BROWN AND CALDWELL

# Quarterly

WINTER•1999
VOLUME•28
NUMBER•1

**INSIDE:**

**The DNAPL tracer test**

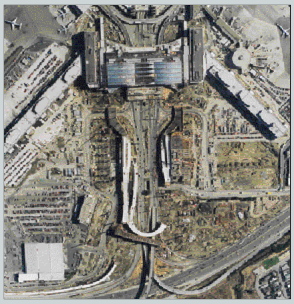
**Watershed regulatory changes**

**Environmental firsts in Arizona**

**Featured this issue — Construction and environmental management for SFO expansion**

BROWN AND CALDWELL

# Quarterly



Shown under construction is the San Francisco International Airport's new international terminal, flanked by new Boarding Areas A and G. The entire area visible below these structures contains the footprints of the main utility corridors, for which Brown and Caldwell managed construction over the past three and a half years.

PHOTO BY NORTHBAY AERIAL PHOTOGRAPHY, VALLEJO, CALIFORNIA

| | |
|---|---|
| **Marketing Communications Manager** | Terry Peckham |
| **Editor** | Lisa Bernstein |
| **Writers** | Lisa Bernstein<br>Laurel English |
| **Assistants** | Andrea Atkins<br>Susan Sicora |

**Produced by** DIABLO PUBLICATIONS (925) 943-1111

**To speak with a Brown and Caldwell representative, call us at (800) 727-2224 or visit our web site at www.brownandcaldwell.com.**

Brown and Caldwell provides environmental engineering and consulting services to public agencies, the federal government, and industry.

*Quarterly* is published by Brown and Caldwell, P.O. Box 8045, Walnut Creek, CA 94596-1220; tel. (925) 937-9010. Subscriptions are free.


C O N T E N T S • W I N T E R • 1 9 9 9



# Quarternotes

## Office News and Moves

Brown and Caldwell has a brand-new location in Tucson, Ariz. **Buck Schmidt,** principal hydrologist, joined the company to manage the office. He has seven years of experience with groundwater resource projects in Arizona, including hydrogeologic investigations and well siting, permitting, and construction management. Contact the office at 2342 East Broadway Boulevard, Suite 109, Tucson, Ariz., 85719, (520) 624-5744 for calls and (520) 624-9581 for faxes.

Buck Schmidt

Eckenfelder's integration into Brown and Caldwell has yielded two new company offices. The Nashville office is located at 227 French Landing Drive, Nashville, Tenn., 37228, (615) 255-2288, voice, (615) 256-8332, faxes. The New Jersey office is at 440 Franklin Turnpike, Mahwah, N.J., 07430, (201) 818-6055, voice, (201) 818-6057, faxes.

The Honolulu office has moved to 119 Merchant Street, Suite 200, Honolulu, Hawaii, 96813. Phone and fax numbers are unchanged: (808) 523-8499, voice, (808) 533-0226, faxes.

## Joining Brown and Caldwell…

*In Pleasant Hill, Calif.:* **Voytek Bajsarowicz** now leads our private-sector operations in the Western U.S. He has 17 years of environmental engineering and managerial experience…A project engineer in the infrastructure group, **Kevin Calderwood, P.E.,** has 17 years of experience engineering, designing, coordinating, doing computer-aided design and drafting, and preparing construction documents for pipeline, roadway, underground utility, and site work projects. He's currently designing pipelines for both trenchless and traditional open-cut construction.

*Elsewhere in California:* **Brian True,** a civil engineer specializing in biosolids management, has joined the Sacramento, Calif., office. His background includes serving as special projects coordinator with the Northwest Biosolids Management Association and managing design and construction of surface and subsurface drainage systems. His current work includes engineering industrial and municipal wastewater treatment and biosolids systems…**Mark Myers, R.E.A.,** is a demolitions expert in the Irvine, Calif., office. He has six years of experience providing environmental services for privately owned companies as well as utilities and municipalities, including closure and decontamination of industrial facilities and services related to underground storage tanks and asbestos.

*In Phoenix:* **Phil Lagas** is now managing this office's environmental services. Lagas has 14 years of experience managing multidisciplinary waste management and environmental projects for commercial and industrial clients throughout the Southwest. He co-chairs the Arizona Association of Industries' air quality subcommittee, which helps develop state policy for air permitting and legislation, and the Arizona Department of Environmental Quality's water-quality permit project steering committee… **Ken Chandler** has 15 years of experience in systems integration of programmable logic controllers (PLC), supervisory control and data acquisition (SCADA) systems, and process instrumentation. His assignments include designing instrumentation, control, and related

*Continued on page 6*

# Watershed-Based Pollutant Trading — An Idea Whose Time Has Come

**Cynthia Paulson, Ph.D., P.E., has helped implement pollutant trading in Colorado, Idaho, and New York City watersheds. She outlines how to make such programs succeed.**

Pollutant trading was first applied several years ago to help achieve air-quality goals. Recently, communities, industries, and regulatory agencies around the country have shown enthusiasm for watershed-based pollutant trading as an innovative, less expensive way to improve water quality.

Pollutant trading reallocates reduction responsibilities among pollutant sources to meet water-quality goals. As described by the U.S. EPA's 1996 "Draft Framework for Watershed-based Trading," any trading scheme involves at least two entities responsible for pollutant sources. One source must achieve a greater-than-required reduction of a given pollutant, creating a "credit." The credit can be purchased by another source, allowing it to contribute a higher load.

Such a trade can occur between point sources of pollutants (such as wastewater treatment plants), between nonpoint sources (such as producers of agricultural or urban runoff), and between point and nonpoint sources. Generally, an administrative structure is created to oversee the trades within a watershed. Trading programs should last at least five years, with possible renewal for two decades or more.

But even with all the interest and potential cost savings, few trading programs have actually gotten off the ground. Our experience has shown that a few critical elements are required if they are to succeed.

*A sound administrative structure provides the foundation.* The first step to a successful program is an effective administrative structure. It can comprise a single decision-making entity, such as a regulatory agency, or a group of interests, such as a watershed association. Although bringing together diverse interests in a watershed association can be a challenge, this structure can be the most effective, since it engages all potential trading partners. The administrative structure must provide clear rules for trading and decision-making and must be flexible enough to address unforeseen conditions.

