matters, but about financial matters, and the objectives of the project.

Many clients do not visit the consultant’s offices. Environmental consulting firms should reflect an image of professionalism without pretension. A tour of the offices can go far to help a client establish a comfort level and confidence in the consulting firm.

Hiring an environmental consulting firm is often the first step in the development of a long term relationship. Experience, qualifications, accessibility, accountability, reputation, comparable costs and standing in the professional community should all be considered with care.

Write in 682 for more information
Eye on the EPA

Recent announcements of interest to the industry

The EPA is proposing a rule that will exempt contaminated media and debris from petroleum underground storage tanks corrective actions that are subject to RCRA (Resource Conservation and Recovery Act). The proposal applies to Subtitle I of RCRA and portions of the TC (toxicity characteristics rule). The TC rule identifies hazardous waste. This exemption is limited to the 25 newly listed organic chemicals of the TC rule.

The proposal maintains the language in the current temporary deferral for UST petroleum contaminated media and debris found in EPA hazardous waste regulations. If this proposed rule becomes final, the current language of the deferral would remain unchanged.

The 60 day public comment period closes in mid-April. The EPA is considering whether the rule should be expanded to exempt all TC contaminants. They are also seeking input on whether to categorizes sources such as above ground tanks and farm and residential USTs of less than 1,100 gallon capacity.

Also, at RCRA sites, a new EPA ruling allows for corrective action management units (CAMUs), in which soils can be excavated and moved about for more effective treatment without triggering land disposal restrictions or minimum technology requirements. The ruling becomes effective April 19.

In other news, the EPA is giving local governments additional mechanisms to meet the UST financial responsibility requirement. Local governments that own or operate USTs containing petroleum were originally required to comply with financial responsibility regulations by October 26, 1990. EPA later extended this date one year.

Additional financial mechanisms for local governments include a bond rating test, a worksheet test, government guarantee and a fund balance test. The mechanisms being finalized take into consideration the financial characteristics of local governments and allow financially capable local governments the opportunity to self insure.

In addition, special districts, such as school districts and airport authorities may also self insure if they have outstanding revenue bonds rated "investment grade." To be eligible to use the test, a local government must have $1 million or more in outstanding bonds.

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Peek before you poke

Case history proves there’s no shortcut to quality control

This case history is from the files of the Association of Engineering Firms Practicing in the Geosciences (ASFE), of Silver Spring, Md. Established in 1969 to help members resolve liability problems, the association has grown to offer a wide range of information for its members. More information about the Case History series, a catalog of technical publications and membership information is available by contacting ASFE at 8811 Colesville Rd., Suite G-106, Silver Spring, Md. 20910 (301) 565-2733.

An environmental attorney contacted an environmental consultant to conduct a preliminary site assessment (PSA) on behalf of his client. The client was a married couple who were purchasing a refrigerated warehouse.

The consultant submitted a PSA Phase One proposal that called for document review, site walkover, interviews of past and present owners and other such services. In the process of conducting the Phase One assessment, the consultant learned that a 25- to 30-year-old underground tank, used to store heating fuel, existed somewhere on the site.

The consultant proposed a Phase Two PSA, calling for three borings to invert depth, field screening, laboratory testing of samples and preparation of a final report. The proposal included the consultant’s
standard terms and conditions, which required the client to identify the location of all underground structures and indemnify the consultant for "damage to subsurface structures or injury or loss arising from damage to subsurface structures which are incorrectly located or not indicated on the diagram(s) provided."

An additional indemnification required the client to hold the consultant harmless "from and against any claims, damages, losses and expenses arising out of or resulting from the performance of the work...or claims...related to hazardous substances or constituents, including hazardous waste."

The consultant wanted to please the client, particularly because doing so could lead to additional business or, at least, referrals from the client's attorney. When the couple indicated that time was a significant factor, the consultant decided to locate the tank on his own, rather than waiting for input from the client.

So, the consultant quickly located the tank with a magnetometer and took borings to determine if it was leaking. Sample recovery in each of the three borings was limited. The logs revealed rubble, cobbles and boulders. The boring within the envelope of the tank met refusal at 1.5 feet. The consultant concluded that the sampling program did not provide enough information to determine if the tank had leaked.

Consequently, the consultant proposed a tank integrity test—in a conversation with the client. The client agreed to the test—orally—but none of this was put in writing.

Integrity testing revealed a leak. Yes, the consultant agreed to a limited excavation, to the top of the tank, to determine the extent of the leak.

The excavation uncovered a crack in the tank that most likely was caused by the boring that met refusal at 1.5 feet. The integrity test had forced approximately 50 gallons of oil through that crack and into the surrounding soil.

The consultant’s site representative admitted responsibility for the damage and assured the client the firm would take care of any problems it had created.

The consultant's project manager removed the contaminated soil and disposed of it at an authorized disposal facility in accordance with state and federal regulations.

As the remediation progressed, the client's attorney drafted a letter (finally, someone is writing things down!) for the consultant to sign. In the letter, the consultant would take responsibility for the spill, confirm that appropriate regulatory officials had been notified, attest that immediate remediation action was taken and state that all the contaminated soil had been removed and disposed of in accordance with state and local regulations.

The lawyer also wanted the consultant to indemnify the couple, any lenders included in financing the purchase of the site or any subsequent

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improvements to it and all future owners against environmental impairment damages!

The consultant thought that to sign such a letter would be a rather tall order, yet at the same time, wanted to proceed with this lawyer in such a way as to retain the possibility of getting future contracts from him. So, the consultant countered by initiating what became a year-long negotiation on the contents of the letter.

The consultant believed he could not enforce the contract's indemnification provisions because the firm had most likely waived its rights to their protection by locating the tank without formal changes to the contract. Then, they compounded the error by admitting responsibility and liability for the problem.

Eventually, the consultant signed an agreement acknowledging that he had caused the problem, notified the proper authorities and cleaned the site in accordance with federal and state regulations.

There are several important lessons to learn from this case.

First, whenever environmental work is involved, a firm must apply maximum effort to quality control because the financial consequences can be so heavy. A high level of concern is also essential when the client can be considered unsophisticated, because courts generally impose a special duty of care on professionals in those circumstances.

A high degree of concern is appropriate, too, when the client’s dealings are being overseen by an attorney. Instead, the consultant rushed field services to please the client. And, as is so often the case, shortcuts led directly to problems.

Secondly, for risks known to the professional, clients should be advised of options, risks and costs—particularly when the client may not be extensively experienced. Warnings should be clearly spelled out, because it is the client who must bear the risk.

Third, documentation is an absolutely essential element of professional liability loss prevention. If it isn’t in writing, it didn’t happen.

In this instance, the client requested integrity testing and excavation based on an oral proposal—no documentation of what the proposal included. This proved to be a significant and on-going problem, because appropriate warnings were not given or, if they were, there was no evidence of them. Contract language, including change orders, should clearly place burden of risk where it belongs.

