HYDRO VISIONS

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GROUNDWATER RESOURCES ASSOCIATION OF CALIFORNIA

Fall 2006

Nitrate in California Groundwater Symposium 2006: Are We Making Progress?

BY BRAD ESSER, LAWRENCE LIVERMORE NATIONAL LABORATORY

Over 170 people attended the 17th Symposium in the Groundwater Resources Association of California Series on Groundwater Contaminants, which was held on April 4 and 5, 2006 in San Joaquin Valley city of Modesto. The symposium was held in conjunction with a Dairy Groundwater Monitoring Workshop and a GRA San Joaquin Valley branch meeting, and all addressed the longstanding problem of nitrate contamination in California groundwater.

GRA's Nitrate Event Organizing Committee Members- First row: Jean Moran, Sarah Raker, Brad Esser; Second row: Thomas Harter, Matt Zidar, Bill Pipes, John Ungvarsky; Back row: Ray Kablanow. Not pictured: Tracy Hemmeter, Paul Sousa, Krista Clark, Laosheng Wu, Steven Silva, and Angela Schroeter

The symposium brought together 25 speakers, 19 poster presentations, and 7 moderators to try and answer the question "Nitrate in California Groundwater: Are We Making Progress?" The diversity of approaches to answering this question is reflected in the program (http://www.grac.org/nitratemain.html) and in the background of the presenters, who included federal researchers (USGS, LLNL, USDA), academic researchers (University of California, California State University, North Carolina State), state and county agency officials (SWRCB and CDFA; Monterey, Tulare and Merced Counties), and the consulting industry. The three panel discussions brought together regulators (federal, state, and county) and stakeholder representatives (farmers, dairymen and farmworkers).

Paul Betancourt gave an inspiring keynote address. Paul is a San Joaquin Valley farmer who now sits on the Central Valley Regional Water Quality Control Board. He is also a member of the Fresno County Farm Bureau, Valley Clean Air Now Board and San Joaquin Valley Air Pollution Control District-Community Advisory Committee, and so brings a valuable perspective to the issue of nitrate contamination in Central Valley groundwater. Paul spoke on the pressures facing farmers in the Central Valley, namely growth and globalization, and the importance of managing and protecting our groundwater for the future, stressing the need for leadership at the regional and state level.

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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.

INSIDE

President's Message

BY THOMAS K.G. MOHR

The Emergent Groundwater Scientist

What do we really know? The groundswell of Emerging Contaminant issues in the last 10 years has produced a series of GRA events to explore new information. A recurring theme has emerged: there's a new, new contaminant that's worse than the last one and requires our attention now. The 'contaminant du jour' syndrome is seductive – it's new, exciting, and eminently more publishable than the same old stuff we've been working on all along. But how do we establish which of the many known and emerging contaminants warrants our attention, effort, and scarce financial resources?

The trouble usually begins when we start looking for it. At our June Emerging Contaminants Conference, we allowed analytical chemists unrestricted access to the microphone for three whole talks. That's a risk by any assessment, but we were rewarded. We learned about the "bored chemists' syndrome," in which chemists with nothing better to do start poking around to isolate some peak or other undifferentiated noise in an unexplored region of the chromatogram. Aha - Perfluorooctanoic acids! 1,4-dioxane! Chlorotrifluoroethylene! Breakthrough moments have made it possible to see more of what's in our water. But the controversy over what to do with the new information is far from settled.

There are five basic challenges to the emerging contaminants puzzle that groundwater scientists must engage and overcome: 1) analysis for detection and quantitation; 2) occurrence, fate, and transport; 3) toxicology and risk; 4) treatment; and 5) regulatory policy. After we've figured all that out, we must 6) somehow make it relevant to the consumers potentially affected by the presence of this newly discovered menace. I suspect that very few of us are well-trained in all of the first five challenges, for we'd need to be schooled in 1) analytical chemistry; 2) hydrogeology, soil chemistry, microbiology; organic and physical chemistry; 3) physiology, toxicology, pharmacology, and risk assessment; 4) environmental engineering; and 5) law, rhetoric, and public administration. But almost none of us are trained or skilled in the counter-intuitive art of 6) risk communication. Can you explain your work to your educated but uninitiated friends and relatives, and produce an appropriate response to the potential risk of a multisyllabic chemical in their drinking water?

