

HYDRO VISIONS

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Perchlorate 2006: Progress Toward Understanding and Cleanup

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Eight years have passed since the perchlorate detection level dropped to single digits, and a great deal has been learned about perchlorate in that time. Does the term 'emerging contaminant' still apply? The 200 attendees from across the country at GRA's fourth conference focusing on perchlorate showed that plenty of GRA's members continue to center their attention on perchlorate, even as it is increasingly found to be ubiquitous in the environment. This year, several additional sources of perchlorate were found; any lingering doubt regarding the contribution of natural sources to low-level concentrations in soil and groundwater, particularly in arid regions, appears to be quickly dissipating.



The Perchlorate 2006 Event Committee

Regardless of the source, human health risk associated with low concentrations of perchlorate continues to be evaluated. California's regulatory guidelines fluctuated from a DHS 18 µg/L Action Level in 1997 to 4 µg/L in 2002, following release of U.S. EPA's revised reference dose (RfD). A Public Health Goal of 6 µg/L was set by OEHHA in March 2004, and DHS reset the Action Level (now called a Notification Level) to the 6 µg/L PHG value. Presently, the Department of Finance is reviewing economic impacts of MCL proposals at different concentrations; DHS is expected to produce a draft MCL in 2006.

On the day of GRA's Perchlorate 2006 Symposium, EPA promulgated a preliminary remediation goal (PRG) of 24.5

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µg/L; the press release coincided with the last hours of the conference. Although the regulatory moving target is a reflection of improved understanding of how perchlorate may affect human health, it has nonetheless fueled confusion and even suspicion within the public community. Public confusion is particularly vivid when presented with the disparity between the State of Massachusetts proposed MCL of only 2 µg/L juxtaposed against the Department of Defense's proposed cleanup level of 200 µg/L.

Health Implications and Recent Developments

GRA President Thomas Mohr opened the conference by noting the increasingly common occurrence of perchlorate in the environment and new epidemiological

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The Groundwater Resources Association of California is dedicated to resource management that protects and improves groundwater through education and technical leadership.



President's Message

BY THOMAS K.G. MOHR

Welcome to the Anthropocene!

It's time to reset your watches and clocks: we've entered a new geologic epoch. The short, post-glacial Holocene epoch has come to its end. The end of an epoch is usually delineated by major, catastrophic geologic change, terminating species or depositing distinct assemblages of sediments, often due to a change in earth's climate or cataclysmic events. In the last few centuries, the effects of man's activity on the surface of the earth have become dominant, and now outpace geologic forces. Nobel Prize winner Dr. Paul J. Crutzen of Germany's Max-Planck-Institute for Chemistry issued the definitive declaration that the Anthropocene began in 1784, with Watt's invention of the steam engine. Dr. Crutzen's article is on the web at www.mpch-mainz.mpg.de/~air/anthropocene.Text.html. In this column, I will paraphrase a few of his points and their relevance to California's groundwater.

The phenomenal growth in human population, ten-fold in 300 years, and the associated increase in man's exploitation of earth's resources, have permanently impacted the earth's surface and hydrosphere. Grazing, urbanization, and extraction and combustion of fossil fuels have dramatically changed runoff, microclimates and global climate, and earth's atmospheric chemistry. Global release of SO_2 from burning coal and oil is twice the sum of all natural emissions. Climatically important 'greenhouse' gases have substantially increased in the atmosphere: CO_2 by more than 30%; and

CH_4 by more than 100%. Atmospheric release of NO from anthropogenic emissions is larger than natural inputs, forming photochemical ozone ('smog') in many regions of the world. More nitrogen is now fixed synthetically and applied as fertilizers in agriculture than fixed naturally in all terrestrial ecosystems. Man's synthesis and discharge of toxic substances has left detectable residues in all environmental media. Flame retardants in polar bear fat and chlorinated solvents in air atop the Andes are examples of the global reach of pollution. CFC emissions have led to the formation of the Antarctic 'ozone hole', a chink in earth's atmospheric armor.

More than half of all accessible fresh water is now used and reused by mankind. Human activity has increased the species extinction rate by 1,000- to 10,000-fold in the tropical rain forests and reefs. Coastal wetlands are also affected by humans; 50% of the world's mangroves have been eliminated by development. Tidal marsh habitat in San Francisco Bay has been reduced by 79% and tidal flat habitat by 42%.

Anthropogenic effects on California's groundwater are familiar to *Hydrovision* readers. Land development for housing and commercial use shifts the recharge/run-off ratio and input to groundwater basins. Global warming is expected to cause earlier onset of snowmelt in the Sierra Nevada and will reduce the duration of recharge from California's rivers and the reliability of surface water supplies. Flooding and levee failures disrupt California's complex

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GRA's 15th Annual Meeting: Assessment, Use, and Management of Groundwater in Areas of Limited Supply

SEPTEMBER 21-22, 2006
SAN DIEGO, CA

GRA will hold its annual meeting in San Diego, September 21-22, 2006, at the Bahia Resort. The theme of this year's meeting is "Assessment, Use, and Management of Groundwater in Areas of Limited Supply." In the face of rising population and potential reductions in other water sources, there is increased interest in utilizing more groundwater in basins where groundwater has been considered a marginal resource. The year's annual meeting will address the hydrologic, water-quality, ecological, transborder, and policy issues that are facing such basins. A detailed list of planned topics is included in the Call for Abstracts (<http://www.grac.org/am.html>). The meeting will be preceded on September 20 with a field trip to the Sweetwater River Watershed in southern San Diego County. The field trip will cover groundwater, surface water, and endangered species issues in the watershed.

The deadline for submitting an abstract for a Paper or a Poster Presentation is June 2, 2006. Please feel free to contact Bill Pipes, Geomatrix Consultants, [(559) 264-2535, wpipes@geomatrix.com] or Sarah Raker, MACTEC Engineering and Consulting, Inc., [(510)-628-3234, slraker@mactec.com] if you would like to discuss your topic for this Symposium before submitting your abstract, or if you have any questions. ♠

Upcoming Events

Emerging Contaminants in Groundwater: A Continually Moving Target

18th Symposium in GRA's *Series on Groundwater Contaminants*

JUNE 7-8, 2006, CONCORD, CA

BY RULA A. DEEB, SYMPOSIUM CHAIR

GRA will hold a one and a half day symposium on emerging contaminants at the Hilton Hotel in Concord, CA on June 7 and 8, 2006. These emerging chemical contaminants include industrial solvent stabilizers (1,4-dioxane), disinfection byproducts (NDMA), pharmaceuticals (antibiotics/drugs), personal care products (polycyclic musks), pesticides/her-

bicides (1,2,3-trichloropropane), fuel oxygenates (MTBE and TBA), and other persistent compounds such as flame retardants (PBDEs) and phthalates. Background information including chemical history of use, sources, nationwide occurrence, analytical methods, physical and chemical properties, behavior in the environment, and technologies for

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High Resolution Site Characterization and Monitoring

2nd Symposium in GRA's *Series on Tools and Technology*

NOVEMBER 14-16, 2006
LONG BEACH, CA

Much has been learned about the behavior of subsurface contaminants in the last three decades of academic laboratory and field research. Yet, site assessments performed at commercial sites in North America often still follow traditional site assessment practices established in the early 1980s. Those assessment practices, which were founded on early, simplistic conceptual models of what the contamination was thought to be

like, often yield ambiguous data sets that prolong site characterization activities and lead to ineffective corrective action. In particular, low resolution site assessments often fail to provide detailed spatial and temporal data necessary to design effective in situ remediation systems and assess the performance of the systems once they are installed.

Recently, new technologies have been developed that allow site investigators

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Wells and Words

BY DAVID W. ABBOTT, P.G., C.H.G.,

How long should a pumping test be conducted to obtain aquifer properties?

Discussions in the groundwater hydrology literature about the recommended elapsed time (ET) of a pumping test has been relegated to a generalized footnote in many texts, providing ranges from 8-hours for a confined aquifer to 72-hours or more for an unconfined aquifer. In general, the duration of time that a test must be conducted should be determined by the time needed to identify aquifer properties. ET depends on project goals, accuracy and precision of data projections, and institutional statutes. However, the

heterogeneous or anisotropic aquifer properties or overlying drainage. Given these two aquifer properties, the behavior of the cone at any distance from the pumping well can be predicted for any length of ET and discharge, except for deviations due to long-term water level trends/fluctuations, and hidden aquifer boundaries, including influences from other pumping wells.

The magnitude of long-term water level trends cannot be predicted from tests alone, but are related to the regional distribution of aquifer recharge and discharge. Non-pumping water levels must be collected systematically to understand the magnitude of these

Technical Corner

When the edge of the cone encounters a recharge boundary, the drawdown per unit time slows or is zero, indicating that the amount of water pumped is equivalent to the amount of water recharged to the aquifer – steady state. This recharge is either from vertical leakage of overlying materials or from direct recharge from surface water. In contrast, when the cone meets an impermeable boundary, the drawdown accelerates per unit time, deepening the cone.