Fourth, it should be recognized that conditions that call for certain types of tests may become apparent only in the field. As such, it should be possible to discuss these activities, and the risks associated with them, in proposals.

Alternatively, standard proposals
could be developed for use on a change order-type basis. This would permit a consultant’s firm to fax a change order to the client, along with appropriate warnings.

Fifth, time constraints made this a fast-track project, in the sense that work began before the site plan identifying underground objects was located (if any existed). Fast-track projects, or projects with relatively severe time constraints, are known to be problem prone. Whenever tight deadlines are involved, extra vigilance is required. When the client imposes a tight schedule, the client should be held responsible for problems that arise because of the deadlines. Clients should also expect to pay additional costs for any extra vigilance needed to prevent time-induced problems.

Sixth, unless some extraordinary circumstance prevails, a consulting firm should never take unilateral action that would cause it to void protection it has in place. In this case, the client agreed to indemnify the consultant for problems associated with the client’s lack of information about location of the tank. By taking on the location task itself, the consultant took over responsibility for the accuracy of the information. Wanting to locate the tank quickly to expedite the project is understandable. However, the client should have been advised of all the options and the need to indemnify the consultant firm.

Seventh, field representatives need to know that they should never admit responsibility for a problem. Their assessment of the cause may be wrong. In any event, they should never commit a consulting firm to being responsible for the consequences.

Admissions of guilt can be extraordinarily damaging should litigation become necessary. Even where it can be shown that the fault positively did not lie with the consultant, the statement, “it's our fault,” can create liability—regardless of the speaker’s position or authority in the company.

The crux of this case is that the missteps had little to do with technical errors—they were primarily administrative blunders.

The consultant’s own words sum it up best, “We should never have gratuitously located the tank on behalf of the client. Then we admitted responsibility for a problem we were powerless to prevent. Finally, we agreed to settle because of the involvement of our client’s attorney. The attorney was affiliated with one of the largest environmental law firms in the area. It was our belief that if we helped solve the problem and maintained a flexible posture, there would be the opportunity for future work from the law firm. In the three years since this case, we have not received one request to submit a proposal from the attorney, anyone else at the firm or any of the firm’s clients.”

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Put this in your headspace

Jar headspace procedure finds volatile organic compounds quickly and inexpensively

By Frank D’Addario

The jar headspace procedure is a quick and simple field screening procedure to determine the presence of volatile organic compounds in soil or water before a full site assessment is conducted. The procedure involves collecting a soil sample, placing it in an airtight container, then analyzing the headspace vapor with a portable detector. The headspace is the area between the sample and the top of the container.

Generally, all that is needed is a portable photoionization detector or a portable flame ionization detector, a glass jar, like a mason jar, and a couple of sheets of aluminum foil to cover the jar.

To collect the sample, a hand auger or trowel is sufficient to collect surface samples of soil piles. Or, if drilling well boreholes, a split spoon sampler collects subsurface samples. If samples are needed from an excavation area, a backhoe is generally used.

The recommended procedure is to half fill the clean glass jar with the soil sample. Quickly cover the open top with one or two sheets of clean aluminum foil and screw on the cap tightly to seal the jar. Sixteen ounce mason type jars are preferred. Jars smaller than eight ounce capacity should not be used.

If the sample is collected from a split spoon, it should be

Information for this article was taken from Technical Assistance Bulletin (TAB) #1 and #1B, prepared by Environment Canada, Ontario Region, under the supervision of Frank D’Addario, senior environmental officer.

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Going deep with rotary drilling

Environmentalists can learn from petroleum industry techniques

By Ronald Bowers

The petroleum exploration industry wrote the book on subsurface drilling. They developed borehole logging methodology specifically designed to locate petroleum hydrocarbon deposits in subsurface materials. There is a great deal the environmental industry can learn from them about borehole logging.

In the petroleum industry, the well site geologist logging an air or mud rotary borehole is known as a mud logger. Air and mud—drilling fluid—are used to displace drill cuttings from the borehole. The mud logger sifts the mud to collect rock fragments or drill cuttings of the subsurface strata. The drill cuttings are analyzed and classified. The drilling mud is also analyzed for entrapped gas and oil.

Although the scale of operations is different, the goals of mud loggers and environmental geologists are the same. Both note any changes in formations, drilling techniques, petroleum “shows” and other details on a drilling record or mudlog for later review.

Hollow stem augering

Hollow stem augering is probably the most common method to perform explorations in unconsolidated materials. In this method, a rotary drill rig turns augers which bring soil to the surface on pitched flights. The pitched flights are welded to and surround the auger stem at the center of the auger flights as shown in Figure one, left.

Hollow stem augers drill through soils and allow the geologist to collect undisturbed soil samples without withdrawing the drill string—the total length of augers. Samples are collected through the center of the auger stem using thin wall samplers, including split spoons, Shelby dumes or continuous samplers, among others. Samples collected in these devices are considered to be undisturbed samples, since they are returned to the surface in their original orientation and in relatively intact condition. The samplers are brought to the surface through the center of the augers, opened and their contents analyzed and logged by the geologist.

Rock coring

In rock coring, a circular, hollow drill bit cuts around a center core cylinder of rock which enters a steel casing, called a scoreboard, as drilling progresses. The scoreboard is brought to the surface and opened, where the intact cylinder of rock is logged and stored. This method is the hard rock equivalent of split spoon soil sampling and produces the best samples for analysis. This method is often slower


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and more expensive than other rotary drilling techniques.

**Air rotary drilling**

Air rotary drilling is one method to use when formations are too hard for the hollow stem augers to penetrate. Air rotary is not a good method to use in soil horizons which may slough and possibly cause borehole collapse. The air rotary method is cheaper and faster than coring a formation and less expensive than mud rotary drilling. This method is less effective than mud rotary if flowing sands or other unstable formations are present.

In the air rotary method, a roller cone drill bit, Figure two, page 20, is attached to a length of drill rods or pipe. As the drill rig rotates the drill string, high pressure filtered air is introduced through the center of the pipe and is forced through jets past rotating cones in the drill bit. The air stream carries the drill cuttings up and out the annulus of the borehole—the area between the borehole and the drill pipe. Another similar method uses an air hammer, similar to a jack hammer, to break up the rock. Air hammer drilling removes the drill cuttings in the same manner as the air rotary method.

The air rotary drilling method is commonly used in both petroleum and environmental exploration. In petroleum drilling, mud-loggers log the drill cuttings and record the amounts of natural gas and petroleum hydrocarbons encountered in subsurface materials while drilling.

On a petroleum drill rig, the air and drill cuttings coming from the borehole are directed away from the borehole through a steel conduit pipe—blueooey line—into a waste pit. The mud logger attaches a two-inch by 18-inch steel pipe as a sampling port to the blueooey line at a 45° angle into the air stream. The two-inch steel pipe is packed with steel wool in the first foot closest to the air stream, and with cotton for the last six inches. A reducer is attached to the end of the two-inch steel pipe where flexible tubing connects the reducer to an air pump that sucks the air through a desiccant and into a hot wire gas detector and a gas chromatograph, as in Figure three, page 23. The hot wire is the petroleum industry’s equivalent to the photo-ionization detector (PID) or flame ionization detector (FID) vapor detectors.