Witness what could be called an experiment: a few years ago, a large group of groundwater consumers received letters advising that possibly harmful levels of a chemical on the Unregulated Contaminant Monitoring Requirements list may be present in their drinking water. During the same general timeframe and not very far away, a much larger group received Consumer Confidence Reports (CCR), in which the same contaminant was reported to be present in tap water at an average concentration almost a thousand times

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HydroVisions is the official publication of the Groundwater Resources Association of California (GRA). GRA's mailing address is 915 L Street, Suite 1000, Sacramento, CA 95814. Any questions or comments concerning this publication should be directed to the newsletter editor at editor@grac.org or faxed to (916) 442-0382.

Upcoming Events

High Resolution Site Characterization and Monitoring

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

PRESENTED IN ASSOCIATION WITH USEPA, CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL (DTSC), CALIFORNIA STATE WATER RESOURCES CONTROL BOARD (SWRCB), THE U.S. GEOLOGICAL SURVEY, AND THE UNIVERSITY OF WATERLOO, CANADA

NOVEMBER 14-16, 2006, WESTIN HOTEL, LONG BEACH, CA

Much has been learned about the behavior of subsurface contaminants in the last three decades, and yet site assessments performed at commercial sites in North America often still follow traditional site assessment practices established in the early 1980s. Recently, new technologies have been developed that allow rapid, high-resolution site assessments that provide unprecedented clarity regarding the nature, extent, and migration of contaminants in the subsurface, and the effectiveness of in situ remediation. This symposium, Second in GRA's new Tools and Technologies Series, will bring together an invited group of top researchers, practitioners, and regulatory experts from around the globe to describe the "state of the science" regarding efficient, high-resolution subsurface site assessments and remediation monitoring. Due to space considerations, the complete listing of participants and presentations is on the GRA website, www.grac.org.

Presentations will be made in six consecutive technical sessions during the first two days of the event. There will also be moderated 15-minute summary and discussion periods at the end of each session. The third day will consist of a hands-on, outdoor field demonstration of state-of-the-art high resolution technologies. The final session of the symposium (Session 7) will consist of six short presentations, by invited panelists from industry, academia, and the regulatory community, on the efforts needed to achieve wider use of these technologies.

Confirmed speakers focusing on high-resolution characterization and monitoring at field research sites from around the world include **Prof. Douglas Mackay (U. C. Davis), Prof. Beth Parker (University of Waterloo), Dr. Jim Butler (Kansas Geological Survey and 2007 Darcy Lecturer), Dr. Gary Wealthall (British Geological Survey), Dr. Susan Hubbard (Lawrence Berkeley Laboratories),** and **Dr. Mette Broholm (Danish Technical University)**. Speakers focusing on innovative technologies and resources investigations include **Dr. Blayne Hartman (H & P Mobile Geochem.), Dr. Randy St. Germain (Dakota Technologies), Mike Taraszki (MACTEC), Seth Pitkin (Stone Environmental), Dr. Stephen Cullen (Daniel B. Stephens, Inc.), Dr. Mark Kram (NFESC), Wes McCall (Geoprobe), Dr. Junfeng Zhu (University of Arizona), Prof. Graham Fogg (UC Davis), Dr. John Izbicki (USGS), Prof. David Rudolph (Univ. of Waterloo), Roy Herndon, Orange County Water District),** and **Hank Baski (BASKI Packer)**.

There will be exhibits by more than 30 invited manufacturers of innovative site characterization and monitoring technologies and software developers. Technical poster presentations will follow the platform presentations on each day of the symposium.