*A strong technical basis — often overlooked, but critical.* Many trading programs have an effective administrative structure but have lacked a strong technical basis to demonstrate that water-quality goals are being met. Without this, trading programs will fail. Trades must meet three minimum technical criteria: 1) exceed baseline requirements, 2) be equivalent, and 3) be quantifiable.

To be eligible for credits, pollutant sources achieving reductions must go beyond the minimum requirements of federal, state, or local law (such as state discharge quality permits and/or local storm water quality ordinances). In other words, pollutant reductions can't be counted twice. And regulatory water-quality programs must be in place and effective before pollutant trading credits can be achieved.

Proposed trades must be equivalent, or similar in character, to be technically sound. The pollutant credits being traded must have similar timing characteristics, so that the overall effect on water quality is similar; for example, continuous wastewater discharge is not similar timing-wise to intermittent storm water runoff. Trades also must be equivalent in spatial terms: the same geographic area affected before the trade must be affected after it. In addition, the pollutants being traded must have equivalent physical characteristics, such as chemical form.

Finally, trade credits must be quantifiable. Monitoring data and/or modeling results must be used to demonstrate the effectiveness of the proposed pollutant reduction mechanism. For example, if the proposed credit is being earned by a storm water retention facility, then facility monitoring data could be collected to show removal of the pollutant over the duration of the program.

Because no trade is perfect, "trade ratios" can account for scientific uncertainty and provide a safety margin. A trade ratio specifies how many units of pollutant a source must reduce to provide one unit of credit. Trade ratios typically range from 2:1 to 4:1. A strong technical basis for a program can minimize trade ratios, which makes the trades more cost-effective.

*Program credibility is key to final approval.* Watershed-based trading is still a new concept, so program credibility is crucial. A regulatory agency, possibly considering trading for the first time, may have many questions and concerns. Dischargers proposing a program should work with technical and administrative staff early on, together thinking through potential problems. Some of the most vocal opposition to trading has come from environmental organizations fearing that inadequate programs might fail to achieve water-quality goals. These concerns can be answered by demonstration of a sound administrative structure and a technical approach ensuring compliance with water-quality goals.

When these critical elements are in place, communities, industries, and wastewater treatment plants can implement successful pollutant trading programs — meeting water-quality goals at significantly lower costs.

*For more detail, contact Cynthia (Cindy) Paulson in Denver at (303) 743-5400.*

# On-Time Arrival for SFO's New International Terminal

**Planning, communication, and creative solutions to utility and environmental issues prevent delays to the airport's $2.6 billion expansion.**

More than 40 million passengers move through San Francisco International Airport each year; 51 million per year are expected in the next decade. In 1995, SFO embarked on a major expansion to more than double the size of its international terminal by the year 2000.

But before construction could begin in this ambitious effort to renovate the world's seventh-busiest airport, utility lines had to be relocated and environmental problems needed resolution. Brown and Caldwell, in a joint venture with Bayez & Patel, is construction manager for the temporary and permanent utility relocations and, under a separate contract, provides environmental consulting services for the renovation (see sidebar).

Both projects are critical to keeping the airport expansion on schedule and within budget, says Michael Lane, a project manager for the airport's Bureau of Design and Construction. Any delays could have cost the airport millions.

"We have to relocate utilities before we can begin building anything," Lane explains. "Obviously, a key concern was identifying existing utilities and moving them in a timely manner. The airport had committed to complete its master plan program in May 2000, which meant fast-tracking a lot of construction. That made utility relocation particularly critical and difficult."

Brown and Caldwell managed installation of telephone and 12-kilovolt electrical duct banks in one of the San Francisco International Aiport's main utility corridors as part of a 90-day fast-track relocation. The 52-foot-wide corridor also holds water, gas, sewer, industrial waste, and storm drain lines.

## Utility relocation challenges

The utility relocation work is a series of projects to move water, wastewater, storm water, gas, fuel, telephone, electric, and fiber-optic lines. "Our task is to relocate utilities out of the footprints of eight new facilities, including the new international terminal, so construction can take place, while keeping the airport operational," says Jill Wienbar, Brown and Caldwell/Bayez & Patel construction manager. Among the challenges:

**Coordinating more than a dozen other construction management teams.** Utility relocation involves all areas of the airport, from the terminals to the airfield. Work has to be coordinated with many different construction managers. "If we needed to relocate a telephone duct bank, Brown and Caldwell and the designers had to sit down with a number of teams to find out their needs and then accommodate them into design and construction," says Lane.

**Maintaining nonstop airport operations.** Brown and Caldwell's prime directive is to perform whatever work needs to be done without interrupting the unending flights, passenger flow, or concession operations. It's no easy task. When utilities in the runways and taxiways needed to be moved, Wienbar had to coordinate work with both the Federal Aviation Authority and the airport's air operations manager. She also works with the airport's maintenance and engineering groups to identify what systems need to be shut down, identify what areas those systems feed, and provide backup solutions to keep as many facilities as possible in operation 24 hours a day.

A jacking pit for boring an 84-inch-diameter reinforced concrete pipe casing under busy Highway 101. The pipe will house new water mains, electrical cables, and fiber optic cables. The work required continuous monitoring and surveying of settlement, along with close coordination with various agencies because it was done on restricted airport property surrounded by a state-regulated endangered species habitat.

**Managing uncertainty.** One of the biggest challenges is the lack of documentation identifying where utility lines run. "A lot of lines have been there 50 years, and a lot of others were put in by tenants," says Wienbar. "When you dig things up, they aren't always what you expect." She developed relationships with key personnel who had been at the airport for 20 or 30 years to help learn where the lines ran. But often, the only way to know for sure was to go out into the field and look for herself.

**Scheduling precisely.** Because of tight timing, work often has to be done around the clock. "In the early phases, I would get calls on the weekend a lot, which usually meant I needed to reach someone at Brown and Caldwell to handle things," recalls Lane. "I could always get hold of someone from the company to come out to the airport at any time." The team worked around the clock during one three-month period, when four of the airport's six major utility corridors were being installed. The tight schedule included heavy penalties for not making a milestone. "If we didn't meet those milestones, follow-on work by other contractors couldn't start on time and the project would have been delayed," notes Wienbar. All milestones were reached on or ahead of schedule.