Drill cutting samples are collected manually from the end of the blueooey line. Attaching a wire colander or sieve to a long stick and placing the sieve in front of the air stream discharge collects the sample. Drill cuttings traveling to the surface in shallow air rotary boreholes reach the surface almost instantaneously, so travel time calculations are not typically considered necessary during shallow air rotary drilling.

**Mud rotary drilling**

Mud rotary drilling is the most common drilling method used in the

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Going deep, from page 19

petroleum industry. It is used to a lesser extent in environmental drilling. In this method, water or drilling fluid lubricate and cool the drill bit, stabilize the borehole and carry drill cuttings to the ground surface or settling pit.

In the petroleum industry, the mud flows down through the drill pipe, past the drill bit and up the borehole annulus. After the mud reaches the ground surface, it passes from the borehole through a steel conduit into a drilling fluid retention tank, called the opossum belly, where the mud may be recycled.

The drilling mud exits the opossum belly and flows over a pitched vibrating wire mesh screen, called a shale shaker. As the mud flows through the wire screen, the drill cuttings are left on top of the screen, while the drilling mud passes through.

The drill cuttings are collected and analyzed by the mud logger at regular intervals. In mud rotary drilling, it is necessary to calculate the travel time of the mud to pass down through the drill pipe and up the annulus to collect the drill cutting sample at the correct time.

The excess drill cuttings vibrate off the pitched wire screen into waste pits. The waste pits are typically lined with an impermeable membrane to prevent groundwater contamination. The drilling mud is then reconditioned and reused within the borehole. Reusing drilling mud in an environmental exploration program may not be acceptable.

The mud logger places an agitator in the opossum belly to drive out any natural gas entrained within the drilling mud. The agitator has a stirring device located within a bell-shaped enclosure that traps the gases leaving the drilling mud. A reducer is located at the top of the enclosure to which flexible tubing is attached. The flexible tubing acts as a suction line in the same manner as in the air rotary gas detection system.

This manner of collecting a gas sample is unlikely to detect volatile vapors unless hydrocarbons are present in the drilling mud in significant quantities. Lab-in-a-bag™ techniques using chromatographic methodologies may prove valuable for testing drilling muds for the presence of hydrocarbons.

Drillers often place surface casing prior to performing rotary drilling to case isolate surface soils from the bedrock. If a particular borehole does have surface casing, the driller should place a “wash-T” onto the casing to direct the flow of the drilling fluids.

A motorized, vibrating shale shaker may be too much for smaller environmental drilling programs. However, it is easy to build a substitute shale shaker out of two-by-four lumber and fine mesh wire screen. Staple the screen to a two foot square wood frame to build a simple, hand powered shale shaker for rock cutting collection.

The basic tasks in borehole logging include sample containerization, VOC (volatile organic compound) screening, sample examination, drill rate recording and other drilling observations.

Continues on page 22→
Who says you have to drill down?

Research suggests it may be better to drill horizontally

By Lawrence Murdoch, Ph.D.

Researchers with the University of Cincinnati and USEPA's Center Hill Research Facility, Cincinnati, Ohio, are developing horizontal drilling techniques to enhance in-situ remediation activities.

The performance of in-situ remediation technologies is often limited by formations of low permeability, limited access beneath structures, channeling by preferred pathways and the inability to deliver or recover compounds from the subsurface. Directional drilling is a technique that can address those limitations. Directional drilling is a method of creating boreholes with trajectories that curve horizontally. The advantages of directional drilling compared with vertical drilling include improvements in access, hydrologic performance and intersection of heterogeneities. It presents the possibility of placing directional borings beneath structures, such as landfills, tanks or buildings to improve site characterization, monitoring or remediation capabilities.

The possibility of retrofitting landfills with leachate collection systems by horizontal drilling has already been demonstrated at several sites. Several theoretical studies have shown that a horizontal well outperforms a vertical well under many hydrologic conditions, because it has a larger zone of influence, typically, a longer screened length, greater specific capacity and a lower screen entrance velocity.

Directional drilling is particularly suited to broad, flat contaminated zones, where a directional well can provide more screened length than a vertical well in the contaminated zone. In areas underlain by tight formations where vertical fractures provide the primary flow paths, directional drilling may be used for intersecting vertical fractures, facilitating access to the preferred flow paths and increasing well yield. Equipment for directional drilling is

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Detecting volatile organics

The detection of any volatile organic compounds is the first indicator that petroleum contamination may be present in subsurface materials. The presence of the volatile organic compounds in the sample decreases relatively rapidly as samples are exposed to the atmosphere, so VOC screening should be a priority when samples are brought to the surface.

The sample should be immediately split into the portion which will be containerized and sent to the analytical laboratory and the portion which will undergo field screening. The portion being containerized for analytical lab testing should be handled first.

Undisturbed soil samples should be screened first with a brief pass by a VOC detector. Representative portions of the sample should be placed into a sealable plastic bag or other container and shaken. After the sample has had time to reach equilibrium, insert the VOC detector and record the reading.

Detection of hydrocarbons in disturbed samples, such as rock cuttings, can be accomplished in several ways. Longwave ultraviolet light causes most hydrocarbons to fluoresce. Therefore, if drill cuttings contain petroleum hydrocarbons, they will fluoresce with a typical green, blue or red color under longwave ultraviolet light. This can be done by placing the drill cuttings in a white dimpled porcelain spot dish, placing the spot dish in the dark and subjecting the sample to the longwave ultraviolet light.

In petroleum mud logging, drill cuttings are also tested for petroleum cuts. A petroleum cut occurs when hydrocarbons are driven from the rock cuttings by solvents or other similar compounds. Lighter fluid can be used as a substitute compound for solvents. A cut is performed by placing a few of the rock cuttings which fluoresced under ultraviolet light into a spot dish and covering the cuttings with lighter fluid. If petroleum is present, it will stream from the cutting and form a film at the surface. As the lighter fluid evaporates, it leaves a ring on the spot dish. Fluorescence colors and cuts should be recorded in the drilling record.

After VOC detection, a sample description should be recorded. Characteristics to describe include:

“Drilling speed observations identify changes in formation lithology and help locate fractures or other zones of weakness in the subsurface strata which may identify a preferential water pathway.”
moisture content, color, material classification, grain size, mineralogy, structure, cohesiveness and other characteristics which may be particular to an individual sample.