This symposium of world-class invited speakers and technology developers promises to be one of GRA's most popular events ever. Make your reservation to attend this one-time symposium early before it is sold out. For more information and to register, visit the GRA website at www.grac.org.

Please feel free to contact Murray Einarson (meinarson@geomatrix.com; 650-400-0248) or Tim Parker (tparker2@slb.com; 916-329-9199) if you have any questions about this upcoming event.

Wells and Words

Technical Corner

BY DAVID W. ABBOTT, P.G., C.HG.,
TODD ENGINEERS

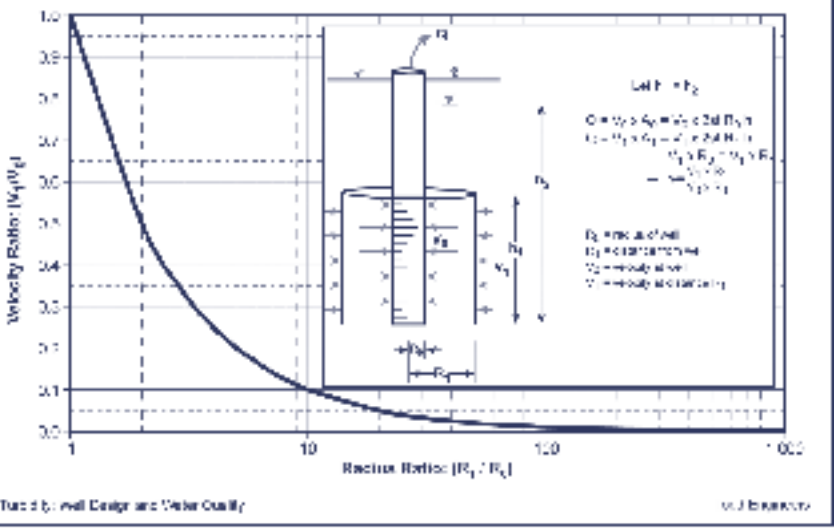
Turbidity: Well Design and Water Quality

Turbidity is the state, condition, or quality of reduced clarity or opaqueness of a fluid due to the presence of suspended matter, and is a measure of the ability of suspended material to disturb, diminish or, *scatter* the penetration of light through a fluid (AGI, 1987, *Glossary of Geology*). Turbidity refers to the presence of suspended solids, organic matter, and/or colloids in water and is measured in nephelometric turbidity units (NTU). Measurements are often based on the length of a light path through water, which causes the image from a flame of a standard candle to disappear (Todd, 1980, *Groundwater Hydrology*). Unlike turbulent surface water, which often contains suspended solids or soluble organic matter, laminar groundwater flow in unconsolidated material is rarely turbid. Turbidity should not be confused with color, which usually results from leaching of organic debris (i.e., tannins) and represents the absorption of light wavelengths rather than the scattering of light. A water sample can have turbidity but no color; alternatively, a sample can have color but no turbidity.

Turbidity in well water results mainly from turbulent flow near the well and is related to the installation, drilling, construction, development, completion, operation, and maintenance of the well. These causes may include: (1) incomplete well development; (2) inappropriate well screen and aperture design; (3) improper filter pack design; (4) incorrect placement of screen locations; (5) excessive pumping water levels, causing cascading water and entrainment of air; and (6) improper pump design, causing excessive well pumpage.

Some elevated turbidity levels can also be related to ineffective subsurface filtration of induced surface water to the well or inadequate sanitary well seals. Effective and induced surface water infiltration to a water well is related to the lineal distance between the surface water body and the well screen, plus aquifer grain-size and -sorting. For instance, the closer the well intake to surface water, the more likely it is that natural subsurface filtration of induced surface water will be ineffective. Furthermore, clean gravel (gravel with unfilled voids) is a poor filtering agent, in contrast to the subsurface filtering potential of medium- to coarse-grained sands or mixed sands and gravel. However, it is relatively rare to find openwork gravel in the geologic environment.