### Handling the issues with many firms

Planning and communication have been essential to this project, where work by competitors often overlaps. Wienbar applies diplomacy, tact, and a consummate understanding of project goals to make sure every team gets what it needs to do the job right, says Brown and Caldwell regional construction manager Denis O'Malley. "She has had to act as facilitator to coordinate contractors we manage, plus other construction managers, airport operations staff, tenants, Pacific Gas & Electric, Pacific Bell, and others. She worked the first two years on a 24-hour on-call basis. I don't think anybody initially understood the extent of coordination that was needed out here, and she did it." He adds: "She understands the importance of frank and candid discussion of issues. She deals with people honestly and fairly — and keeps the client's needs paramount."

Says Lane, "Over the past three years, Jill and her team have managed, on a day-to-day level, design and construction of almost $100 million in utility relocation. Today we're finalizing the last major contract, and there have been no claims, we're under budget, and we met the needs of the master plan."

*Contact Brown and Caldwell/Bayez & Patel construction manager Jill Wienbar at (650) 635-5970 for more information on the utility relocation project for the San Francisco International Airport expansion program. Contact Houshang Esmaili at (650) 876-8026 for more information about the environmental services.*

## ENVIRONMENTAL SOLUTIONS SAVE MILLIONS

"Most new buildings at the airport are constructed in contaminated areas," says Houshang Esmaili, Dr. Eng., Brown and Caldwell's project manager for environmental services at the San Francisco International Airport. "In most cases, you have to remediate before anyone can build, and you have to do that without affecting construction schedules.

"Every day of delay could cost the airport millions of dollars."

In large-scale projects like this one, encountering unexpected hazardous waste can mean delays of months, a year, or even more. Remarkably, no such delays have occurred — not only because of previous characterization and remediation, but because of a wise approach to unexpected problems.

Brown and Caldwell has been performing environmental characterization and cleanup services at the airport since 1997. Before that, Esmaili's team reviewed the work of other environmental consultants and served as senior technical consultant, proposing the innovative program that has helped keep work on schedule. The firm recommended making each of the project's general contractors (GCs) responsible for cleaning up contamination they might encounter. "So the airport included remediation specs in all construction contracts so that no contractor could stop work for reasons of contamination," explains Esmaili. "If contamination is encountered, the GC becomes a hazardous waste remediation contractor and must bring in its hazardous waste team. There is no stoppage of work and no delay of schedule.

"At the same time, we helped the airport retain on-call remediation contractors, who are available on short notice, at the airport's discretion, to handle unanticipated hazardous materials. The combination of these two approaches resulted in zero delays."

Also, Brown and Caldwell helped save the airport millions of dollars in remediation costs by identifying the least costly remediation and disposal methods, and by making sure the airport received favorable terms when disposing of contaminated materials. For instance, the team determined that the airport could treat most of its contaminated groundwater at its onsite industrial waste treatment facility instead of leasing costly treatment equipment. Another example: When a contractor needed to dispose of 50,000 cubic yards of excavated bay mud from a construction site, Brown and Caldwell located a nearby municipal landfill that would take it free of charge, saving the airport approximately $500,000.

# The DNAPL Tracer Test Delineates A Troublesome Contaminant

**Using in-house computer models, Eckenfelder/Brown and Caldwell shows that a new method for delineating dense, nonaqueous-phase liquids can be effective at a reasonable cost.**

Remediation of aquifers contaminated by dense, nonaqueous-phase liquids (DNAPLs) — which include many solvents and other chemicals used in manufacturing — is one of the most vexing problems of site owners. Until recently, feasible methods to show where DNAPL is and how much is present have been elusive. But now, a team from Eckenfelder/Brown and Caldwell's (E/BC) Nashville office — chemist Dave Wilson and hydrogeologists Ron Burt, Greg Christians, and Sam Williams — has shown that DNAPL can be cost-effectively delineated with a technique called the tracer test, supported by one- and two-dimensional computer modeling programs developed at E/BC.

## Ubiquitous, but hard to find

DNAPLs include such commonly found chemicals as trichloroethene (TCE), carbon tetrachloride (CT), and tetrachloroethene (PCE). Denser than water, these liquids migrate downward through soil and aquifers, leaving a trail of residual droplets and collecting in pools or seeping into fractures at the permeable unit base. Once in an aquifer, accumulated DNAPL slowly dissolves into groundwater flowing past it. "The immobilized DNAPL can be a source of continuous impact to groundwater for the hundreds of years until it dissolves away," says Burt.

By the early 80s, it was understood that these dissolved chemicals were greatly affecting groundwater, but it took several years for DNAPL to be recognized as a common *source* of the impacts. And along with this recognition came the discovery that DNAPL was extremely difficult to delineate and remove.

Two removal techniques, though, have shown promise: solvent flushing and surfactant flushing. Both help DNAPL dissolve, and the surfactant method helps DNAPL mobilize from the aquifer. The hitch is that these promising methods require direct delivery of treatment to all portions of the aquifer containing DNAPL, because any DNAPL missed could dissolve to unacceptable levels after site closure. Yet no cost-effective method for delineation so far has existed. Geophysical techniques have not been useful except under ideal conditions. Hydrophobic dyes give information only about material sampled from a borehole. The use of threshold aqueous concentrations measured in groundwater or soil samples as a marker for DNAPL can be unreliable because of unknown components in the nonaqueous phase, and because, for soil samples, it gives information only about material from the borehole.

## Overcoming hitches: the tracer test

The DNAPL tracer test overcomes these problems. Its method is based on oil-field techniques that have been around since 1971 but were applied to DNAPL assessment only in 1994. University research groups used complex two- and three-dimensional computer simulations to evaluate the method.

E/BC incorporated the previous research results, but employed a practical methodology and simpler computer models developed in-house — with no loss in accuracy. E/BC remains one of the very few companies experienced in the test's application.