**Drilling speed**

Drilling speed observations identify changes in formation lithology and help locate fractures or other zones of weakness in the subsurface strata which might identify a preferential water pathway. Drilling penetration rates can often be correlated with downhole geophysical logs. This task is performed mechanically on petroleum drill rigs by a device which marks a paper chart each time a specific measure, usually one foot, is drilled. Mud loggers often hook an electric micro-switch to this device to remotely record drilling rates in a logging trailer.

On a typical environmental drilling job, presence of a logging trailer is unlikely. However, it is important to closely follow the rate of drilling penetration during environmental rotary drilling. Mechanically recorded drilling rates may eventually become common in environmental drilling, but for now, a yardstick can be used to measure increments which are marked on the drill stem with chalk. The time required to drill these intervals can be measured with a stop watch and the time interval recorded on the drilling record.

The environmental industry can learn from the long experience of the petroleum exploration industry in the development of more efficient drilling techniques."

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**Figure three: Typical rotary drilling gas collection system.**

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State money talks

State assurance funds are shaping compliance and corrective action

By Mathew Small, Patricia Koman, Martin Rodriguez and M. Kim Savage

The state assurance funds are affecting day-to-day operation and management of underground storage tanks across the country.

The cleanup money available through these funds provides a strong financial incentive for increased compliance with the technical UST requirements, which is a prerequisite for participation in most funds. Data indicate compliance rates are improving in states with assurance funds. This improved compliance should also increase prevention and early detection of releases, thus reducing the need for extensive remediation efforts in the future.

The state funds have the potential to influence the cost, speed and quality of remediation work performed. Cleanup efforts carried out under a fund are usually more closely monitored by state personnel and reviewed for reasonable cost prior to payout. This could have the effect of standardizing costs and performance expectations for cleanups using a given technology.

Because the state fund ultimately pays full or partial costs of remediation, fund administrator oversight may also influence reporting requirements, remedial technology selection and final cleanup levels for some sites. However, technical decisions should not be made on the basis of financial criteria alone.

Financial responsibility for USTs

In the event of a release, cleanup can easily cost several hundred thousand dollars. The federal financial responsibility regulations were created to ensure that anyone who owns or operates a petroleum UST system will be able to pay for any cleanup or third party damages. These regulations are also intended to protect the owner and operator from financial disaster in the event of a leak resulting in an expensive cleanup. By federal law, the burden of financial responsibility for cleanups and third party liability ultimately lies with the tank owner and operator.

Unquestionably, complying with the federal financial responsibility requirements for USTs can be expensive—though generally less than paying for a corrective action. Most tank owners and operators do not have the financial resources to comply with these requirements on their own: self insurance, a guarantee or a fully funded trust. Therefore, most are resorting to private insurance or participation in state assurance funds.

Private insurance policies may be difficult to secure and demand high premiums. In addition, most private insurers and state funds require that owners and operators be in complete compliance with the technical UST regulations—forcing many to upgrade their tank systems.

Economic impacts of UST regulations

The cost of upgrading existing UST systems to comply with the technical regulations can be substantial. This problem was partially addressed by implementing a phased approach for requiring compliance with the technical regulations to allow time to plan for upgrades. However, technical compliance required to obtain financial responsibility coverage has artificially accelerated implementation of the technical compliance requirements, creating an additional financial burden for many owners and operators.

When the regulations were promulgated in September 1988, the EPA projected the total incremental costs for corrective actions to be about $32 billion. At that time, according to the projections, it was anticipated that tank owners could pay out over $28,770 per tank over the next 30 years to comply with the new regulations. Some of the elements in that projection have decreased in cost as new technologies have been established and more competition has entered the market. Some of the other costs have increased from the initial analysis as a result of individual state requirements.

When the regulations were being considered in 1984, approximately 75 percent of all retail motor fuel outlets were owned or operated by a small business, defined as firms with less than $4.6 million in annual sales, and all firms with only one or two outlets. EPA estimates that historically these small outlets were going out of business, at a

For more information about the authors, see page 33.
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rate of three to four percent each year. The UST regulations were expected to increase that rate to 6.2 percent per year, assuming average corrective action costs of around $18,000 per UST.

The costs of regulatory compliance must be weighed against the benefits of protecting human health and the environment. In terms of health and resource protection, the benefits of preserving and protecting drinking water aquifers, public water supply wells, surface water bodies, soils and ecosystems are substantial, but not easily quantified.

**Funds ease economic impacts**

Many state governments are working to reduce the adverse economic impacts to tank owners and operators, especially to small businesses, through their funds. Data indicate that potential business failures of the small owners and operators are greatly reduced when state funds are readily available.

Once approved by EPA, state funds can be used by owners or operators to satisfy the federal financial responsibility requirements in lieu of other mechanisms—or as a partial mechanism used in combination with other allowable mechanisms. For example, an owner or operator in Arizona could combine state fund coverage for corrective action, which has a $10,000 deductible, with $10,000 in private insurance to cover the deductible and $1 million private coverage for third party liability to achieve compliance with the requirements. Because significant premiums are not required to be eligible to receive state funds, this may be the only means available for some owners to comply with the financial responsibility requirements.

State funds are supported through a variety of sources. In general, tank registration fees or some form of petroleum tax are the most common funding methods for the state funds. Whatever the method used to collect the money, state funds provide a mechanism to ultimately pass on some of the costs of compliance to the petroleum consumer.

However, not all costs are passed on, and the financial impact of regulatory compliance on petroleum marketers, especially small business, can be devastating. One of the largest costs, corrective action, is very difficult to pass on to consumers. The costs for a cleanup can be high, and some funds provide money only as a reimbursement—requiring significant up-front cash outlays by the owner and operator. Those owners and operators who are not in compliance with technical UST regulations may have their reimbursable amounts reduced or even denied.

In some states, depending on the funding source, maintaining solvency of the fund may become an issue. Sunset clauses, which phase out a state fund after a specified period of time, may be overly optimistic in their predicted decline in fund use. Some funds are receiving far more requests for money than is available. For example, California predicts it may take something like five to six years to complete payment of their initial claims, and more claims are coming in every month.

**State funds nationwide**

Of the 43 state funds, to date, $1 billion has been collected nationally per year; $500 million has been paid out to date. Twenty-nine funds have been approved by EPA to meet the federal financial responsibility requirements. Seven additional states have submitted requests to EPA for approval of their funds. Seven states have not yet submitted proposals. Another seven states have no state fund program in development.

Of those states without funds, some have written legislation to allow the development of financial assurance fund programs while others have made the decision not to support or develop a fund. This decision is often based on a limited number of UST owners within the state, a state government which opposes further taxation of the business community, or a state whose tax base could not support a fund.

To meet state-specific needs, each of the 29 approved state funds contains unique design characteristics and approaches, as shown in Figure one, page 30-31. The federal regulations allow for a diversity of approaches. The majority of funds cover at least partial corrective action and third party liability, with some type of deductible. The extent of regulatory compliance required is the most common factor affecting limits of coverage.