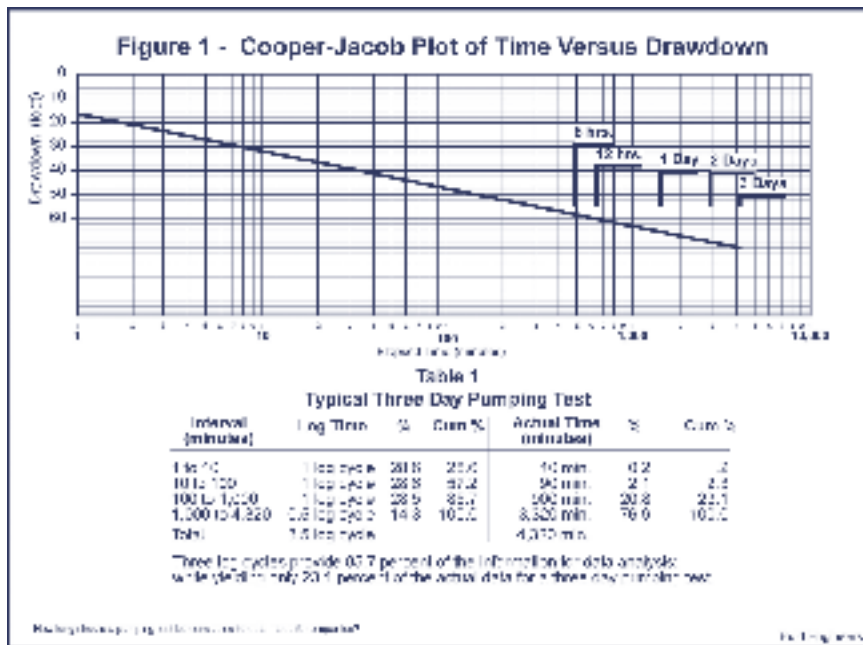
In low-yield aquifers or large diameter wells, aquifer properties cannot be determined unless the ET of the test exceeds the critical time (see Driscoll, *Groundwater and Wells*, 1986) to account for casing storage. The critical time may range from minutes in high-yield aquifers to days in low-yield aquifers.

Data analysis methods can determine the duration of the test. Observation (obs) wells are a critical component to any test; without them the storativity cannot be determined. However, the spatial position of the obs well compared to the pumping well is crucial to determining the recommended ET. Obs wells (or boundaries) located at large distances from the pumping well will require tests of longer duration to observe significant aquifer responses, especially in low-yield aquifers.

Field data analysis, interpretation, and observations are usually the key to successful tests. Initially, all pumping tests should be planned for at least 24 hours, while field analysis and interpretation of the early-time data can be used to adjust the ET. For example, if a test encounters a surface water recharge boundary at 6-hours, there is no reason to continue the test to 24-hours.

Usually, long-term (>12 hours) tests pose significant logistical and analytical challenges, particularly on single well

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recommended ET of a test is connected distinctly to (1) aquifer properties, (2) data analysis methods, and (3) the purpose of the test.

Aquifer properties (transmissivity and storativity) describe and predict the shape and rate at which the cone-of-depression expands and deepens during a test, notwithstanding any

fluctuations, trends, and their subsequent impact to well yields. The rate of expansion of the cone in confined aquifers is rapid, while in unconfined aquifers it is slower. In addition, leakage (aka delayed yield) slows the expansion of the cone in unconfined aquifers. Therefore, duration of a test for an unconfined aquifer is usually longer than for a confined aquifer.

The Seaside Basin Adjudication — Designing Order from Chaos

BY STEVEN HOCH AND RUSSELL MCGLOTHLIN, HATCH & PARENT

Politics, like sausage, is best not seen in the making, and certainly water politics in California lends credence to this adage. A prime example is the Monterey Peninsula. Thirty years of local political infighting, coupled with the influence of a thinly veiled anti-growth agenda on water planning, has left the Monterey Peninsula one drought away from a water supply crisis. However, the recent adjudication of the Seaside Groundwater Basin (“Seaside Basin” or “Basin”) and the appointment of a multi-stakeholder “watermaster” to manage the Basin provides the Monterey Peninsula with an opportunity to make real progress in preserving key components of its water supply. While the struggle to get to this point was not pretty, the final judgment, issued in March by Judge Roger Randall, sets forth a well crafted management plan – or “physical solution” – for the Basin and the community that relies upon its well being.

Background

The California American Water Company (“Cal Am”) is the primary municipal water supplier for the Monterey Peninsula. The company has no connection to the State Water Project or other imported supplies, and thus meets its customers’ water demands from local water sources, including the Carmel River and the tiny Seaside Basin. As a result, water shortages and their attendant conflicts have plagued the Peninsula for several decades. The situation worsened in 1995 when the State Water Resources Control Board issued

Technical Corner

WR Order 95-10, finding that Cal Am was illegally diverting 10,730 acre-feet per year from the Carmel River. The State Board ordered Cal Am to reduce its draw from the river and instead to maximize its extractions from the relatively small Seaside Basin.

Cal Am’s subsequent increase in extractions from the Basin, combined with other pumping, resulted in Basin overdraft, lowered water tables along the coast, and thus, a present risk of seawater intrusion into the Basin. Seawater intrusion has beset its neighbor to the north, the Salinas Basin, for decades. To ameliorate the Basin’s fate from the stalemate created by local politics, Cal Am brought a lawsuit against the other Basin groundwater users in 2003 to adjudicate the Basin and place its future in the hands of the Superior Court.

The Basin

The Basin is only about 24 square miles in size and is located just north of the City of Monterey. It is bordered by the Salinas Basin to the north and the Monterey Bay to the west. The Basin has two prominent subareas, the Coastal and inland Laguna Seca Subareas, which are partially separated by an anticline. Accordingly, the adjudication dealt with each subarea distinctly, and separately adjudicated the rights among the parties producing groundwater from each subarea.

The Basin’s safe yield is estimated to be in the range of 2,600 to 3,000 acre-feet per year, with the substantial majority of the yield provided by the Coastal Subarea. However, annual groundwater production in recent years has averaged about 5,600 acre-feet, and during some years has exceeded 6,000 acre-feet. This substantial annual overdraft has lowered water levels within the Basin’s principal groundwater aquifers – the Santa Margarita Aquifer and

Paso Robles Aquifer. The lowering of water tables near the coast, particularly in the Santa Margarita Aquifer, raised legitimate concerns that seawater would intrude into the onshore portions of the Basin. Fortunately, no seawater intrusion into either aquifer has been detected to date.

The Parties

Cal Am sued all other significant groundwater users, including the City of Seaside, Sand City, the County of Monterey, and several private landowners. Cal Am also sued the cities of Monterey and Del Rey Oaks because portions of the Basin are within their respective jurisdictions. In addition, the Monterey Peninsula Water Management District (“MPWMD”) and the Monterey County Water Resources Agency (“MCWRA”) intervened in the lawsuit because each claimed it had jurisdiction over certain activities that affect the Basin, and that the Superior Court could not interfere with that jurisdiction.

The Legal Issues

Groundwater adjudications can be either a relatively simple and civilized process of obtaining a judicially approved settlement among the stakeholders, or it can be a protracted and expensive contested litigation. The Seaside Basin Adjudication was a little of both. The adjudication involved three principal issues common to almost all groundwater adjudications: (a) the total amount of available groundwater; (b) allocation to each pumper; and (c) responsibility for managing the Basin. Remarkably, the second issue (dividing rights to the Basin’s groundwater) was largely settled by stipulation among the pumping parties. In essence, the pumpers agreed to generally follow the priority set forth by California groundwater law for implementing a physical solution. Accordingly, two sets of rights were

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California Legislative Corner

Sacramento Legislative Update

TIM PARKER, CHAIR, LEGISLATIVE COMMITTEE; CHRIS FRAHM AND PAUL BAUER, HATCH & PARENT, LEGISLATIVE ADVOCATES

After months of negotiations and being left at the altar in March, the infrastructure bond deal finally came together in the first week of May. The package was crafted by the Leaders of both houses and includes four separate bonds:

- ◆ \$19.9 billion transportation bond
- ◆ \$10.4 billion education bond
- ◆ \$ 4.09 billion flood protection bond
- ◆ \$ 2.85 billion housing bond

The Governor is expected to sign all of the bond bills. The dedicated water and natural resources bond measure that had previously been under discussion was not brought back for round two. The surface storage component of this bond measure was the most controversial element of the negotiations last March. Another reason the water bond measure was not included in this round is the widely-held belief in the Capitol that the water community supports the so-called “Caves Initiative” which is already on the ballot.

So, as of now, the package that will go before the voters in November includes the four infrastructure bonds noted above and the Caves Initiative. Many water agencies are concerned about either the amount of the funds or proposed uses of the funds in the Caves Initiative, or both. There is a feeling that at a time the State is reaching the upper limits of its bonding capacity, too little of this \$5.2 Billion measure is allocated for water supply reliability and water quality projects. Like Prop 50, the Caves Initiative promises safe drinking water

and water quality for all Californians, and yet, the share of funding allocated to this objective is proportionally small.

As far as groundwater is concerned, the Caves Initiative includes \$50 million for the Department of Health Services for projects to prevent or reduce contamination of groundwater that serves as a source of drinking water. There are a number of other sections of the bond that could be applied to groundwater projects including but not limited to Integrated Regional Water Management Plan (IRWMP) funding in the amount of \$1 Billion. GRA's Legislative Committee will be studying the Caves Initiative in further detail and making a recommendation to the GRA Board of Directors in the near future. Look for an update on the GRA website.