Figure 1 - Approximate Variation of Groundwater Velocity Surrounding a Pumping Well



Groundwater velocity significantly and rapidly decreases with the radial distance from a pumping well, reducing the effective energy to lift and mobilize colloidal particles. Figure 1 and calculations show that at a distance double the radius of the well, the radial groundwater velocity in a concentric cylinder around and toward the pumping well reduces by a minimum of one-half; if the distance is ten-fold, the velocity is one-tenth of that at the well. Generally, if the distance is N times the radius of the well; the velocity at that distance is approximately N^{-1} of the velocity at the well.

In most cases, elevated turbidity can be attributed to the design, operation, and maintenance of the well. Perforations or screens placed opposite or directly underlying fine-grained aquifer or non-aquifer materials may result in persistent and elevated turbidity as the fine-grained materials are ripped from the formation and removed from the well. Such mining can also result in the collapse of overlying fine-grained materials.

Excessive well yields or over-pumping not only decrease well efficiency and shorten well life expectancies, but increase near-well entrance velocities, so that fine-grained material can be continuously mobilized and pumped out of the well. This can result in collapse of the framework of the aquifer and increased turbidity levels.

Turbidity represents not only an aesthetic problem, but is often associ-

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Technical Corner

Nitrate Forensics

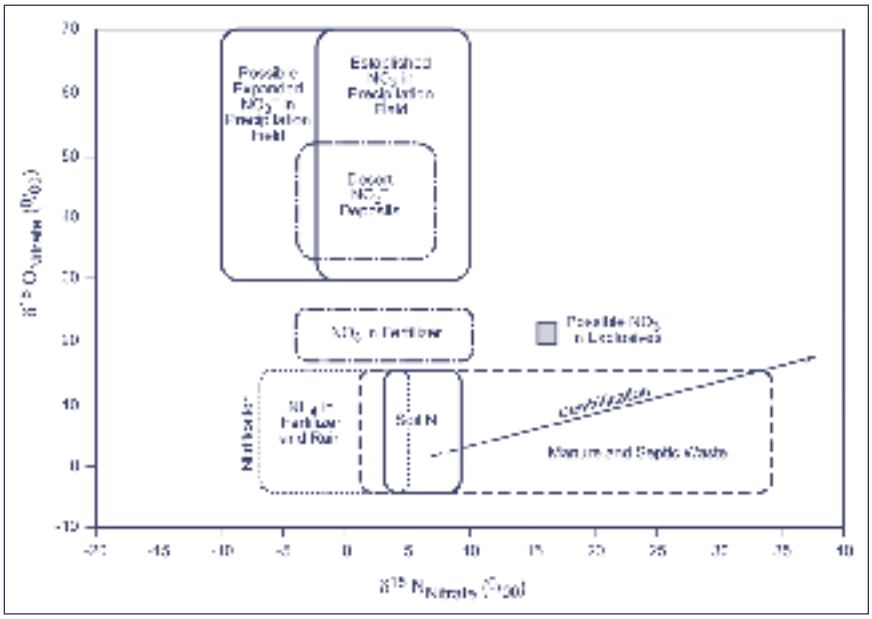
BY WILLIAM E. MOTZER, PH.D., PG, SENIOR GEOCHEMIST, TODD ENGINEERS

Introduction

Contamination of groundwater by nitrate (NO_3^-) from various sources continues to be a problem through much of the U.S., particularly in the midwest and California, where it is much more of a problem than perchlorate, with nitrate contaminating groundwater in many Central Valley alluvial aquifers. Most nitrate contamination sources are easily defined, particularly if there is a single known source such as a cattle feed lot, but in some areas – particularly urbanized rural locations – distinguishing between human (anthropogenic) and natural (geogenic) sources is somewhat more complicated. This brief article describes one excellent method for fingerprinting nitrate sources. The U.S. Geological Survey's Isotope Group in Menlo Park and the Lawrence Livermore National Laboratory Nitrate Working Group at Lawrence Livermore National Laboratory have pioneered most of the recent research in isotope forensics. This article is somewhat abbreviated in the interests of space constraints; the full version, including references, is posted on our website, www.grac.org.