Florida has the oldest fund, and it has the largest number of claims, 13,000. California has 6,275 claims and New York has 5,484. Florida also has the largest number of covered third party claims with 998, while Maine has 55, Michigan, 50 and Vermont, 28.

For many states, the number of claims processed is only a small percentage of the sites with claims. Fund administration is a time-consuming process—requiring approval of cleanup plans, competitive bidding and a variety of other cost control measures and management practices. Furthermore, the number of claims may increase as the federal leak detection requirements are phased in and more releases are.

*Continues on page 28→*
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Money talks, from page 26

discovered. This would increase the already high workload of fund staff, leading to longer delays in reimbursement in some states.

Higher numbers of claims could also place an unexpected financial burden on some funds that were not designed for high levels of claims activity.

Impacts on corrective action and compliance

Because most state funds are relatively new, many of the impacts in the field on compliance and corrective action are still being identified. Significant influences are already obvious in the areas of cleanup standards, technology selection, cleanup speed, cleanup cost and increased compliance rates.

In the past, states typically reviewed corrective action results only to determine compliance with cleanup guidelines and closure requirements for protection of human health and the environment. With the advent of the funds, corrective action costs are also reviewed by another central body—the fund administrator or review board. The state body administering the fund is usually separate from the technical group historically responsible for compliance and corrective action review.

When a state is paying for all or part of a cleanup project through a fund, the overall efficiency, speed and effectiveness of the remediation are reviewed through the reimbursal approval process. As a result, cleanup goals must include cost considerations as well as contaminant concentration target levels. If the fund is paying out large sums of money at the end of a remediation project to remove small quantities of residual contamination, there may be pressure from fund administrators to revise cleanup levels based on economics and diminishing returns. These cost considerations could ultimately influence the contaminant concentration target levels established for cleanup and site closure.

Indeed, if this is not done, the entire fund could be exhausted to restore a small number of sites to pristine condition, rather than to reimburse a larger universe of owners and operators for cleanup to, perhaps, a more "reasonable" level. As a result, there is some potential for remediation technology selection to be driven more directly by cost considerations than by site specific hydrogeologic factors. This could cause problems when contamination disposal or media transfer solutions, which may be less protective of human health and the environment, are selected over contaminant destruction or reduction technologies, purely on the basis of cost.

However, there is opportunity for state fund oversight to be used to remove some barriers to the application and use of innovative cleanup technologies. Consultants may be more inclined to use a given application of an innovative technology if the state fund administrator will hold them harmless and not responsible to absorb the costs of potential failure. Likewise, the owner or operator might feel more inclined to pursue innovative cleanup technologies if the cost of potential failure is reduced by state fund support. However, fund administrators may be unwilling to fund technologies without a proven track record or established unit costs.

Some states are looking at setting standard rate guidelines which will be used to determine reasonableness of cost for various remediation cleanup technologies. Some states are also requiring registration or pre-qualification of firms that perform tank removals and cleanups. In addition, owners and operators are often required to obtain multiple bids for remediation to be eligible for state fund assistance. All these factors could have a dramatic effect on the consulting industry—tending towards the standardization of the fees charged for each type of remedial approach. This could reduce overall remediation costs for the average UST owner or operator and reduce state fund expenditures per site.

Speed of cleanups is an economic concern, as in the old adage, "time is money." Efficient use of state fund dollars may require that site assessment, remedial system design and testing and

---

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The Dragun Corporation
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28 April 1993 Soils
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☐ Technical and service support.
☐ Financing support.
☐ I'm interested in all aspects of soil remediation listed above.
<table>
<thead>
<tr>
<th>State</th>
<th>Agency With Primary Responsibility</th>
<th>Types of Tanks Covered</th>
<th>No. of Tanks Covered</th>
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<td>AK</td>
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<td>P, A</td>
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</table>

1. P = Petroleum; U = Used oil; H = Heating oil; A = Aboveground; C = Chemical; F = Farm; M = Mixed.
2. N/A = "Not Applicable"
3. Actually based on data applications for reimbursement received.
4. Deductible applies to commercial tanks only.
5. Actually based on number of facilities.
6. Actually based on date that cleanup costs are incurred.
7. Private insurance with reimbursement subsidized by the State.

Based on responses to a survey conducted by the South Dakota Petroleum Release Compensation Fund.

30 April 1993 Soils
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<th>Corrective Action</th>
<th>Third-Party</th>
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<th>Deductibles Apply</th>
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</table>

Continues on page 33→

April 1993 Soils 31
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Write in 259
remedial action be combined as much as possible to minimize actual time spent on the site. Quick remedial response is one of the best ways to cut costs, by minimizing the potential for contaminant migration and reducing the cleanup effort needed. However, the speed with which money is available for cleanup may be more influential on time to remedial response than a streamlined corrective action. Where reimbursement or direct payment is delayed, corrective actions could be stalled for economic reasons.

One of the most important factors in reducing the number of cleanups nationwide is to reduce the number of new leaks. Most state funds require substantial compliance with UST technical regulations to participate and receive money. Funds that require technical compliance, along with loan programs and other financial assistance for UST system upgrades, should improve compliance with leak detection regulations.

Although they come in different shapes and sizes, the state funds have had a major impact on owners and operators, regulatory agencies and the population as a whole. With funds and loan programs at their disposal, owners and operators are better able to meet federal financial responsibility requirements—and are more likely to meet UST technical requirements in order to participate in the fund. State funds provide a cost effective option to comply with federal UST financial responsibility requirements. With fund assistance available, owners and operators are also more likely to report an unauthorized release earlier, before the extent of contamination poses a more severe threat to human health and the environment.

The availability of state funds and oversight for cleanups should help to speed remedial response, standardize costs for a given technology and improve technical compliance rates.

The challenge for the future of state funds will be to use these financial tools in a partnership with technical expertise to provide cost effective cleanups that ultimately protect human health and the environment.

Matthew Small: B.S. Geology, California State University; M.Eng., Mineral Engineering, University of California, Berkeley; five years private consultant. Currently, hydrogeologist, U.S. EPA, Region 9, Office of Underground Storage Tanks, San Francisco, Calif.
Patricia Koman: B.A. Chemistry, University of Virginia; four years private consultant; scientist for U.S. EPA Region 9. Currently pursuing M.P.P., University of California, Berkeley.

The authors wish to acknowledge the contributions of:
Stephanie Bergman, U.S. EPA Headquarters, Washington, D.C.
Andrea Osborne, U.S. EPA Headquarters, Washington, D.C.
South Dakota Petroleum Release Compensation Fund

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Write in 281

April 1993 Soils 33
Integra Plastics offers covers, liners
Integra Plastics, Inc., Madison, S.D., introduces jumbo-sized polyethylene covers and liners in custom sizes ranging up to 200' x 200' with thicknesses from six to 30 mil, with or without internal reinforcements. All liners and covers are manufactured using the "power bond" seaming technique, which eliminates the unsightly overlap flap that often causes seam failures and added repairs, Integra says.