Senate Bill 1242 by Senator Lowenthal becomes all the more important with \$1 Billion allocated to IRWMPs in the Caves Initiative. A working group is being formed and the bill is expected to be amended to reflect stakeholder concerns in the near future.

In addition to the high profile bond discussions the legislative process is beginning to pick up. Policy committees are hearing legislation introduced this year. One of the most significant bills of the year relating to groundwater is Senate Bill 1640 by Senator Sheila Kuehl. With minor changes, the bill is a reintroduction of Senate Bill 820 which was vetoed last year by Governor Schwarzenegger. Senator Kuehl is the Chair of the Senate Natural Resources and Water Committee and in a very good position to move the bill forward. The bill as drafted addresses many of the concerns the Governor raised in his veto message last year.

The Governor will release his May Budget Revision on May 12th. This annual event is the kickoff to the budget season. Given that all sides are busy

declaring victory as a result of the bonds, it will remain to be seen whether the Legislature and Governor will be in a position to extend the goodwill and also pass a timely budget. Recent reports from the Department of Finance indicate that state revenues are exceeding earlier projections. This bodes well for the negotiations. Undoubtedly, all gloves will be off soon as we head into the November elections. ◆

GRA Promotes Groundwater at the Capitol

On April 17, GRA welcomed more than 40 members to spend the day in the Capitol for our annual Legislative Symposium and Lobby Day. During the program, fashioned as, “Groundwater Quantity, Quality and Quid Pro Quo’s -- What Issue Trade Offs Will be Required to Ensure Funding for Vital Groundwater Programs,” the membership heard from a number of key Capitol players including Senator Bob Margett, State Water Resources Control Board Member Jerry Secundy, Department of Water Resources Director Lester Snow, and Dennis O'Connor, Principal Consultant to the Senate Natural Resources and Water Committee, chaired by Senator Sheila Kuehl. A lively group of panelists including Virginia Grebbian, Walt Wadlow and Desi Alvarez, joined the program to talk with these leaders about water bonds, user fees and Integrated Regional Water Management Planning. Following the program, Richard Katz, former Assembly Member and State

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U.S. EPA News

BY JOHN UNGVASKY,
EPA REGION 9

Source Water Collaborative

EPA and thirteen national organizations have signed an agreement to work together to promote and implement source water protection. The effort, known as the Source Water Collaborative, is further described at http://www.epa.gov/safewater/protect/pdfs/visionstatement_swp.pdf.

Large Capacity Septic Systems

EPA has updated its web site addressing Large Capacity Septic Systems. The underground injection control program regulates shallow injection of non-hazardous fluids in a category called class five (or Class V) wells. A large capacity septic system is considered a type of Class V well. To learn more go to http://www.epa.gov/safewater/uic/classv/class5_types_lcscs.html.

Management Handbook for Septic/Decentralized Systems

EPA has published *Management Handbook for Septic/Decentralized Systems*, a how-to guide for implementing EPA's Voluntary National Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems. The guide describes a step-by-step approach for the development of a community management program for decentralized wastewater systems. For more information, go to: <http://cfpub.epa.gov/owm/septic/guidelines.cfm#handbook>.

Septic Systems — What to Do after the Flood

In response to recent natural disasters, EPA has released a two-page question and answer document titled, *Septic Systems – What to Do after the Flood*. For more information, go to: http://www.epa.gov/safewater/faq/emerg_sepctic.html.

Federal Legislative/Regulatory Corner

Tools to Help Small Utilities Control Arsenic

EPA has released a set of user-friendly multimedia tools and products to guide small drinking-water utilities in making treatment decisions to meet new regulations to control arsenic. Kits including all of the new arsenic tools will be provided to EPA's state and technical assistance partners for distribution to public water systems affected by the arsenic regulation. The anchor product is the "Arsenic Virtual Trade Show," a learning portal for arsenic-treatment technology, which features a database of vendors, a treatment-decision tree, and tips for evaluating and selecting treatment providers. To launch the Arsenic Virtual Trade Show, go to: <http://www.arsenictradeshow.org>.

Hazardous Substances Technical Liaison Newsletter

Many of the following news items were extracted from the January 2006 Hazardous Substances Technical Liaison Region 9 Newsletter, which provides a wealth of information on hazardous substances, including topics related to ground water. If you wish to receive this quarterly newsletter by email, contact Michael Gill at gill.michael@epa.gov. Newsletter archives can be found at <http://intranet.epa.gov/ospintra/scienceportal/hstmlnews.htm>.

Message Mapping: Guide For Effective Crisis Communication

Recent public health disasters demonstrate the need to provide clear and consistent messages to the public, the news media, policy makers and other stakeholders. Risk managers facing a crisis can use a new systems-based technique for analyzing and presenting information called "Message Mapping," explained in a new workbook, *Risk Communication in Action: Tools of Message Mapping*. For the complete

article, go to: <http://www.epa.gov/ORD/NRMRL/news/news012006.htm>.

Workshop on Nanotechnology for Site Remediation

A workshop on using nanomaterials for site remediation was recently held in Washington, DC. The workshop presented the latest research results from federally sponsored research grants and current practices, and served as a collaborative forum among various researchers to increase understanding and explore the use of nanotechnology for hazardous waste site remediation. A draft version of the proceedings is at: <http://www.emsus.com/frtr/nano/index.htm>.

Field-Based Perchlorate Measurement Instrument

The National Defense Center for Environmental Excellence (NDCEE) has successfully completed a demonstration of a field-deployable prototype instrument that measures perchlorate concentrations in water. Demonstration results indicate that the instrument offers advantages over EPA Method 314, including less expensive components, portability, faster results, a potentially lower detection limit, and is less prone to interference in high-salinity samples. For more information on the perchlorate monitor, please contact Hany Zaghoul at hany.h.zaghoul@erdc.usace.army.mil or Bill Tumblin at tumblinw@ctc.com.

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NDMA — Not Just Rocket Science Anymore

BY BART SIMMONS

What is your greatest source of NDMA: beer, second-hand cigarette smoke, or groundwater? The answer, of course, depends on the level of contamination, but efforts to control NDMA in groundwater will ensure that a beer in a smoke-filled room will dwarf the contribution from groundwater.

In 1998 N-nitrosodimethylamine (NDMA) was found in a drinking water well in eastern Sacramento County, and was later reported elsewhere in California. This initial report was related to an Aerojet aerospace facility; until 1976, NDMA was used in the synthesis of *unsym*-Dimethylhydrazine, UDMH, or 1,1-Dimethylhydrazine, a liquid rocket fuel, and was present at about 0.1% in the final fuel product. According to the

National Toxicology Program (NTP), NDMA is no longer manufactured in large commercial quantities in the U.S., although it is used in small quantities in research and is produced as a by-product in chemical plants using dimethylamine.

NDMA is a mutagen, causes DNA damage in short-term tests, has caused cancer in mammals, and is listed as B2: reasonably anticipated to be a human carcinogen. Like other nitrosoamines, it is a very potent carcinogen, which motivated the Cal/EPA Office of Environmental Health Hazard Assessment (OEHHA) to establish the low Public Health Goal of 3 ng/L. NDMA is a candidate for a low drinking water standard; the current notification level is 3 ng/L. Estimates indicate that air, diet, and smoking contribute to potential human exposure at levels of a few micrograms per day. Beer, for example, often contains 100 to 1,000 ng/L NDMA (WHO, 2002).

Chemist's Corner

In November, 1999, the California Department of Health Services (DHS) began a study with water suppliers on the occurrence of NDMA in treated water. One identified source was ion-exchange resin. NDMA has been found in recycled water which had been treated using ion-exchange resin. NDMA formation appears to be affected by chloramination, cationic polymers, detention times, and bacteria.

Although there is no formal drinking water standard for NDMA, DHS has established a list of acceptable test criteria, including the use of gas chromatography-mass spectrometry and a stable isotope internal standard. DHS also is maintaining a list of “Laboratories Capable of Low-Level Analyses for NDMA.”

NDMA is photolyzed by UV light to methylamine or dimethylamine, depending on the NDMA concentration pH (*Environ. Sci. Technol.*, 39 (7), 2101-2106, 2005). Dissolved oxygen also increases the yield of methylamine and nitrate.

The levels of NDMA precursors, such as dimethylamines, and more generally, dissolved organic nitrogen, are of concern. The half life in surface water of these compounds appear to be on the order of days, which means that discharges of precursors could impact downstream drinking water treatment plants. NDMA has high water solubility, low partitioning to solids, and a high potential for groundwater transport.

If the thought of NDMA in drinking water still bothers you, relax and have a beer.