The test works this way: Injection wells are placed on one side of the aquifer test domain and recovery wells on the opposite side. A slug of dilute solutions of at least two different alcohols is injected into the aquifer. One alcohol partitions between the water and the DNAPL (typically, an alcohol of intermediate chain length, such as butanol, pentanol, or octanol) and the other does not (a nonpartitioning, nonadsorbing tracer such as isopropyl alcohol). As the alcohols are transported through the aquifer, the partitioning tracer is retarded by any DNAPL present, because only a fraction of this tracer remains in the mobile aqueous phase; the rest of the tracer is trapped for a time in the immobile droplets of DNAPL. Water samples are taken regularly from the recovery wells and analyzed for both tracers. The transit times of the partitioning and nonpartitioning tracers are recorded, and tracer concentration is plotted against time. If no DNAPL is present, the mean transit times of the two tracers will be identical, as will be the plots of tracer concentration versus time. If DNAPL is present, the plots will differ. The plots are compared to computer simulations for estimation of the *quantity* of DNAPL contained in the aquifer test domain.

One advantage of the test is that it's environmentally benign: It doesn't cause the uncontrolled mobilization of the target compounds, and the tracers are relatively nontoxic and readily biodegraded.

The test has limitations. Although it sensitively reveals DNAPL, it delivers more qualitative than quantitative estimates of the amount present because of non-ideal conditions in the subsurface. In addition, it may not detect pooled DNAPL, because of the smaller surface area that accumulations expose to the passing tracer. If results are viewed as lower bound estimates, however, the test enables more effective remediation of DNAPL than ever before.

## Cost-effective computer modeling

What makes the E/BC's tracer test not only effective, but cost-effective? The one- and two-dimensional computer modeling, using programs written by Wilson. While previous investigators relied on expensive supercomputers to do complex three-dimensional simulations, Wilson uses a desk-top personal computer to simulate the complex interactions of the alcohols, DNAPL, and groundwater flow.

"The three-dimensional models can more rigorously simulate the system," says Wilson. "Unfortunately, it's impractical to collect sufficiently detailed data on an aquifer to justify their expense."

Also, Wilson made two significant innovations over earlier models: 1) His models account for the kinetics of diffusion of partitioning tracers into and from the droplets of DNAPL and 2) they account for porous clay lenses of low permeability, into and from which tracers may diffuse.

## Application at a Texas Air Force facility

At Air Force Plant 4, a government-owned, contractor-operated facility near the Fort Worth, Texas, Naval Air Station, portions of a shallow alluvial aquifer are contaminated with DNAPL. A remedial investigation had identified an extensive plume of TCE and other volatile organic compounds in the groundwater. The U.S. EPA in 1996 specified that the remedy for this area include DNAPL removal and groundwater extraction.

Jacobs Engineering Group was contracted to remediate the site under the auspices of the Air Force Center for Environmental Excellence, Brooks Air Force Base, Texas. Jacobs subcontracted with Eckenfelder to perform tracer tests, to evaluate the extent of DNAPL migration along a paleochannel in the bedrock surface underlying the aquifer. E/BC's Nashville team performed the tests at two locations, in May through July 1998.

E/BC set operating parameters using laboratory tests, computer modeling, and field tests. In the lab, bench-scale columns of aquifer materials, collected from borings, were tested under varied flow rates. The one-dimensional model then was tested to check if it could simulate the bench-scale tests. Next, the two-dimensional model — similar to the one-dimensional model, but incorporating known and estimated characteristics of the aquifer and suspected DNAPL, and using varied assumptions about DNAPL concentrations, distributions, and accessibility — helped establish reasonable operating parameters, such as flow rates and injection times. Finally, sodium chloride was injected and recovered at the site as a conservative tracer to confirm the advection rate and establish sampling intervals.

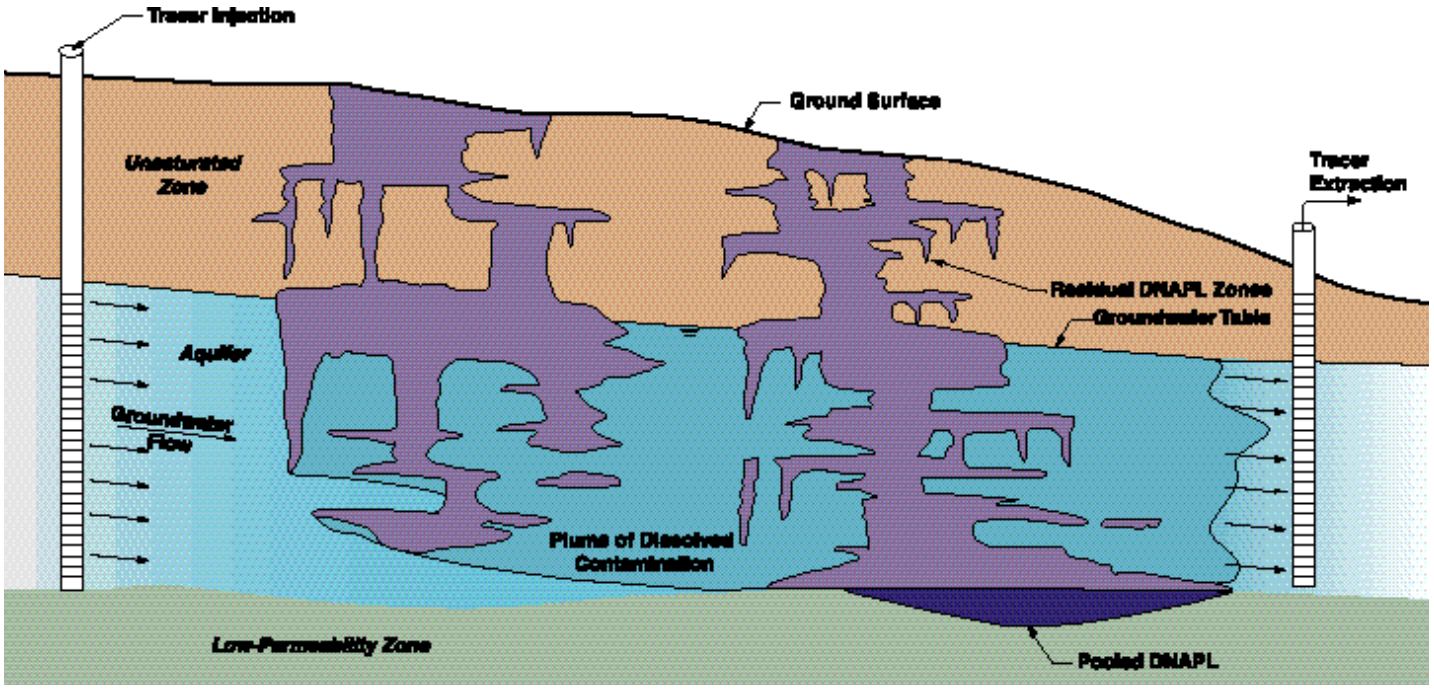
In the actual tests, tap water was injected into the three-injection-well array as groundwater was extracted from the three recovery wells. Once steady-state flow had been achieved, a volume of three selected tracers (two partitioning and one nonpartitioning) was fed into the injection wells. Christians and Williams monitored the system and periodically sampled the tracers around the clock at the extraction wells.