Modular systems control petro spills
ModuTank, Inc.'s modular storage systems, rapidly bolted together on site, control petroleum spills as mandated by the Oil Pollution Act of 1990, ModuTank president said recently at Petro-Safe '93. Modular tanks are easily hand-assembled from steel panels, the Long Island, N.Y.-based company says.

Sand packed well screen
Atlantic Screen's sand packed screen holds back sediment
Atlantic Screen & Mfg. Inc., Milton, Del., introduces the sand packed well screen to hold back ultra fine sediment and sand.

Three inch and larger diameters are available. The screens ensure uniform gravel thickness with the screen and gravel pack in one operation. Custom lotting and gravel packs are available, Atlantic Screen says.

Incineration show to discuss solutions
The University of California, Irvine, is sponsoring the 12th Annual Incineration Conference to discuss thermal treatment of radioactive, hazardous, chemical, mixed, weapon destruction and medical wastes.

The 1993 show will be held May 3-7 at the Holiday Inn-World's Fair and Knoxville Convention Center, Knoxville, Tenn.

The technical program will include papers on topics from thermal treatment systems and compliance to community concerns.

To attend, contact: C. Baker, University of California, Environmental Health & Safety, Irvine, Calif. 92717. Phone: 715-856-7066, Fax: 714-856-8539; R. Kagel, Dow Chemical, 517-636-2377 or E. McDaniel, ORNL, 615-574-0439.
O₂/CO₂ respirometer measures oxygen
Columbus Instruments, Columbus, Ohio, introduces a O₂/CO₂ respirometer that measures oxygen consumption and CO₂ production simultaneously in one to 20 chambers. The respirometer can be used for monitoring and optimizing remedial bacterial growths in shoreline soil and sea water contaminated by oil.

Write in 694

New respirometer from Columbus Instruments

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Often, in the mad rush to satisfy state or federal regulators, characterization and identification analyses are overlooked. After the regulators are gone, questions come up like: “Was it all ours?” or “Just how old was it?” It is usually too late to ask these questions because all of the evidence needed (oil sheens, contaminated soils) has been removed.

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Petroleum Product Identifications
Expert Witnesses • Soil and Water Testing

Write in 055

April 1993 Soils 35
transferred to the jar immediately after opening. If the sample is collected from an excavation or soil pile, it should be pulled from freshly exposed soil.

Headspace development should be allowed for at least 10 minutes. Vigorously shake jars for 15 seconds both at the beginning and end of the headspace development period. Where ambient temperatures are below zero degrees Centigrade, headspace development should be taken inside a heated vehicle or building. Ambient temperature during headspace analysis should be recorded and reported.

Headspace analysis should be completed on the same working day that the sample is collected.

After the 10 minute headspace development, remove the screw lid to expose the foil seal. Puncture the foil seal with an instrument sampling probe to a point about one-half the headspace depth. Take care to avoid uptake of water droplets or soil particles.

Or, syringe withdrawal of a headspace sample, to be injected into an instrument probe or septum-fitted inlet is acceptable—if the methodology can be verified using a test gas standard.

After the probe is inserted through the foil seal, record the highest meter response as the jar headspace concentration. Using the foil seal with probe insertion method, maximum response should occur between two and five seconds. Erratic meter response may occur at high organic vapor concentrations or under conditions of elevated headspace moisture content. If that is the case, headspace data should be discounted.

Instruments with digital LED or LCD display may not be able to discern maximum headspace response unless equipped with a maximum hold feature or strip-chart recorder.

The photoionization detector or flame ionization detector should be calibrated one to three times a day—or prior to beginning sample analysis. They should be calibrated to yield total organic vapors in parts per million to a benzene equivalent. Photoionization detectors should be operated with a minimum 10.2 eV probe. For best results, use an 11.7 eV probe. Operation, maintenance and calibration of the equipment should follow manufacturer’s specifications.

The point of the headspace procedure is not to determine hydrocarbon contamination levels. Organic vapor surveys, such as jar headspace, are a tool to locate contamination hot spots. It is an aid to determine the extent of contamination, to determine the presence of vapors and serve as a guide to direct a subsurface investigation.

Vapor concentration measurements from jar headspace analysis are often quite different from the results obtained from laboratory methods. The findings of jar headspace analysis do not correspond to any other test levels or lab results and give different results than a TPH (total petroleum hydrocarbon) analysis.

Jar headspace analysis yields a value that represents the amount of organic vapors present, measured in ppm. Since different organic chemicals have different vapor pressures, the types of organic vapors that this analysis will detect varies with the type of instrument and probe used. Different instruments and probes measure different vapors and give different readings. Also, the presence of methane can interfere with vapor readings. Some instruments do not measure methane. Others do, and still others have methane elimination as an option.

At all sites, background levels of organic vapors should be identified before the actual vapor survey takes place. Once background levels are established, a plan of action should be developed that takes into account odor, staining and instrument readings to identify potentially contaminated areas.

There are no established guidelines that outline what criteria should be applied to organic vapor readings, nor do organic vapor readings correspond to another analytical parameter.

In general, for photoionization detectors, any reading over 10 ppm may indicate high contamination levels. For flame ionization detectors, a reading over 30 ppm should prompt a more detailed investigation.

Combustible gas indicators are used to determine the lower explosive limit of the vapors present in an atmosphere. Lower explosive limits (LEL) are usually determined for confined spaces. The explosive limit depends on the mixture of product vapor and oxygen necessary to produce fire or explosion in the presence of an ignition source. The lower explosive limit is expressed as the percent of product vapor by volume in air. Most petroleum products are flammable between 1 percent and 10 percent lower explosive limit. Below 1 percent, the air/fuel mixture is too lean to ignite. Above 10 percent, the mixture is too rich to ignite. But, even though an air/fuel mixture may be too rich to ignite, at or above 10 percent is an extremely dangerous health and safety hazard.

For example, gasoline’s flammable range is 1.4 to 7.6 percent by volume in air. This means that the air must be composed of between 1.4 and 7.6 percent gasoline vapor for it to be flammable. Since 1.4 percent is the minimum amount of gasoline vapor that must be present in air for it to ignite, it is the lower explosive limit for gasoline.

Occasionally, it may be expressed that, “organic vapor concentrations exceeded 100 percent of the LEL.” In the example of gasoline, the LEL is 1.4 percent. So, when organic vapor concentrations exceed 100 percent of the LEL, this means that there was more than 1.4 percent gasoline vapor in the air.

If the percent of LEL is less than ten, continue monitoring with caution. If it approaches 10 to 25 percent, use extreme caution, especially as the figure climbs. When it reaches 25 percent or more, there is an explosion hazard. Withdraw from the area immediately.

Before resuming any on-site activity, project personnel should consult with experts in fire and explosion prevention to develop procedures for continuing operations.