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International Association of Hydrogeologists News

Groundwater at the World Water Forum

The World Water Forum, the 4th in the series, was held from March 16-22, 2006 in Mexico City and had the main theme “Local Actions for a Global Challenge.” The meeting is held every three years under the auspices of the World Water Council and the host country and attracts a large attendance from governments, commerce, professional societies, NGOs and the public. Groundwater is not high on the agenda, partly because, as Stephen Foster, President of the International Association of Hydrogeologists (IAH) explains in the March issue of IAH’s News and Information, “it is everywhere so it is nowhere in particular.” However, the recognition of the increasing significance of proper groundwater management is well demonstrated by the increasing profile which groundwater issues have had these successive three year gatherings. In 2000 in The Hague there was just one session, in 2003 at Kyoto there was a groundwater theme day, while in Mexico City a number of very well attended sponsored sessions featured strongly on groundwater issues. WWF Sessions and Conveners included: Groundwater Protection in Africa (United Nations Environment Program/UNESCO); Shared groundwater resources for sustainable management (UNESCO); Groundwater for Life and Livelihoods - a framework for action (IAH/Association of Geoscientists for International Development/World Bank); and Groundwater Management in the Middle East and North Africa region (World Bank). Other sessions and details may be found on the IAH web site at <http://www.iah.org/News/2006/059.html>.

Continued on page 12

Alliance Corner

NGWA News

BY CLIFF TREYENS

Groundwater fun!? You bet! That’s the goal of the National Ground Water Association’s new Ground Water Adventurers Web site for children, grades K-12 (www.groundwateradventurers.org). The purpose of Ground Water Adventurers is to raise children’s awareness of groundwater as the consumers and groundwater professionals of the future, using brain ticklers, puzzles, and cool experiments. “Exploring groundwater is an adventure. Many in our industry have experienced the adventure of exploring groundwater, whether studying an aquifer or drilling a well. Now children can experience it, too,” said NGWA volunteer Kathy Lien, who helped prompt the idea.

John Christiansen, another NGWA volunteer and water well contractor, agreed, saying, “I’ve met very few groundwater professionals who weren’t passionate about what they do. We want to give children the opportunity to explore groundwater and develop some of that same passion through this program.”

To help satisfy the appetites of Ground Water Adventurers, the program serves up *Ground Water Gorp* (“gorp” is slang for trail mix)—a tasty mix of kid-friendly fun, facts and more. *Ground Water Gorp* is accessed through the Web site. Also, for a nominal cost, children can purchase Ground Water Adventurers t-shirt online featuring the Web site’s icon, an aquifer personified (see figure). “NGWA’s Ground Water Adventurers could be a big help in getting information on groundwater into schools all

across the country,” says NGWA Board Member and Public Awareness Committee Chairman Alan Eades.

The new Web site coincides with NGWA’s recent adoption of a statement on the importance of Earth Science Education. In so doing, NGWA joined other private and public geoscience organizations in recognizing that a science-literate citizenry is vital to the nation’s well-being and security. Addressing future environmental and resources challenges, including complex water resources evaluation and sustainability issues, requires a better understanding of the interrelationships between Earth systems’ processes. Accordingly, NGWA endorsed adoption of National Science Education Standards by all public and private school systems. Such standards, developed by the National Academies, integrate the cross-disciplinary Earth science expertise necessary to apply this knowledge for the betterment of the environment and society.

In addition, NGWA has an “Educator Resources” section on its web site (www.ngwa.org). Teachers can find information on workshops and training, lesson plans, classroom materials, free posters, and reference tools. For more information on NGWA’s groundwater awareness initiatives, contact NGWA Public Awareness Director Cliff Treyens at 800-551-7379, ext. 554, or ctreyens@ngwa.org. ♠



GRA Extends Sincere Appreciation to its Co-Chairs and Sponsors for its April 2006 *Groundwater Contaminants Series* Symposium, "Nitrate in California's Groundwater: Are We Making Progress?"

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Organizational Corner

An Extreme Makeover For GRA's Website

BY MARTIN STEINPRESS,
GRA DIRECTOR AND
COMMUNICATIONS CHAIR

The GRA website has undergone a complete redesign, and members are encouraged to check it out at <http://www.grac.org>. The most obvious change is an enhanced look and feel, but closer exploration will reveal a number of valuable functionality upgrades, including:

- ◆ Easier/more intuitive navigation
- ◆ General site search (under the left side button)
- ◆ *Hydro Visions* archive search (Publications > Search HydroVisions)
- ◆ Improved search engine placement
- ◆ Fully automated Membership Application (Membership > Join GRA)

GRA's website is an essential part of our mission to protect and improve California's groundwater resources through education and technical leadership. The website is currently averaging approximately 5,000 unique visitors per month. We strive to make the site a comprehensive source of information for both industry professionals and the general public. Please remember to check out the website for:

- ◆ Latest groundwater news
- ◆ Upcoming event announcements, calls for abstracts and registration
- ◆ Legislative updates

- ◆ Job opportunities or to post your own firm's open positions
- ◆ Membership renewals and updates to your contact information
- ◆ Back issues of *HydroVisions*
- ◆ Branch meeting announcements and registration information

GRA expresses its appreciation to our ace Webmaster, Kevin Blatt, for his tireless work in developing and implementing the redesign. You can check out his personal site at <http://www.iHappi.com>.

As part of this process, GRA welcomes your feedback and suggestions as always. To submit feedback on the GRA website, please email the GRA Web & Database Administrator at dbadmin@grac.org.

The Future of Agriculture: Science, Stewardship, and Sustainability (Integrating Science, Technology, and Policy to Address Environmental Challenges in the Agricultural Setting)

The U.S. Environmental Protection Agency (EPA), the National Institute of Environmental Health Sciences (NIEHS), and the Center for Hazardous Substance Research (CHSR) at Kansas State University, a consortium member of the Midwest Hazardous Substance Research Center (HSRC), will host the *International Conference on The Future of Agriculture* on August 7-9, 2006 at the Hyatt Regency in downtown Sacramento, California. The registration (early-bird) deadline is July 5. For more information go to GRA's website or www.dce.ksu.edu/dce/conf/ag&environment.

David Keith Todd, 1923 to 2006

David Keith Todd, Ph.D., one of the founders of modern groundwater science and mentor to



hundreds of groundwater scientists, passed away the evening of April 23, 2006 after a brief but valiant struggle with acute leukemia. Among

his many accomplishments, David is best known for his textbook, *Groundwater Hydrology*, widely acknowledged as one of the first texts to address groundwater management in an accessible and comprehensive manner.

Dr. Todd has contributed much to the science of groundwater hydrology through his research, teaching, and consulting. In 1964 he was honored -- along with astronaut Gus Grissom -- with the first Distinguished Alumnus Award from Purdue University. In addition to uncounted honors and awards over the many years of his career, he was recognized in 1999 by GRA with its Lifetime Achievement Award. Most recently Dr. Todd was selected to provide the keynote address to the 24th Biennial Groundwater Conference, where he provided a retrospective of 50 years of progress in groundwater management.

David Todd is survived by his wife, Rolly Todd, their two sons, Stuart Keith Todd and Brian Wesley Todd. More information on David Keith Todd may be found at www.grac.org and at www.toddengineers.com/david_keith_todd_memorial.html. 💧

Organizational Corner

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International Association of Hydrogeologists News

— Continued from Page 9

In his statement on World Water Day, March 22, 2006, UN Secretary-General Kofi Annan said: “On this World Water Day, let us recognize the cultural, environmental and economic importance of clean water, and strengthen our efforts to protect rivers, lakes and aquifers. We need to distribute water more equitably, and increase the efficiency of water use, especially in agriculture. Let us mount a sustained effort – among international bodies, governments and local communities, and across traditions and cultures - that will reach our goals.” The next World Water Forum is planned to occur in Istanbul in 2009. ♠

studies that question whether exposure to perchlorate at low levels produces toxic effects. **Dr. Gibbs (Kerr McGee)** discussed a study of human health impact from exposure to perchlorate. Biomonitoring was performed on residents of three Chilean towns, in two of which perchlorate is present in drinking water. Results from testing creatine (urine), neonatal (cord) blood, and breast milk of pregnant or nursing Chilean women indicated no adverse affect to iodine uptake, and no differences in thyroid hormone ratios between people drinking clean water and people drinking water with perchlorate at 110 µg/L. **Rose Knox (MassDEP)** presented the State of Massachusetts' perchlorate response plan, and conveyed that the current state PHG has been under review since the National Academy of Sciences (NAS) released their findings. Since the conference, Massachusetts has proposed a 2 µg/L MCL; public

Public confusion stems from Massachusetts' proposed MCL of only 2 µg/L juxtaposed against the DoD's proposed cleanup level of 200 µg/L.

hearings continue on the nation's first proposed perchlorate regulatory standard. MassDEP has documented several sources of perchlorate from commonly used materials, including fireworks, blasting, industrial discharges, and sodium hypochlorite (bleach). Perchlorate had already been measured at concentrations ranging from 89 to 8,000 µg/L in household bleach, which is also widely used for well disinfection. **Dr. Ben Blount (CDC)** presented findings from biomonitoring done to determine whether exposure to dietary perchlorate may impair thyroid function. Blount acknowledges that nitrate and thiocyanate also inhibit iodide uptake. Urine samples collected from CDC lab techs revealed that measured perchlorate concentrations averaged 7.8 µg/L, including an anomalously high value of 35 µg/L. Toxicologically, these values were all below the NAS RfD of 0.7 µg/Kg-

day. Because tap water for the Atlanta area averages 0.2 µg/L, it was concluded that food was the source of perchlorate in this test group. **John Borkovich (California SWRCB)** described California's response to perchlorate impacts to groundwater. The State is currently developing an MCL (DHS), has set a PHG (OEHHA), and has adopted emergency regulations (DTSC). Best management practices (BMPs) established by DTSC took effect December 30, 2005. Investigation of prioritized DOD facilities is ongoing, and the State continues to watch areas of perchlorate impacts, including the Llagas Basin, Rialto-Colton, Aerojet (Sacramento, LA), Santa Susana/San Fernando Valley, and the Lower Colorado River.