"One of the highlights of the Air Force Plant 4 tests," says Burt, "is that the partitioning of the tracers turned out to be severely limited by diffusion rates. Dave's model can account for that. The other models won't."

## Meaningful results

The tracer tests cost-effectively revealed DNAPL's presence at both locations and confirmed that it has migrated along the paleochannel. Although the estimated DNAPL masses must be viewed as lower bounds, and further delineation using more tracer tests must be done, the results about DNAPL distribution and quantity allowed Jacobs and the Air Force to target their remediation efforts.

*Contact Ron Burt in Nashville at (615) 255-2288 for more information about the DNAPL tracer test.*




In a subsurface, porous medium, DNAPL moves downward in response to gravity and spreads laterally, where it meets resistance at zones of lower permeability. The illustration shows DNAPL tracers injected into the aquifer from a well upgradient of the contamination and retrieved for evaluation from a downgradient well.

# Quarternotes

## Joining Brown and Caldwell…(continued)

electrical systems and programming PLC- and PC-based operator-interface systems.

*In Florida:* **Curtis Kunihiro, P.E.,** is the new manager of the Orlando office. For more than 20 years, he has performed process and design engineering for municipal and industrial wastewater treatment facilities, reclaimed water facilities, and biosolids dewatering and composting projects. He is responsible for projects and business development in central Florida…Based in the Miami office, project manager **Hank Ouimet** is expanding the company's design-build work in the Southeast. Ouimet has more than 10 years of engineering, construction, and design/build experience, including solid waste landfill development and closure, underground utility installation, environmental remediation, and environmental risk management.

## New Company Officers from Eckenfelder

The integration of Eckenfelder and Brown and Caldwell has yielded seven new senior officers, each with decades of expertise that is being applied to projects throughout the company.

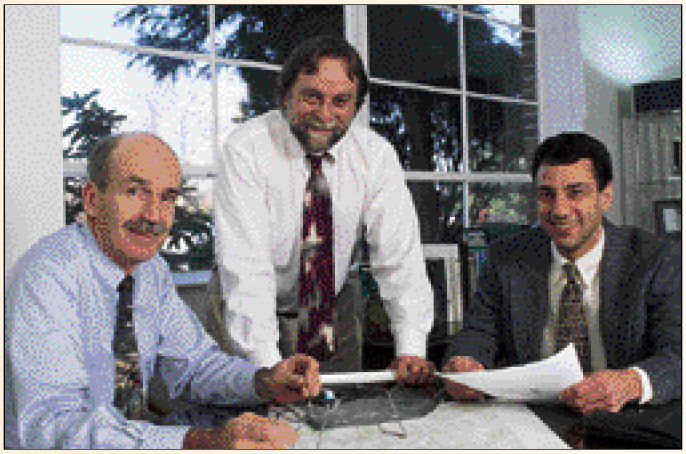
**James H. Clarke, Ph.D., senior vice president,** has more than 25 years of experience in environmental chemistry, specializing in the fate and transport of chemicals and environmental forensics. His work ranges from designing data-acquisition programs for risk evaluation to developing innovative remediation technologies. He has served as an expert witness and a consultant in a number of environmental litigation cases. Clarke is an adjunct professor at Vanderbilt University and a member of the National Academy of Science Committee on Remediation of Buried and Tank Wastes for the Department of Energy.

**Jeffrey Pintenich, P.E., vice president,** specializes in the reclamation of contaminated land, brownfields, and environmental due diligence involving industrial facilities. His 25-year career includes environmental site assessments and compliance audits of more than 100 facilities. Pintenich also has investigated soil, groundwater, surface water, sediment, waste, and air quality at sites; identified and applied reclamation technologies; and designed a variety of cleanup methods. He is the co-author of three reference textbooks.

**D. Rick Davis** is a Brown and Caldwell **vice president** as well as director of the Nashville-based Eckenfelder Laboratory, LLC, now a wholly owned affiliate of Brown and Caldwell. Davis has been associated with the widely respected lab for more than 20 years, and has lectured nationwide on the practical applications of laboratory data. Partly because of its small size — Eckenfelder Laboratory has a staff of less than 30 — it provides unusually responsive service. The lab counts as its clients many Fortune 100 companies and retains customers even after a particular consulting project is over.

**Vice President Celeste Patterson, CPA,** has more than 16 years of experience with accounting, information systems, contracts, and administration. In more than 10 years with Eckenfelder, she oversaw accounting practices including financial statement preparation, tax reporting, division planning, policy implementation, and administering external financial affairs. She now oversees accounting and administrative activities for the newly integrated nine-office Eastern region.

Rick Davis, Celeste Patterson, James Clarke, and Jeffrey Pintenich in Nashville



Robert Mutch, Michael Brother, and Gary DiPippo in Mahwah, N.J.

**Senior Vice President Robert D. Mutch, Jr., P.Hg., P.E.,** has more than 26 years of experience in hydrogeology, solid waste management, and remediation of waste disposal sites. Mutch is experienced in the computer modeling of groundwater flow and contaminant transport and the design of remediation measures at Superfund, RCRA, and other waste disposal sites. Registered as both a professional hydrogeologist and professional engineer, Mutch often serves as an expert witness for cases involving environmental liabilities. He is an adjunct professor of hydrogeology at Manhattan College.

With over 25 years of experience, **Vice President Gary J. DiPippo, P.E.,** specializes in solid waste management and industrial site remediation with an emphasis on the practical, cost-effective application of new technologies, including geosynthetics, landfill liners, and groundwater extraction and treatment. He works closely with industrial clients, primarily potentially responsible party (PRP) groups, to develop creative approaches to site remediation. He has served as an instructor for the Center for Professional Advancement.