Write in 685 for more information.
Tank costs correction

Installation comparison

In the January-February 1993 issue of Soils, the article on page 20, "Tank Installation: Comparing Dollars and Cents," contained typographical errors in the table "Total Costs." The table is reprinted here with corrections. Soils regrets the error.

<table>
<thead>
<tr>
<th>Product Description</th>
<th>Capacity</th>
<th>Cost</th>
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</thead>
<tbody>
<tr>
<td>Horizontal AST with Concrete Containment and Sealer</td>
<td>500 gal.</td>
<td>$1,913</td>
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<td></td>
<td>1,000 gal.</td>
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<td>Single Wall UST with Concrete Vault, Sealer &amp; Liquid Detection</td>
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<td>Single Wall UST with Carbon Steel Box &amp; Liquid Detection</td>
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<table>
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<th>Product Description</th>
<th>Capacity</th>
<th>Cost</th>
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<td>Horizontal AST with Earth Diking and Synthetic Liner</td>
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<td>Double Wall UST with Liquid Detection</td>
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<td>$12,633</td>
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All aboard the training track

The industry is buzzing with specialized training opportunities

There is a wealth of training opportunity for soil remediation, underground storage tanks and related issues. Here is a sampling of a few of the types of courses and resources available from universities as well as private corporations and industry associations. This listing is not comprehensive. For information about courses near you, contact local colleges and universities.

**Georgia Tech Research Institute**
Georgia Institute of Technology
Atlanta, Georgia 30332
For information: 404-894-7430
To register: 404-894-2400
Space Science Building

Hazardous Material Control and Emergency Response $900
May 10-14          October 11-15
June 14-18          November 8-12
September 13-17     December 6-10

Hazmat Technician Emergency Response
Annual Refresher $195
October 8

Management of Underground Storage Tank Systems $795
June 14-18          October 11-15

Southeastern Safety and Health Conference
Exhibitors, $595    Participants, $245
April 26-28

Role of Environmental Audits and Site Assessment in Property Transfers $795
May 24-28          August 9-13      November 1-5

Occupational Respiratory Protection $495
(plus $75 exam)
June 8-10          October 5-7

Confined Space Entry Procedures $300
October 21-22

Trenching and Excavation $175
April 21            July 20

---

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Occupational And Environmental Safety Training Division
Texas Engineering Extension
The Texas A&M University System
College Station, Texas 77843
409-845-3418

Phase I Site Assessment for Property Transfer $550
March 29-April 1, Baton Rouge, La.; April 27-30, Dallas, Texas; June 7-10, San Antonio, Texas; June 21-24, College Station, Texas; July 12-15, San Antonio, Texas; August 9-12, Baton Rouge, La.; August 30-September 2, College Station, Texas

Phase II Environmental Sampling Investigation $650
April 19-22, May 24-27 at Riverside Campus, Bryan, Texas

Remediation Technologies and Phase III Site Assessment $525
May 11-13 at Riverside Campus, Bryan, Texas

Environmental Monitoring Well Driller's Course $195
July 22, San Marcos, Texas; July 29, Corpus Christi, Texas; August 3, Lubbock, Texas; August 5, Abilene, Texas

Confined Space Safety $575
June 15-17, College Station, Texas

Tank Truck Emergency Response $575
May 5-7; June 7-9; June 30-July 2; August 18-20, College Station, Texas

Railroad Tank Car Emergencies $895
June 21-25; August 23-27; College Station, Texas

Pipeline Hazardous Materials Response $750
May 10-13; July 13-16, College Station, Texas

UST A&B Installer and Remover Training $695
May 17-21; July 12-16, Riverside Campus, Bryan, Texas

USTs for Owners and Consultants $495
June 8-10, San Antonio, Texas

Risk Management Technologies, Inc.
1020 N. Fairfax St., Suite 201
Alexandria, Va. 22314
703-549-0977

Risk Management in Business and Real Estate: Strategies for Industrial and Financial Companies $695
May 20-21 (also in June in San Francisco, Calif.)
Ritz Carlton Hotel
Pentagon City, Arlington, Va.

Department of Engineering Professional Development
The College of Engineering University of Wisconsin-Madison
432 North Lake Street
Madison, Wisc. 53706
800-462-0876

Monitoring Well: Design, Installation and Sampling $750
May 5-7, University of Wisconsin-Madison campus

Independent Study Course:
Technology of Underground Liquid Storage Systems, $295, 800-358-2736

Resource Meetings:
National Environmental Training Association, April 19-21, Seattle, Wash., 617-489-2302
No-Dig '93, North American Society for Trenchless Technology, May 2-5, San Jose, Calif., 312-644-0828
Hydrocarbon Contaminated Soils and Groundwater, May 10-13, Houston, Texas, 413-549-5170
National Association of Environmental Professionals, May 24-26, Raleigh, N.C., 202-965-1500
HVAC, Coalition of the American Consulting Engineers Council, June 6-9, Washington, D.C., 202-347-7474
Hazmat International, June 9-11, Atlantic City, N.J., 708-469-3373
Air & Waste Management Association, June 13-18, Denver, Colo., 412-232-3444
Contaminated Soils: Hydrocarbon and Heavy Metals, July 14-16, Ann Arbor, Mich., 413-549-5170
Petroleum Equipment Institute, October 5-7, Salt Lake City, Utah, 918-494-9696
Petroleum Marketers Association of America, October 23-26, New Orleans, La., 703-351-8000

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Write in 353

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is not practical due to space limitations.

The hex plate, inoculated with the six microorganisms isolated from the gasoline contaminated soil, is placed into the jar. An additional hex plate, containing known hydrocarbon degrading bacteria manufactured by Waste Stream Technology, is included in the jar for comparison and serves as a positive control.

The control hex plate contains manufactured blend types:
- M-4: degrades gasoline, chlorohydrocarbons, phenols, alcohols;
- M-5: degrades polynuclear aromatic hydrocarbons, fuel oils;
- M-B4W: degrades fuel oils, cutting oils, crude oil;
- M-KS4: degrades fuel oils and cutting oils;
- M-B4C: degrades xylenes, toluene, volatile organics;
- M-A2: degrades aniline, benzo-amines.

A number of these bacteria blends are not gasoline degraders, but are included in the study for comparison to demonstrate biological specificity for different fuel types.

These hex plates were incubated at room temperature (22°C) for seven days to allow the microorganisms to adapt to the gasoline saturated atmosphere. The hex plates were examined daily to monitor growth rates of the different bacterial strains.

The level of bacterial growth on the indigenous isolated hex plate ranges from none to moderate. The level of bacterial growth in the manufactured blends hex plate ranges from none to heavy as in the photo right. This is due to the fact that only a few of the manufactured blends are able to degrade gasoline.

Bioaugmentation over biostimulation

If biostimulation is used to increase the relative concentration of hydrocarbon degrading bacteria at a site, the overall effect is a decrease in the overall time and cost for a remediation project.