Public Policy and Risk Communication

Sylvia Hamilton described how the San Martin community (southern Santa Clara County) responded to the news of widespread perchlorate detected in hundreds of private wells and several municipal and small water system wells, attributed

Continued on page 14

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to a former Olin Corporation highway flare production facility formerly located in Morgan Hill, CA. Formation of the Perchlorate Community Advisory Group (PCAG) greatly improved communication of the investigation status. The community has learned much since the initial months of great anticipation, fear, and anger when the contamination first came to light. The keys to successful and timely problem solving are education, active listening, and open communication. Monthly PCAG meetings host presentations from municipalities, the Santa Clara Valley Water District (SCVWD), the RWQCB, and Olin Corporation regarding new and emerging information from the ongoing investigation. USEPA's Bruce Macler discussed the status of future regulation of currently unregulated contaminants, including boron, MTBE, and perchlorate. A drinking water source contribution to perchlorate exposure risk has not yet been determined, but EPA has accepted the NAS recommended RfD of 0.0007 mg/kg-d, or about 25 µg/L in drinking water. Future regulation may be determined in 2006, but a Federal MCL is probably several years away yet and uncertainties remain about high-volume treatment options.

Thomas Vandenburg (Dongell Lawrence Finney Claypool LLP) noted the relevance of 'non-traditional' perchlorate sources to 'novel' legal theories concerning the abil-

ity of private parties to file claims against public and private water entities for storing and handling water. He believes that the impact of the recent Supreme Court ruling in *Cooper v. Aviall* will be significant. Vandenburg discussed several toxic tort claims including *Palmissano v. Olin*, *Allen, et al v. Aerojet*, and *Aguilar v. Exxon Mobil Corporation*, which dealt with standards for proof of medical causation in toxic tort claims under California law. Carol Aziz (GeoSyntec Consultants) provided results from a federally funded assessment of perchlorate in our environment from 'alternative' sources. Results are available at www.serdp.org. Alternative sources include Chilean fertilizer, chlorine products (e.g. sodium chlorate and herbicides), safety flares, explosives, and fireworks. The study concluded that perchlorate is far more widespread than previously realized, and its presence in groundwater is not solely attributable to military or aerospace activities. Appropriate and achievable standards need to account for this new realization.

Soil and Vadose Zone Remediation

Four presentations were given on the subject of perchlorate remediation in vadose zone soils. Patrick Evans (CDM) presented theory and laboratory evidence supporting the use of gas-phase electron donors to

promote the biodegradation of perchlorate in deep vadose zone environments that are inaccessible to excavation or water flushing techniques. Field pilot tests of this

Perhaps perchlorate is no longer an emerging contaminant.

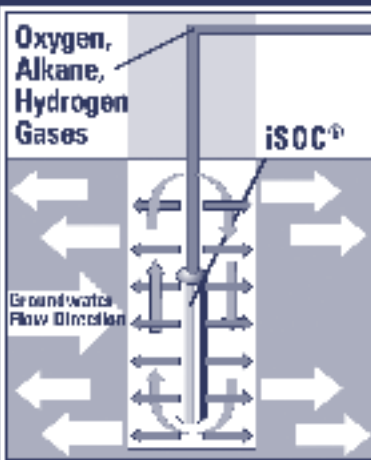
gas-phase electron donor injection technology are anticipated in 2006. Evan Cox (GeoSyntec Consultants) followed with a presentation of results from full-scale ex situ and

in situ soil remediation activities at a site in Morgan Hill, California. Ex situ soil remediation activities were successfully completed in 2005, reducing perchlorate concentrations from 7,000 ppb to 12 ppb within months. In situ soil remediation via surface infiltration of electron donors is ongoing to treat approximately 40,000 yd³ of soil at the site. Benjamin Wuerl (Arcadis) presented results from two pilot tests where high-pressure injections of dilute corn syrup and ethanol were employed to promote biodegradation of perchlorate in low permeability and heterogeneous materials; the method achieved perchlorate concentration reductions ranging from 81 to 93% at one site, and from 29 to 48% at the second site. Todd Battey (Earth Tech) presented the pilot test results for soil flushing from a thick (130 feet) vadose zone in an arid environment at Edwards Air Force Base in California. Results showed that perchlorate could be flushed to underlying groundwater, where it could be captured by extraction wells for ex situ treatment by ion exchange.

Occurrence, Chemistry, and Forensics

Dr. Andrew Jackson (Texas Tech University; TTU) presented his most recent research on oxygen (¹⁷O) isotope studies of perchlorate in atmospheric precipitation. TTU has conducted extensive investigations of perchlorate in groundwater in the Texas panhandle and eastern New Mexico. Results indicate that oxygen isotopes of perchlorate found in north Texas wells is similar to the isotopic signature of perchlorate found in Chilean nitrate deposits, suggesting an atmospheric origin. Perchlorate found in unsaturated soils and plant residues in the southwestern U.S. also have oxygen isotopic signatures indicative of an atmospheric origin for perchlorate.

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Dr. Greta Orris (USGS) presented her research of naturally occurring perchlorate in desert areas of the western U.S. Much of the perchlorate found in desert soils has no obvious anthropogenic origin and is therefore considered to be naturally occurring. Sample analysis by the USGS shows that perchlorate is present at low concentrations (0.1 ppb to 10 ppb) in surface soils, and that perchlorate can also accumulate in native plants. Some of this perchlorate may be trapped in plant die off, leading to localized areas of concentrated natural perchlorate.

Dr. David Stonestrom (USGS) discussed research on the accumulation of natural perchlorate beneath xerophytes in arid and semi-arid regions. Dr. Stonestrom's presentation focused on areas of the Mojave Desert and Colorado Plateau. Perchlorate concentrations up to 452 ppb of ClO_4^-/kg of pore water have been measured in the root zone near Amarogosa Farms, Nevada. In the Colorado Plateau, concentrations in pore water ranged to greater than 1,200 ppb ClO_4^-/kg . A comparison of the perchlorate-to-chloride mole ratios has shown that the ratio is about 20 times higher in precipitation than in pore water. Thomas Mohr (SCVWD) described a forensic study using isotopes to determine perchlorate sources in the Llagas Basin in South Santa Clara County. The EPA-funded study is expected to provide an estimate of perchlorate background concentrations and distinguish between natural and anthropogenic origins of perchlorate, and possibly between different anthropogenic sources of perchlorate.

Innovative and Evolving Groundwater Remediation Techniques

Dr. Bruce E. Rittman (Arizona State University) discussed the successful pilot test of membrane biofilm reactor (MBfR) technology, which uses hydrogen gas as an electron donor via microscopic, hollow fiber membranes. Dr. John D. Coates (UC Berkeley) reported that selective electron donors (e.g. certain hydroquinones) stimulate microbial reduction of perchlorate while minimizing stimulation of iron and sulfate reduction. Dr. Valentine Nzengung (University of Georgia and PLANTECO

Environmental Consultants, Inc.) discussed lab results showing that surfactant-modified clays (SMCs) are highly effective at adsorbing perchlorate from water, with a capacity of 4,000 to 44,000 mg/kg, depending upon the type of clay and concentrations of competing ions. Dr. Marc A. Deschusses (UC Riverside) presented batch experiment and column study results showing that large-scale treatment of perchlorate-contaminated water using autotrophic bacteria (e.g. *Dechloromonas*) in the presence of zero-valent iron (ZVI) is feasible.

Plume Characterization and Case Histories

The case studies session included a discussion of perchlorate distribution at the Olin Corporation site in Morgan Hill, California (Michael Taraszki, MACTEC), perchlorate sources at the Aerojet site in Central Valley, California (Scott Seyfried, LFR), and processes influencing perchlorate migration through the thick vadose zones found in the San Gabriel Basin or Rialto

Colton (Nicole Sweetland, D.B. Stephens & Associates). Case studies presented in this session stressed the importance of thorough characterization of the study area to provide a comprehensive assessment of important mechanisms controlling the distribution of perchlorate.

The basin characterization project for the Olin case employed continuous multi-channel tubing (CMT) to install multi-level monitoring wells for rapid collection of groundwater head measurements and samples at up to nine discrete depths, some deeper than 400 feet. In addition to perchlorate, groundwater samples were also tested for stable isotopes of oxygen and hydrogen to trace the influence of imported water of Sierra Nevada origin into the basin, and determine its effect on perchlorate and nitrate concentrations. The Aerojet project also used isotope data to discern the origins of perchlorate from fertilizer residuals from previous land use. Thick vadose zones, commonly found in

Continued on Page 16

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western states, provide large reservoirs for perchlorate and other contaminants that may impact groundwater quality, requiring a detailed understanding of pathways for precipitation infiltration, associated mass transport patterns, and strategies for determining vadose zone properties.