**Michael Brother, CGWP, vice president,** has performed and overseen hydrogeologic investigations of many of the nation's hazardous and solid waste management and disposal facilities, including the world's largest landfill and many industrial sites. With more than 18 years of experience, Brother is an expert in the emerging area of "industrial paleontology," a term he helped coin. He has provided expert testimony and litigation support for cases involving environmental insurance coverage and cost allocation and recovery. He serves as an instructor for the Center for Professional Advancement.

## Arizona Cleanup and Closure Firsts

Brown and Caldwell has achieved environmental firsts for three sites involving leaking underground storage tanks (USTs) in Arizona, where regulatory case closure is especially tough to accomplish. The company's Phoenix team demonstrated that contaminated groundwater had been cleaned up using natural attenuation; obtained regulatory signoff of a gasoline-impacted site without remediation; and implemented a soil excavation method for the first time in the state, cutting significant costs.

### *New Methods Clean Up Industrial Manufacturing Site*

Because Arizona's limited water supply makes any aquifer a potential source of drinking water, fewer than 5 percent of sites in the state with contaminated groundwater have achieved regulatory case closure. Geologist **Jim Clarke** and his UST remediation team recently gained closure of one of these — and it was the first in which monitored natural attenuation was used to demonstrate that remediation had been completed.

Soil and groundwater at an industrial manufacturer's warehouse site in Phoenix was impacted by gasoline from a leaking UST. Brown and Caldwell's groundwater investigation also showed that an off-site plume of perchloroethene was crossing the property. The manufacturer wanted to vacate the site, but it couldn't break its lease until the regulatory case was closed.

In late 1994, Brown and Caldwell began a soil and groundwater remediation program that involved air sparging and soil-vapor extraction. The air-sparging system — one of the first to be installed in the state — was designed by project manager Jim Clarke and project engineer **Dan Ayers** and installed by field technician **Steve Zambroski**. The system blew air into the ground, which caused the gasoline to be volatilized and captured by the soil-vapor extraction system. Air sparging also enhanced biodegradation by feeding oxygen to naturally occurring bacteria, which destroyed hydrocarbons in the groundwater. When benzene concentrations in the groundwater dropped below Arizona's mandated cleanup level after a year, the system was shut down, and a state-required post-remediation groundwater monitoring program began. As is typical with active gasoline-remediation systems, benzene concentrations rebounded to slightly above cleanup level within three months of system shutdown.

First-in-the-state use of a large-diameter flight auger to excavate contaminated soils at a former gasoline station saved time and money, allowing rapid regulatory case closure and sale of the property.

The typical response would have been to reinitiate the same remediation system. But Clarke and Zambroski proposed to monitor natural biodegradation of the remaining gasoline in the groundwater, since they already had fostered this process with air sparging. The initial data indicated that the bacteria in the soil were actively degrading the remaining gasoline. The next two groundwater monitoring events, over about nine months, showed that biologic activity had completed remediation and gasoline contamination had been completely removed. The Arizona Department of Environmental Quality (ADEQ) signed off on the site in February 1998.

Whereas natural biodegradation alone would have taken two decades or more, the first-time combination of air sparging, soil-vapor extraction, and monitoring of natural attenuation accomplished cleanup in less than a few years — at approximately one third the cost of a typical groundwater-remediation in Arizona.

### *Assessing Practical Impacts at a City Maintenance Yard*

In another rarity for the state, Brown and Caldwell gained a site's closure without characterization. In 1997, City of Page workers removing an old UST from a maintenance yard discovered that the soil below it was minimally impacted by gasoline. ADEQ called for full characterization of the site and possible remediation.

But Jim Clarke's data review indicated that this wasn't necessary. He argued that the site's shallow bedrock and deep groundwater meant not only that soil samples couldn't be collected, but that the groundwater wouldn't be impacted. He also argued that exposure risks at this city yard were minimal. With a single letter, he won approval of case closure for the as-is site, saving the City of Page thousands of dollars in characterization and remediation costs.

### *A Different Digging Method Saves Money*

The first-in-the-state solution employed by Brown and Caldwell at a former Unocal site was a technical and logistical one. A historic gasoline release had been discovered following demolition of a bank branch that had been built on the site. A Phase 2 environmental site assessment performed by another consultant for a fast-food chain had found gasoline-impacted soils. A 1995 investigation by Brown and Caldwell for Unocal confirmed these findings, and the ADEQ required characterization and remediation. The fast-food chain, which was in the process of purchasing the site, wanted rapid closure. But the soil conditions prevented remediation using conventional techniques such as soil-vapor extraction.

The solution: employing a large-diameter flight-auger method to excavate and characterize the impacted soils. As far as Clarke and project geologist **Eric Mears** know, this system had never before been used in Arizona. The team drilled four 8-foot-diameter holes to depths of 100 feet in less than a week — compared to the 20 4-foot-diameter, 30-foot-deep holes that would have had to have been drilled over three weeks if more conventional bucket-auger methods had been used. Though the system was expensive, the method reduced the quantity of soil excavated, thus reducing soil treatment and disposal, and overall project costs. The impacted soils were fully characterized and removed, and the case was closed by ADEQ three months later.

## Watershed Regulatory Watch

The federal EPA recently took action to address three major water-quality issues: ammonia, nutrients, and whole effluent toxicity. Municipal and industrial wastewater dischargers may be affected. Below is a summary of each of these regulatory changes and how to respond.

### Ambient Water-Quality Criteria for Ammonia

On August 18, 1998, the EPA cited in the Federal Register that it had made available an update of its 1984 "Ambient Water Quality Criteria for Ammonia." Key modifications are summarized below:

- Criteria for acute and chronic conditions for ammonia in receiving water are now expressed as total ammonia versus un-ionized ammonia.
- The definition of acute conditions has changed, in that the relationship between pH and temperature has been revised.
- Chronic conditions are now defined based on chronic toxicity data rather than an acute-to-chronic ratio.
- The criteria for chronic conditions are the same whether or not salmonids are present.
- The averaging period for definition of chronic conditions was increased from 4 days to 30 days.
- Chronic criteria are no longer adjusted for temperature, but only for pH.
- Under winter or cold weather conditions, the criteria for ammonia concentrations in receiving water may be increased by as much as three times on a site-specific basis if sensitive species in early life stages are not present.