However, an indigenous degrader may be stimulated along with all other members of the ecosystem. Therefore, each established niche increases, resulting in identical proportions of all members. This may only slightly increase the rate of target degradation, since population dynamics prevent overgrowth by a single species. In addition, stimulation of pathogenic organisms may occur. The outcome of treatment is somewhat unpredictable, and the fate of the organisms and contaminants is unknown.

Bioaugmentation is the addition of specific target degrading microorganisms at a contaminated site. It has many advantages over biostimulation. On-site production and application rapidly increase the concentration of petroleum degrading bacteria to levels associated with optimal biodegradation. The bacteria chosen for production are target-specific, non-pathogenic and proven safe. Costs associated with bioaugmentation are minimized by the speed, predictability and technical merit of the process.

Write in 682 for more information
Owens Corning Fiberglas Corp., Toledo, Ohio, says their new line of oil/water separator tanks takes in storm water runoff from fuel stations, airports, parking lots and other areas where vehicles may leak oils, separates free floating oils and discharges effluent water. The system can reduce the oil concentration left in the effluent down to no more than 10 ppm. The system works on the hydrostatic principle. At setup, the tank is filled with water. Then, as rainwater runoff enters the tank through the inlet line, it is directed through oil coalescing plates where the oil separation process occurs. The coalescer plates are mounted in packs within the tank. Individual plates, spaced at 1/4-inch intervals, make up each plate pack. All internal components, including the coalescing plate packs and mounting hardware are rustproof. The plate packs capture free floating oil droplets as they flow through the system. When captured, the individual droplets accumulate into larger droplets, which rise to the top of the coalescer plate packs. Solids that may enter the tank with the storm water fall through holes at the bottom of the coalescer plate packs for removal. The system can handle free floating oils that are not chemically emulsified or dissolved. The oil can then be manually removed from the top of the tank or automatically removed with a small pump. Electronic sensors are available that can determine how much oil has accumulated in the tank. The coalescer plate packs are accessible for cleaning via standard manways mounted to the tank top. Single wall tanks are available in capacities of 600 to 48,000 gallons. Double wall tanks range from 600 to 30,000 gallons. Both have inlet flow capabilities ranging from 20 to 5,500 gallons per minute. The double wall models can be provided with an EPA approved Hydrostatic Monitoring system, which allows the tank to be continuously monitored for leaks. Write in 688 for more information.
Learning is earning

My dictionary says education is, “training by which people (generally young) learn to develop their mental powers.” Ha! I guess I need a new dictionary, because I do not know of any successful business people who do not value and insist upon continuing education—and many of these successful business people are quite old, like my boss, for example.

On the other hand, the soil remediation industry is still quite young. As Stephen Testa points out in his article on page 8, it is difficult to find a consulting firm with more than 10 years of experience. A young industry is still learning, or should be. I know I have never had a conversation with anyone who claims to have the industry figured out, once and for all. Everyone is hungry for the latest developments, test results, outcomes.

Certainly educational information about the industry is at the forefront of Soils’ reason for being. That is what we do here. I get many calls from people who want to copy articles to pass out at training sessions, or to include in information packets.

Fortunately, the academic community is doing a bang up job of putting together courses for environmental professionals to continue their education as the industry progresses. (See the article on page 38, listing some representative course offerings.)

Another excellent way to gain information is to learn from the mistakes of others. The article on page 12 is an example of that type of learning—a case history of a site assessment gone awry, winding up in prolonged hassles for the site owner and the consultant. It is not a story with a happy ending, but for those who are willing to learn, it teaches several lessons about approaching a site with a leaking petroleum storage tank lurking beneath the surface.

More companies are slowly becoming more forthcoming with environmental information. Even two years ago, I often found myself trying to interview sources for articles who were reluctant to answer questions. Imagine! A site owner turning down my offer to splash his contamination miseries all over the cover of Soils magazine!

Developers of new equipment and processes were also reluctant to chat in detail about their new discovery or invention.

But, that is all changing. Companies are more willing to share their experiences. I see a trend toward more disclosure, more willingness to exchange information. Some big corporations are leading the way—or perhaps being pushed along by watchdog environmental groups and government regulations—to reveal more about the nature of their environmental liabilities.

Some companies who have developed processes that enhance other processes are looking to partner and complement each other, rather than compete and elbow each other out of the picture.

There is no shortage of information to absorb and there is apparent eagerness to learn.

One difficulty is assessing the value of a course or seminar in advance. With margins so tight and staff so streamlined, it can be difficult to pay, say, $1,000 to send an employee out for two or three days of study. How can you be sure the expense and effort is worthwhile? It’s always a gamble. First, consider the reputation of whoever is offering the course.

With a little effort, you can find a person who has taken the course to ask about its value.

So much depends on the instructor of a course. Anyone who has been to high school knows how that works—two teachers may teach the same subject, but everyone knows which teacher to get and which one to avoid.

The tuition for some of these courses may range from $200 to $900 for two or three days. This cost, combined with travel and lodging costs, as well as the cost of having the employee out of the office, obligates and entitles the potential student to take steps to ensure value.

I believe association meetings and industry conventions are an excellent resource for education. There’s nothing like getting out there and seeing people—everyone with his or her best foot forward...mingling, eavesdropping. It is almost impossible not to bring back new ideas and refreshed enthusiasm from such a gathering.

“Even two years ago, I often found myself trying to interview sources who were reluctant to answer questions. Imagine! A site owner turning down my offer to splash his contamination miseries all over the cover of Soils magazine!”
Cathodic protection is an electrical method of corrosion control for steel underground storage tanks. The EPA requires cathodic protection and periodic testing to prevent corrosion of all steel tanks in place by December 1998. Galvanic corrosion in ferrous metals is caused by the flow of direct current from one point (an anode) to another point (cathode). It is a scientific principle that all metal materials must return to their lowest energy level. Anodes corrode, but cathodes don't. So, the concept of cathodic protection is to make the tank function as a non-corroding cathode. Direct current is applied to the tank environment (the subsurface) to be picked up on the tank surface. This protective current overcomes corrosive currents on the tank. There are two basic ways to accomplish this. Impressed current cathodic protection requires constant application of an outside source of electrical power (rectifier). The rectifier converts AC to DC power. Impressed current systems are often used to protect existing tanks with large areas of exposed steel. Inert anodes are typically made of titanium or niobium rod with a thin coating of ruthenium, rubidium or platinum. Direct bury wiring connects the anodes and tanks to the rectifier.

The sacrificial anode method relies on the natural potential difference between the metallic sacrificial anode and the steel tank to provide a protective flow of current. This system is typically restricted to new installations. Galvanic, sacrificial anodes are made of magnesium or zinc. They are attached directly to the tank and piping and require no external power.

The varying resistivity, conductivitiy and oxygen content of soils influence the rate of corrosion. Different alloys in the tank and piping installation (including welded areas) can corrode at different rates.
Above are two new ways to promote your company's products and services. Call 816-254-8735 to discover how easy it is to increase sales.
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