Groundwater Remediation/Treatment Case Studies

Mr. Peter Ritchey (Calgon Carbon Corporation) presented an update on technology evolution, including the current ion exchange options of non-regenerable fixed bed and regenerable moving bed, and the next-step of utilizing a ferric chloride/hydrochloric acid regenerant solution in fixed bed systems. Andrea Davis (Applied Research Associates, Inc.) discussed innovative and evolving perchlorate remediation ion exchange techniques using weak base anion (WBA) resins, regenerable as well as perchlorate-specific, developed in part with The Purolite Company. Avram Frankel (ARCADIS) rounded out the session by discussing the selection of how various treatment technologies, such as the Hall bioreactor, ion exchange, liquid-phase GAC, GAC, and MBfR, were considered for treatment of groundwater contaminated by perchlorate, nitrate, CVOCs, and hexavalent chromium, including a discussion of technology evaluation and lifecycle costing.

Policy Roundtable — Water Replacement Orders

The conference concluded with a panel discussion among attorneys active on perchlorate cases representing the State, private well owners, industry, and public well operators. The panel included: Ms. Lori Okun of the Central Coast RWQCB; Mr. Jorge Leon of the Santa Ana RWQCB; Mr. Colin Pearce, representative for private San Martin well owners in the Olin case; Mr. Randolph Visser, counsel for Olin; and Mr. Steve Elie, counsel for two Inland Empire water purveyors.

The panel focused on the implications of the SWRCB's ruling on an appeal of a water replacement order related to the south San Martin perchlorate plume, and the future of water replacement orders, given the SWRCB decision and proposed legislation. The panel engaged in an animated debate covering a range of issues from what level defines an impact to a well; when replacement water is warranted; the level of proof for cleanup and abatement orders containing water replacement orders; and, cleanup levels vs. drinking water levels. The discussions probed the genesis

We are making progress toward understanding perchlorate occurrence, health effects, and cleanup, but questions and complications remain.

of state policy and law, and included parallels drawn to *Alice in Wonderland*, invoked by Visser to parody the regulators' over-interpretation of individual words in the Water Code. The panel did a fine job debating legal matters in lay terms, and applying lessons from perchlorate to other groundwater contaminants.

GRA's *Perchlorate 2006* Symposium clearly demonstrated that we are making progress toward understanding perchlorate occurrence, health effects, and cleanup, but questions and complications remain. For instance, the 2004 change to the DHS Notification Level from 4 µg/L to 6 µg/L left many water utilities and well owners in limbo, with uncertainty regarding replacement water and serving or consuming water with detectable levels of perchlorate. Epidemiological studies in Chile suggest that populations exposed to 120 ppb are not adversely affected; however, toxicological reviews by Massachusetts DEP arrive at a draft MCL of 2 ppb. Biomonitoring of excreted perchlorate suggests that many of the foods we eat bioaccumulate perchlorate and contribute to perchlorate ingestion, which is not regulated by health agencies, contrary to drinking water. Bench-scale, pilot-scale, and full-scale soil treatment applications show that we can eliminate perchlorate in soils and protect groundwater resources; however, the identification of multiple anthropogenic and natural sources of perchlorate complicates allocation of cleanup costs. GRA will continue

to track the 'emerging' issue of monitoring and treating perchlorate (perhaps itself no longer an emerging contaminant) to determine whether a Perchlorate 2007 conference is warranted.

Editors Note: The authors are all members of the Event Committee, whom GRA wishes to thank for their efforts. The symposium proceedings will be available at www.grac.org.

High Resolution Site Characterization and Monitoring — Continued from Page 3

to perform rapid, high-resolution site assessments that provide unprecedented clarity regarding the nature, extent, and migration of contaminants in the subsurface. Increasingly, these technologies, which include high-resolution geophysical methods, cone penetrometer testing (CPT), driven direct push (DP) chemical sensors, high-resolution vertical groundwater profilers, and multilevel groundwater monitoring systems, are being applied in new configurations, e.g., advanced or installed along transects perpendicular to the groundwater flow direction, that have been shown to be particularly effective at many contaminated sites.

This symposium will bring together a group of top researchers and practitioners from around the world, to present the "state of the science" regarding efficient, high-resolution site assessments. Dr. John Cherry, from the University of Waterloo, will set the stage early in the symposium by providing a historical perspective on the importance of high-resolution measurements in field studies performed by researchers at the University of Waterloo.

GRA welcomes submittals of abstracts for poster presentations for this symposium. Please feel free to contact Murray Einarson (meinaron@geomatrix.com or 650-400-0248) or Tim Parker (tparker2@slb.com or 916-329-9199) if you have any questions about this upcoming event.

and vital network of water distribution canals. Design of California's infrastructure relies on prediction of annual floods using the log-Pearson type 3 (LP3) distribution for flood-frequency analyses; however, log-log power-law fits to partial-duration flood series show that the LP3 approach systematically underestimates flood frequency and severity¹. Trends toward increasing flood frequency and magnitude, possibly a consequence of climate change, development and logging, suggest that low-lying communities and water resources infrastructure may be much more vulnerable than engineers and planners anticipated². Most scientists agree that human activity is causing Earth to warm rapidly, leading to ice melt and sea level rise; some believe that a 'tipping point' phenomenon could rapidly advance the inundation of California's delta and other areas that lie well below possible near-future elevated sea levels.

Salinity build-up in California's agricultural soils limits their productivity, and heavy pumping has drawn seawater into inland aquifers and induced land subsidence. The industrial and agricultural discharge of toxic substances to California's groundwater has impaired beneficial uses and increased the cost to render groundwater safe for consumption.

Crutzen's declaration of the Anthropocene epoch emphasizes mankind's central role in geology and ecology. Mankind will remain a major geologic force for millennia. Our challenge as resource stewards is to develop and adopt a strategy to guide local and national political leaders toward global, sustainable, management of earth's resources. The sum of known anthropogenic effects on California's groundwater calls for improved understanding of these trends and their consequences, and strategic action toward stemming their deleterious effects.

A recurring theme in GRA's annual meetings and symposia has been groundwater sustainability. USGS defines groundwater sustainability as "groundwater use that can be sustained for an indefinite time without causing unacceptable environmental, economic, or social consequences." The goals for sustainable groundwater management include obtaining reliable long-term yields

from aquifers, efficient water use, preservation of groundwater quality, protection of ecosystems sustained by groundwater discharge, and integration of groundwater and surface water management.

Some of California's groundwater basins lack basic groundwater data necessary for basin managers and policymakers to make informed decisions for sustainable groundwater resources management. AB 599 and the GAMA program have made significant progress toward filling data gaps; GRA continues to track other bills (820/1640) that facilitate coordinated collection and analysis of groundwater data through monitoring, reporting, and data management.

These challenges to man's resourcefulness seem daunting, but I remain optimistic. Solutions will be found in the realm of the noosphere – the sphere of human thought, or the impact of scientific and technological progress and other effects of our cognitive activity. At each GRA symposium I attend, industry, government, and academic leaders continue to surprise me with their ingenuity and willingness to bring opposing stakeholders together to work toward common ground and sustainable solutions to increasingly complex problems. Necessity is the mother of invention. Groundwater scientists will find solutions to bring about sustainable groundwater management through the Anthropocene and beyond.

1. Turcotte, D.L., and Greene, L., 1993, A scale-invariant approach to flood frequency analysis: Stochastic Hydrology and Hydraulics, v. 7, p. 33-40.

2. www.maths.ox.ac.uk/~malamud/BDM_Papers_PDF/MalamudTurcotte_CommentOnFloods_Geology_2003.pdf.

Thomas Mohr is GRA's President and a Hydrogeologist with the Santa Clara Valley Water District. ♠

GRA Promotes Groundwater at the Capitol — Continued from Page 6

Water Resources Control Board Member entertained our audience with his views of what has gone well and what has gone not quite as well during his years in the Capitol. As usual, our afternoon was capped with visits in the Capitol. We would very much like to thank our sponsors, Golden State Water Company (Symposium Level), CH2MHILL (Luncheon Sponsor) and Integrated Resource Management (Continental Breakfast Sponsor) without whose support this exciting day would not have been possible. ♠

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established: the Standard Production Allocation (akin to appropriative rights) and Alternative Production Allocation (akin to overlying rights). The overlying landowners agreed to cap the maximum quantity of water that each would annually extract from the Basin in exchange for a commitment that (a) their overlying rights (i.e., Alternative Production Allocation) would not be reduced by future planned ramp-downs in cumulative Basin production, (b) their rights would be granted priority over non-overlying rights (i.e., appropriative rights) in times of shortage, and (c) they would not incur assessments to fund the planned replenishment of the Basin (i.e., the costs of the physical solution would be borne by the appropriators).

Additional nuances were added to the division of rights to add flexibility and functionality. For example, the Judgment provides a pre-set process to allow for a “condemnation” of Alternative Production Allocation by Cal Am (the principal appropriator) should that become necessary to allow Cal Am to continue to meet its municipal water demands, and a process for valuing the condemnation payment, should this occur. These provisions effectively articulated a water law principle referred to as the “doctrine of intervening public use” within the Judgment. Other provisions added to promote flexibility included provisions for storage of imported water and carryover of unused Standard Production Allocation (i.e., appropriative rights), and transferability of Standard Production Allocation between groundwater users. Finally, the Judgment established a three-year period in which those holding Alternative Production Allocation could convert their allocation into Standard Production Allocation, which would then make the allocation transferable.