#### *How to Respond*

The revised criteria may be more restrictive under certain conditions and less restrictive under cold weather conditions. Municipalities and industries discharging ammonia to surface waters may need to conduct site-specific studies to more accurately characterize receiving water and determine which criteria apply.

### National Strategy for the Development of Regional Nutrient Criteria

The EPA has identified nutrients as second only to siltation as the source of impairment to streams and rivers. The agency released a new document, a key part of the Clean Water Action Plan, in June 1998, outlining its national strategy to reduce nutrient overenrichment of waters. Here are highlights:

Members of the City of Lincoln, Neb., water-quality studies team, which included Brown and Caldwell staff, conduct a chemical and biological assessment of a receiving water. Similar assessments may be part of wastewater dischargers' responses to recent federal regulatory changes regarding ammonia, nutrients, and whole effluent toxicity tests.

- Add nutrients to water-quality standards.
- Focus on regions and water bodies, and tailor criteria to different geographical areas.
- Develop criteria for: 1) streams, rivers, and reservoirs; 2) estuaries and coastal marine environments; and 3) wetlands.
- Form national and regional teams of state and tribal representatives to help develop the criteria.
- Focus on nitrogen, phosphorus, chlorophyll *a*, Secchi depth, and algal biomass.

#### *How to Respond*

The EPA expects states and tribes to adopt the criteria developed for the various water body types within three years after the EPA completes Guidance Documents, or by the end of 2003. To participate in this process, treatment facility managers and governing boards may want to:
1) Become active in the development of your state's criteria.
2) Characterize site-specific receiving water conditions as they relate to nutrients.
3) Assess the ability of your treatment facility to remove nutrients.
4) Consider how your existing treatment process can be optimized.

### Studies to Quantify Variability in Whole Effluent Toxicity (WET) Tests

The EPA recently completed a settlement agreement with the Western Coalition of Arid States (WESTCAS) over the issue of WET testing variability. The dispute arose because WET tests, which characterize overall effluent toxicity, have been criticized for their potential to generate false positive results that indicate an effluent is more toxic than it actually is. The settlement terms include the EPA's agreement to perform a series of multi-laboratory studies to quantify variability in WET tests and make new rules about test methods. This work by the EPA will be conducted in 1999. The draft policy will attempt to promote consistency among states in determining when WET limits should be included in National Permit Discharge Elimination (NPDES) permits.

The new EPA rules may recommend that greater confidence-intervals be allowed in test results for receiving waters with little or no dilution and for sublethal endpoint measurements (regarding the growth and reproduction of test species). The new rules also may mandate that a demonstrable dose-response relationship be present before a toxicity test is determined to fail, and they may allow adjustments to the test for hardness, ionic strength, and pH shift or shock during testing.

#### *How to Respond*

Current EPA WET test methods will remain valid while the agency completes the studies and new rules. Meanwhile, dischargers should ensure that WET tests are conducted under acceptable conditions by a reputable laboratory. If a test fails, dischargers can take various actions short of an extensive toxicity identification evaluation (TIE) or reduction evaluation (TRE). These could include: 1) thoroughly reviewing test results; 2) rerunning the test; 3) performing a limited study to characterize effluent.

*Contact Bret Linenfelser in Denver at (303) 743-5442, for more information. Linenfelser also can provide regular updates about future changes to watershed regulations and their effects on dischargers.*

# Don't Forget Technology…or the Technologist

Project delivery systems, contract outsourcing, risk-based compliance, and "managed" solutions are grabbing headlines these days — and for good reason, as they are bringing newfound value to the environmental industry.

In the surge of all these exciting strategies, however, technology (and the technologist) steadily marches on, providing what's still intensely sought after — groundbreakingly efficient, long-term solutions. *Delivering* solutions must start with *developing and applying the right ones.*

The solutions that last, and yield a whole new way to see and solve problems, are technological.

Because environmental technology is a critical part of our business of delivering client success, we work at it — searching for breakthroughs and innovations, developing, pushing, and applying technology to achieve environmental results in ways that are faster, smaller, cheaper, and better.

Technology doesn't mean impracticality. On the contrary, great new technology creatively unites science and practical application. The results of Brown and Caldwell's new technologies are tangibly successful, yielding tremendous value to our customers in both money and time. Here are *five* recent examples.

**Class A biosolids are produced more simply and cheaply.** Brown and Caldwell's changes to tank geometry, cover design, and mixing systems have yielded significant advancements to anaerobic digestion technology. Now operating at full-scale, these innovations to an age-old process have made thermophilic digestion more practical. The net result is a Class A biosolids product at less cost produced with conventional equipment. Moreover, this new technology has excellent retrofit capability.


Craig Goehring

**Particle dynamics and hydrodynamics save big capital dollars.** Our understanding of the two key elements affecting clarifier design — wastewater constituents and their medium — is precise. Therefore, we know how to diagnose particle dynamics *and* hydrodynamics accurately and how to prescribe the right solutions. Our proven breakthroughs in clarification technology could void new construction of secondary clarifiers in the U.S. for the next 10 years. That's the most economical delivery system you can have: no new clarifier construction. Our customers will attest to the performance reliability of these units, at significantly higher capacities.

**Selector flavor is the difference.** Selector technology — the mechanism for selecting the correct microorganism for actual waste conditions — in activated sludge treatment systems is not new. For the first time, however, Brown and Caldwell is demonstrating that resourceful application of this technology makes the difference. By choosing the right selectors, and then optimizing the support systems, we have been achieving consistent sludge settlement and more reliable treatment operations in smaller or fewer tanks. In other words, capacity is gained on the same plant footprint. (The key isn't the right selector; it's the right technologist.)

**Exploratory boring and testing bring higher yield.** Innovations in drilling exploratory soil borings and testing the subsurface have produced more-efficient and lower-cost ways to obtain key geologic and hydrologic information. Through inventive application of oil industry practices, our technologists are using inflatable packers in small-diameter borings, along with novel procedures, to conduct slug testing and depth-specific groundwater sampling at discrete levels. This technology is reducing risk and lowering cost for new water production and groundwater recharge wells.