Sources

Sources of anthropogenic nitrate contamination to groundwater are septic systems, sanitary sewage effluent releases, domestic animal wastes, and home and farm usage of nitrogen fertilizer. Other nitrate sources include explosives and pyrotechnics, such as fireworks, flares and torches, and munitions. Nitrate contamination also occurs from the degradation of cyanide (CN^-), an industrial pollutant, particularly common to historic gasworks sites.



Nitrate in groundwater from geogenic sources include those that are desert-derived, such as the Chilean Atacama Desert deposits (which also contain natural perchlorate), caliche and playa lake evaporate deposits, and desert vadose zone soils. Recent research at the New Mexico Institute of Mining and Technology at the University of Nevada and U.S. Geological Survey has shown that nitrate in desert soils occurred at much greater quantities than previously reported, with subsoil nitrate ranging from 2,000 to 10,000 kilograms per hectare (kg/ha). Farmers typically only apply nitrogen fertilizers in amounts ranging from 25 to 250 kg/ha per year. The researchers concluded that this naturally-occurring vadose zone nitrogen reservoir had the potential to become mobilized, thereby leaching large amounts of nitrate to groundwater.

Fingerprinting Nitrate Sources Using Stable Isotopes

How can one distinguish between anthropogenic and geogenic nitrate? Conventional nitrate analysis only gives quantitative data and does not discriminate between sources. However, if one examines the stable isotopes of nitrate, unique fingerprints for different sources can be obtained.

Most stable isotopes in substances are determined by using isotope ratio mass spectrometry (IRMS), in which a beam of charged ions is generated from the thermal ionization of a solid sample (known as a "solid source") or by ionizing a gaseous sample ("gas source"). Solid source IRMS is used for elements with high atomic masses such as strontium, lead, and uranium. For most light elements (i.e., hydrogen, nitrogen, and oxygen) the analyzed material is converted to a gas prior to analysis. The isotopic concentrations are then measured as a ratio of the isotope to a common nuclide. In the case of gas source IRMS, it is measured against an international standard.

Stable nitrogen and oxygen isotopes are useful in indicating sources when nitrate is present in surface or groundwater. Delta nitrate-nitrogen ($\delta^{15}N_{nitrate}$) and nitrate-oxygen ($\delta^{18}O_{nitrate}$) isotope

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North Gualala Decision

BY MICHAEL FIFE, HATCH & PARENT

On May 31, 2006, the First District Appellate Court issued its decision in the case *North Gualala Water Company v. State Water Resources Control Board*. The case addresses the legal criteria to be used in deciding whether groundwater pumping in the vicinity of a surface stream should fall within the permitting jurisdiction of the State Water Resources Control Board ("SWRCB").

The lower court ruled against the North Gualala Water Company, holding that the four part test articulated in the Garrapata case (*In re Garrapata Water Co.*, SWRCB Decision No. 1639, June 17, 1999) was satisfied in the area where the pumping was occurring. This test requires: (1) a subsurface channel must be present; (2) the channel must have a relatively impermeable bed and banks; (3) the course of the channel must be known or capable of being determined by reasonable inference; and (4) groundwater must be flowing in the channel.

Of concern to many people throughout the State, the lower court opinion also contained troubling language which seemed to support an "impacts" based test which would hold that any pumping which impacts a surface stream falls within the SWRCB permitting jurisdiction. The lower court opinion also seemed to support the general concept that wide alluvial groundwater basins (such as the San Fernando Basin) could be considered wide subsurface channels. The appellate court rejected both these ideas and affirmed that the Water Code section 1200 limitation on the SWRCB's jurisdiction was clearly intended as a *limitation*, which precludes jurisdiction in wide alluvial

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California Legislative Corner

2006 Legislative Summary

BY GRA LEGISLATIVE COMMITTEE

The 2005-06 Legislative Session adjourned on August 31. Senate Pro Tem Don Perata said that the Legislature "defied political physics" by having a very productive session in an election year. Among the rare feats accomplished this year was an on-time state budget, an infrastructure package of bonds placed on the ballot by the Legislature, a groundbreaking bill to combat global warming and a bill to create competition in the cable television industry.