Deciding on how much total groundwater production would be allowed was challenging, as it pitted the risk of seawater intrusion against the prospect of substantially diminished water supplies for the Monterey Peninsula and the ensuing economic consequences that would be created. The groundwater producers requested the court to allow a seven-year period of production at historical quantities subject to reductions if necessary to respond to detections of seawater intru-

sion, which would be followed by scheduled reductions in the eighth year. The MPWMD and MCWRA argued for an immediate reduction and a shorter period for scheduled reductions to commence. Ultimately, Judge Randall settled upon a three-year period of production at historical averages followed by a 10% reduction triennially thereafter designed to return the Basin’s water tables above sea level. The reductions can be forestalled or eliminated if imported water supplies are obtained in equivalent quantities to augment the Basin. The Judgment further requires the creation of a robust Basin Monitoring and Management Plan and provides for a plan to address seawater intrusion should it occur despite the scheduled reductions in cumulative production over time.

Key to the success of the physical solution is the planned importation of supplemental water supplies to the Basin and the Monterey Peninsula. The Judgment creates incentives and resources for the watermaster and the various stakeholders to pursue these necessary new supplies. First, the planned reductions, and the prospect of earlier reductions should seawater intrusion occur, establish the principal motivation to obtain these supplemental supplies. Moreover, the Judgment imposes two types of replenishment assessments that will raise funds to procure supplemental water supplies for Basin replenishment. Further, the Judgment specifically obligates Cal Am to obtain and develop sufficient long-term supplies to prepare for planned reductions in its allocation and otherwise augment its water supply.

Fortunately, multiple sources of supplemental supplies can be feasibly obtained within the near and mid-term if the various stakeholders cooperate with each other. These potential supplemental supplies include local and regional desalination plans, aquifer storage and recovery programs that would tap surplus winter flows from the Carmel River, recycled water for non-potable uses, and advanced treatment of recycled water for Basin recharge.

The most contested and interesting issue in the case was the matter of future Basin governance. The groundwater producers and all of the cities argued for the creation of a multi-party watermaster to make Basin management decisions subject to the

Court’s ongoing oversight. The MPWMD argued that either no watermaster should be created in deference to its water management powers originating from its enabling legislation (Water Code Appendix, Chapter 118), or it alone should be appointed as watermaster. Remarkably, the MPWMD argued that because of its status as a special district created by the Legislature, the court had no jurisdiction to establish a multi-party watermaster and that it was already actually managing the Basin. Judge Randall disagreed and ordered the creation of a nine-party watermaster with weighted voting totaling 13 votes. The appointments and voting positions are as follows: Cal Am (3), the City of Seaside (2), the MPWMD (2), the MCWRA (2), the City of Monterey (1), the City of Del Rey Oaks (1), Sand City (1), the Coastal Subarea Landowner Representative (1/2), and the Laguna Seca Subarea Landowner Representative (1/2). Like almost every other groundwater adjudication, the Judgment also reserves continuing jurisdiction in the Superior Court to review watermaster decisions on its own initiative or by a motion by a party, to resolve future disputes and to issue subsequent orders.

The Prognosis

The Judgment became final on March 27, 2006. It presents the opportunity for more prudent water management going forward and a new era of cooperation among the local water stakeholders seated on the Basin Watermaster. To do so, each stakeholder must decide to (a) not appeal Randall’s ruling, an action that would likely stymie the Judgment’s management plan for a year or more, and (b) commit to put past antagonism behind in exchange for cooperation. Hopefully, the certainty afforded by the Judgment and the recourse to the Judge will help to steer the stakeholders to achieve efficient Basin management and expedited procurement of necessary supplemental water supplies.

Steven Hoch and Russell McGlothlin are both attorneys with the law firm of Hatch & Parent, which represented the City of Seaside in the Seaside Basin Adjudication. Hatch & Parent specializes in transactional negotiations, administrative proceedings, and litigation of all facets of water rights and water quality. 💧

Emerging Contaminants in Groundwater: A Continually Moving

Target — Continued from Page 3

removal from soil and groundwater will be presented. In addition, standard of care issues and federal and state drinking water standards will be discussed.

Experts from academia, regulatory agencies, consulting, industry, and the legal arena will participate in seven platform sessions, two posters sessions and a GRA San Francisco branch dinner panel presentation that will be held in conjunction with the Symposium (<http://www.grac.org/sanfrancisco.asp>). Featured academic speakers include David Sedlak and Shaily Mahendra (U.C. Berkeley), Paul Traytnek (Oregon Health and Science University), Peter Fox (Arizona State University), and Eduard Hoehn from the Swiss Federal Institute for Water Science and Technology. Industrial sector speakers include Dr. Reid Bowman (Applied Process Technology), Dr. Andy Eaton (MWH Laboratories), Dr. Pat Evans from CDM, Elisabeth Hawley from Malcolm Pirnie, Dr. Saied Tousi from Pall Corporation, Phyllis Stanin from Todd Engineers, Dr. Richard C. Pleus from Intertox and others. Offering perspectives from the regulatory arena are Dr. Bruce Macler and Dr. David Munch from US EPA, Thomas Mohr from Santa Clara Valley Water District, Virginia Yingling from the Minnesota Department of Health, and others. Additional speakers include Dr. Jean Moran from Lawrence Berkeley National Laboratory and Dr. Janis Hulla from the United States Army Corps of Engineers.

The combination of invited speakers and experts from key areas, along with talks chosen from the submitted abstracts, will make this an important event for all water quality professionals interested in emerging contaminants. Program details can be viewed at <http://www.grac.org/contaminantsagenda.pdf>. For registration information, or if you are interested in exhibiting your organization's services or being an event sponsor, please contact GRA at 916-446-3626 or e-mail Mary Megarry at mmegarry@nossaman.com. 💧

Wells and Words — Continued from Page 4

tests. Logistical problems include maintenance of a long-term constant discharge (or head) with the reliable operation of the pump and associated equipment including motors, pumps, fuels, and discharge lines. Analytical problems include correction of the drawdown from various factors including atmospheric barometric changes, regional water level fluctuations, and hidden pumping from nearby wells. In summary, the shorter the pumping test, the more likely logistical problems can be easily resolved, while drawdown data will not require analytical corrections.

ET is a logarithmic (log) function of the analytical solutions to pumping tests. Figure 1 shows a Cooper-Jacob plot. Note that the arithmetic length on the time axis from 1 to 3 days is the same length between 8 hours and 24 hours. Table 1 compares the test data based on a log cycle and arithmetic approach. A 72-hour test is equivalent to 3.5 log cycles (starting from one minute) or 3,320 minutes. Note that in less than one day (1,000 minutes), 85.7% of the 3.5 log cycles have been measured; while arithmetically only 23.1% of the 3,320 minutes have been collected. This implies that drawdown measurements during a test are weighted in favor of early-time data rather than late-time data, unless the test is operated to extraordinary lengths.

The purpose of the pumping test can determine the duration of the test. Tests are conducted to (a) estimate well efficiency and performance, (b) ascertain long-term well yields, (c) determine effective dewatering plans, (d) locate unknown groundwater barriers, (e) resolve influences to nearby wells, streams, and wetlands,

(f) determine responses from over- and under-lying aquifers and confining units, and (g) measure water quality.

Conducting a reliable, analyzable, and cost effective test with either primary or secondary porosity (i.e., fractures) requires the aquifer be pumped at a realistic, constant, and measurable discharge for an appropriate ET, extending beyond casing storage. Obs wells that respond clearly during a test are highly desirable for a complete description of the aquifer parameters. The flexibility in determining the ET of a pumping test allows for better use of capital investments in collecting data that is hydraulically coherent and defensible. Instead of multiple-day, -week, or -month pumping tests, a strategically located and designed obs well is a technically superior solution to understanding long-term aquifer responses.

David W. Abbott is with Todd Engineers in Emeryville and may be reached at dabbott@toddengineers.com. The complete article has been posted on www.grac.org/hydrovisions.asp. 💧

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Sacramento Branch Highlights

BY STEVE LOFHOLM, BRANCH SECRETARY

The Sacramento Branch's first meeting of the New Year was held on January 11th. Jon Goetz, a project manager with MWH, gave a presentation on SHEDTOOL, an innovative tool for data storage and graphical display. The SHEDTOOL application was originally developed for the Sacramento Groundwater Authority (SGA) and subsequently has been used by the U.S. Army Corp of Engineers and the California Department of Water Resources. SHEDTOOL is a stand-alone application that allows entry, storage, retrieval, and presentation of groundwater data, and interfaces with groundwater models to provide for calibration and future forecasting of groundwater and surface water behavior. It also works

with graphical programs to generate groundwater maps and lithologic profiles (cross sections) with well construction data, long-term monitoring data, and aquifer characteristics.