**DNAPL tracer test — a testament to the technologist.** As you know if you've read the feature story on page 4, breakthrough modeling has moved complex and expensive testing of a hard-to-characterize contaminant from a supercomputer to a laptop — saving time and money, and delivering meaningful results.

The brilliance and passion of many people at Brown and Caldwell have produced these technological advances. The advances themselves produce something more: big economies for our clients.

— *Craig Goehring, P.E., CEO*

## Moving Up

**Vice President Steve Krugel, P.E.,** a 21-year Brown and Caldwell veteran, was appointed business unit manager of the company's Northwest region. Krugel led the recent upgrade and expansion of the Annacis and Lulu Island wastewater treatment facilities in Vancouver, British Columbia (*Quarterly* Summer 1998), for which Brown and Caldwell designed the first thermophilic digesters in North America. In addition to overseeing the region's six offices, Krugel is managing a new $30 million project to plan and design a temperature-phased anaerobic digestion system for the City of Duluth, Minn. Krugel holds a master's degree in environmental engineering from the University of California at Berkeley.


Steve Krugel

**Lloyd Slezak, P.E.,** has been named a vice president and manager of the Vancouver office. During his seven years with Brown and Caldwell, Slezak has held increasingly responsible roles in the Vancouver wastewater program expansion, leading design of the new cogeneration facilities and other major contracts as well as design engineering services during construction and startup of the entire project. As technical coordinator for ABR Consultants, Brown and Caldwell's joint venture partner for the Greater Vancouver Regional District, Slezak now oversees design managers of numerous ongoing projects. Slezak has a master's degree in civil and environmental engineering from Utah State University.


Lloyd Slezak


Eric Wahlberg

**Eric Wahlberg, Ph.D., P.E.,** was promoted to vice president and charged with orchestrating the company's process optimization services. A former wastewater treatment plant operator in Colorado, Wahlberg has a longstanding resolve to put research and science into the hands of plant practitioners. His work as an operator was followed by graduate studies at Clemson University, S.C., where he received a master's degree and a doctorate in environmental systems engineering. In his four years with Brown and Caldwell, Wahlberg has provided process optimization services for many public and private clients across the country. He was awarded the 1997 George Bradley Gascoigne Medal and 1995 Harrison Prescott Eddy medal from the Water Environment Federation.

## TECHNICAL PAPERS

The technical papers listed below are available to readers. For copies, please write, call, or e-mail Andrea Atkins, Brown and Caldwell, 3480 Buskirk Avenue, Pleasant Hill, Calif., 94523, (510) 210-2464, aatkins@brwncald.com, or access them via our web site at www.brownandcaldwell.com.

SCHNEIDER, Doug L., et al.
"Design Considerations for Reliable Operation of Enclosed, Low-Emission Waste Gas Burners for Digester Gas" No. 687

MELCER, Henryk, et al.
"Evaluation of the U.S. EPA Recommended Approach to Predicting Air Emissions from Pulp and Paper Industry Landfills" No. 688

MELCER, Henryk, et al.
"Techniques for Modeling Hazardous Air Pollutant Emissions from Landfills" No. 689

WILSON, Steve, et al.
"Quality Assurance Evaluations for Biosolids Management Programs: An NBMA Pilot Project" No. 690

MELCER, Henryk, et al.
"Full-Scale Experience with Biological Process Models — Calibration Issues" No. 691

MELCER, Henryk, et al.
"Modeling of Storm Water Flow Impacts on Treatment Plant Performance and Load Sharing Between Neighboring Plants" No. 692

SCHAFER, Perry L., et al.
"Defining Critical Process Elements to Achieve Economical Class A Biosolids through High-Temperature Anaerobic Digestion Systems" No. 693

WILLIAMS, David B., et al.
"Benchmarking at the Miami-Dade Water and Sewer Department to Achieve Competitive Utility Performance" No. 694

SALO, John E., et al.
"Achieving Cost Savings for Atlanta's Water and Wastewater Systems through Contract Management and Re-Engineering" No. 695

JACOBS, Tom, et al.
"Consolidation of Biosolids Facilities at Wichita" No. 696

PARKER, Denny S., et al.
"The Great Secondary Clarifier Debate: I. Surface Overflow Rate Is Not an Appropriate Design Criterion for Dimensioning Secondary Clarifiers" No. 697

PARKER, Denny S., et al.
"The Great Secondary Clarifier Debate: II. Secondary Clarifiers Should Not Be Used for Sludge Storage" No. 698

WAHLBERG, Eric. J., et al.
"A Whole Plant Approach to Evaluating Activated Sludge Treatment Plant Capacity" No. 699

CRITES, Ronald W., et al.
"Costs of Constructed Wetlands Systems" No. 700

HOPKINS, W. Alan, et al.
"Interaction of Fuel Hydrocarbons and Chlorinated Solvents at an Aviation Maintenance Facility" No. 701

PARKER, Denny S., et al.
"Full-Scale Evaluation of Factors Affecting the Performance of Anoxic Selectors" No. 702

### New Wetlands and Bioremediation Books

New from McGraw-Hill, "Small and Decentralized Wastewater Management Systems," offers comprehensive information on the design of alternative collection systems, covering the conventional as well as the innovative for smaller treatment plants and individual decentralized systems. Brown and Caldwell wetlands engineer Ron Crites, P.E., co-authored the book with University of California, Davis, professor George Tchobanoglous. To order, call (800) 262-4729 or go online to www.amazon.com.

"Bioremediation" is the latest volume published by the American Academy of Environmental Engineers (AAEE) on innovative site remediation and technology. Robert D. Norris, Ph.D., of the Nashville office, is one of its principal authors. The book provides the basis for evaluation of several bioremediation technologies, and design basics and case histories for each. You can order it from the AAEE bookstore at (410) 266-3390 (phone) or (410) 266-7653 (fax), or via email to aaee@ea.net.

BROWN AND CALDWELL

P.O. Box 8045
Walnut Creek, CA 94596-1220

**ADDRESS CORRECTION REQUESTED**

BULK
RATE
U.S. POSTAGE
PAID
PERMIT NO. 11882
SAN FRANCISCO, CA