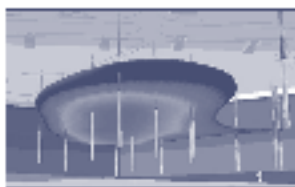
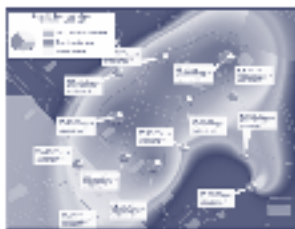
The February meeting featured Ton Vorster, RWQCB, and Brian Lewis, DTSC, for a discussion of what's new and upcoming in groundwater from the Central Valley RWQCB's and DTSC's point of view. Ms. Vorster is program manager of the Groundwater Cleanup Program for the Central Valley Region with responsibilities for the cleanup and remediation of both Federal facilities and private sites. Mr. Brian Lewis is Chief of the Geological Services Unit, Department of Toxic Substances Control. His unit is responsible for providing geological support for permitting, closing, and remediating hazardous waste sites. This was the second year in a row for this annual overview, which detailed some emerging issues, and provided a summary of new guidance documents and training opportunities open to consultants.

At the March meeting, Dr. Tim Horner, an Associate Professor in the Geology Department at CSU Sacramento, gave a presentation titled "Salmon Habitat and Gravel Studies on the American River." Dr. Horner's research is focused on salmonid (salmon and trout) spawning requirements in the American River. The results of their research show that the salmonids spawning density is highest in riffles where there is optimal current velocity (up to a threshold of 3 feet per second), water depth, and grain size. Water temperature is also a critical factor. Spawning only begins when water temperatures drop to 65 degrees. The conclusion of their studies thus far is that dissolved oxygen and intergravel flow are critical components of this story, but can be difficult to measure in the shallow subsurface. Dr. Horner and his students plan to employ several techniques including tracer tests and heat flow analyses to estimate seepage through riffles and other high-use features. 💧

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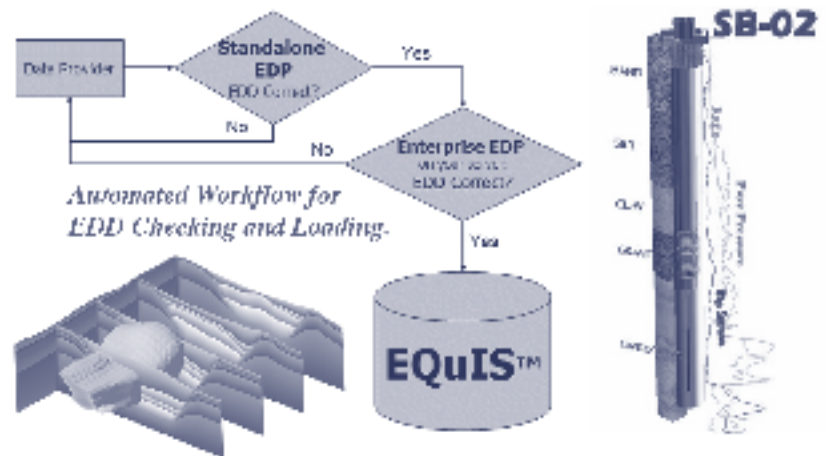
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San Francisco Bay Branch Highlights

BY KATRIN SCHLIEWEN,
BRANCH SECRETARY

January 2006 - Dr. Andrew Jackson, Ph.D., P.E., associate professor at the Water Resources Center at Texas Tech University, presented "Occurrence of Atmospherically Generated Perchlorate in Arid and Semi-Arid Regions of North America" to a large audience of members, nonmembers, and students on the evening before the GRA Perchlorate Symposium at the Santa Clara Hyatt. Dr. Jackson began his talk with an overview of the wide variety of known or suspected anthropogenic and natural sources of perchlorate in groundwater. Current research indicates that perchlorate is present throughout surface and groundwater in arid and semi-arid areas, and background concentrations are significant, often greater than current proposed regulatory standards. Elevated perchlorate concentrations detected in much of the Ogallala Aquifer in northern Texas are likely due to naturally occurring perchlorate, based on the detection of perchlorate in samples collected from monitoring or water supply wells over an enormous area, much of which is devoid of industrial activity, in groundwater down to 450 feet below ground surface, and in groundwater that has been age tested to approximately 2,000 years old. Dr. Jackson's research has determined that a likely source of perchlorate in the Ogallala Aquifer is from precipitation, which transports atmospherically produced perchlorate. Perchlorate can be produced in the atmosphere where chloride attached to particulate matter interacts with ozone during electrical activity. Dr. Jackson's talk was an excellent overview of perchlorate, its occurrence in the environment, and potential sources, effectively leading participants into the Perchlorate Symposium.

February 2006 - The February 22 dinner meeting, held at Spenger's in Berkeley, featured the popular annual update from the San Francisco Regional Water Qual-

ity Control Board. Speakers Stephen Hill and Alec Naugle discussed, among other topics, the new lead agency determination procedures to allocate sites to the various oversight agencies; the increased importance of public participation (PP) and identification of PP categories; a summary of commonly used screening levels in the Bay Area; a basin plan update; an update of the groundwater ambient monitoring assessment (GAMA) program; and regulations and concerns governing aquifer storage and recovery (ASR) programs. Mr. Hill and Mr. Naugle can be contacted via email for additional information at shill@waterboards.ca.gov and anaugle@waterboards.ca.gov, respectively. ♠

San Joaquin Valley Branch Highlights

BY BILL PIPES, BRANCH PRESIDENT

Our February speaker was W. Greg Hamer of Geomatrix Consultants, Inc.. Greg spoke on "The Development of an Artificial Recharge Program to Capture Storm Water Runoff and Increase Groundwater Supplies in Southern California."

We combined our March and April branch meeting dinner into one. It was held in conjunction with GRA's Nitrate in Groundwater Symposium in Modesto, California. Our speaker for the evening was John Menke of the State Water Resources Control Board. John's presen-

tation was titled "Groundwater Impacts from Confined Animal Facilities"

Our meetings are dinner meetings and are held the third Thursday of the month. Meeting notices are mailed out each month and email reminders are sent frequently. We also post notices of all our meetings on the GRA website (www.grac.org). If you would like to be on our mailing/emailing list, please contact Diana Babshoff at (559) 264-2535 or dbabshoff@geomatrix.com. ♠

Central Coast Branch Highlights

BY BRAD HERREMA,
BRANCH PRESIDENT

The Branch welcomed Noah Heller, founder of BESST, Inc., to its April 5 meeting. Mr. Heller spoke to the group about a unique new technique for velocity profiling and sampling in production wells, without removal of pumping equipment or taking the well out of service. The Central Coast Branch will next meet June 7, at which time the staff of the Goleta Water District will discuss the lessons learned in their current ASR well rehabilitation project. Further details regarding this meeting and information for those wishing to attend can be found at <http://www.grac.org/centralcoast.asp>. The branch will meet again in early August, at which time we hope to welcome current GRA President Tom Mohr as our speaker. ♠



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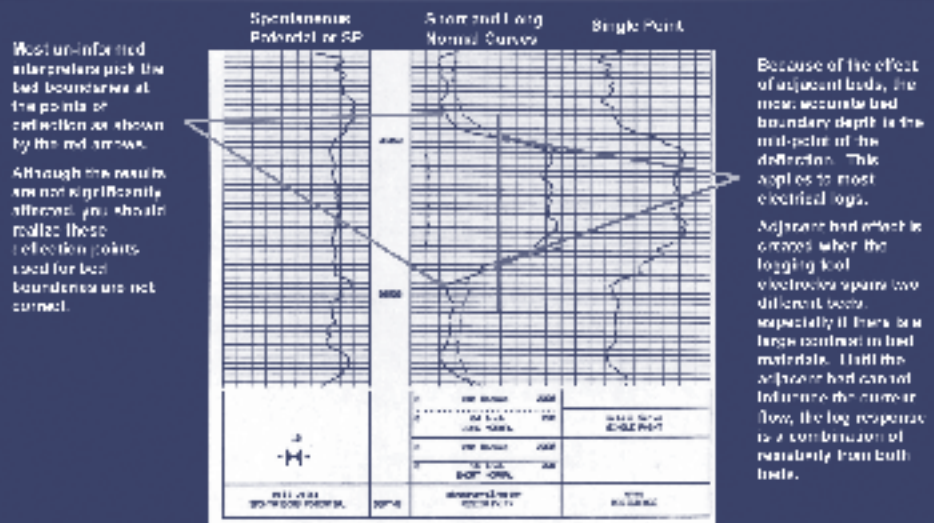
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(Please visit www.grac.org for detailed information, updates, and registration unless noted)

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|--|--|---|--|
| GRA Symposium <i>Emerging Contaminants & Water Quality: Current & Future Challenges</i> | June 7-8, 2006 Concord, CA | GRA Board Meeting | August 5, 2006 Pt. Richmond, CA |
| GRA Sponsored Course <i>Model Calibration & Predictive Uncertainty Analysis Using PEST</i> | September 13-15, 2006 San Francisco, CA | GRA Course <i>Introduction to Groundwater and Watershed Hydrology: Monitoring, Assessment & Protection</i> | October 2-3, 2006 Glendale, CA |
| GRA 15th Annual Meeting <i>Assessment, Use & Management of Groundwater in Areas of Limited Supply</i> | September 21-22, 2006 San Diego, CA | GRA Symposium <i>High Resolution Site Characterization & Monitoring</i> | November 14-16, 2006 Long Beach, CA |



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