The most significant groundwater bill of the year, SB 1640 by Senator Sheila Kuehl, strengthens the groundwater monitoring system in the state of California. GRA worked closely with Senator Kuehl and the committee consultant, Dennis O'Connor, to refine and perfect the bill. Stalled on the Assembly Floor for three days and unable to reach the 41 votes necessary for passage, the bill finally mustered 46 votes in the Assembly and was passed on the last night of Session. The bill is now pending signature on the Governor's desk, however, a long list of agricultural interests and the California Chamber of Commerce remain in opposition. Although there is an equally long list of water interests in support, including the ***Groundwater Resources Association***, the list of opponents and the fate of last year's SB 820 makes SB 1640 a potential candidate for a veto. GRA has been asked to form a SB 1640 Implementation Technical Committee to help water agencies and DWR begin implementing SB 1640. The Governor must act on all legislation by September 30.

Another bill of interest to GRA, SB 187 by Senator Nell Soto, relating to drinking water standards was also sent to the Governor. The bill as amended in the Assembly authorizes the Department of Health Services to consider the potential health effects in assessing the economic feasibility for maximum contaminant levels (MCL). The bill is intended to bring accountability and integrity to the process of setting chemical exposure limits in California. Senator Soto believes that state regulators have not been aggressively setting standards to protect the most vulnerable in our population. Therefore the bill would require DHS to report monthly if it fails to adopt a MCL standard. This bill left the Senate with much tougher language requiring DHS to take action; however, the Assembly amendments moderated the impact on DHS and the bill is much more likely to be signed.

Recent polling by the Public Policy Institute of California suggests that the bond initiatives on the November ballot may face an uphill battle. Among likely voters, 76% of Republicans and 48% of Democrats think the total bond amount is too high. We will keep you posted as significant developments occur so please stay in touch with us through the GRA website or contact us at 916-441-1232 or pbauer@hatchparent.com or cfrahm@hatchparent.com.

Santa Ana Water Board Considers Waste Discharge Requirements for the Injection/Percolation of Imported Water

BY MARTIN STEINPRESS, P.G., C.HG, ACWA GROUNDWATER COMMITTEE MEMBER

At the Association for California Water Agencies (ACWA) Spring Conference, the Groundwater Committee was briefed by the Santa Ana Regional Water Quality Control Board's Executive Officer, Gerard Thibeault, on the proposed Resolution No. R8-2006-0042 and Order No. R8-2006-0005 – Initial Study and Negative Declaration and Issuance of General Waste Discharge Requirements for the Discharge of Salts Through the Injection/Percolation of Imported State Project Water, Colorado River Water or Imported Well Water to Recharge Groundwater Management Zones Within the Santa Ana Region. The ACWA membership and Board of Directors had serious concerns relating to the proposed Resolution and Order, believing that it inappropriately classifies imported water as "waste," in direct violation of applicable law, and could set a dangerous precedent with state-wide implications.

In a May 17, 2006 letter to the Regional Board, ACWA proposed that the Regional Board convene a collaborative process intended to achieve appropriate salt management in the Santa Ana River watershed without triggering a legal confrontation. On May 19, 2006, the Regional Board met to discuss the staff proposal to regulate the recharge of State Water Project water, Colorado River water, and imported well water, and a number of ACWA members testified in support of the ACWA position. The Regional Board had little discussion, noting that the Regional Board has always tried to work with stakeholders and that salt management is of utmost importance to the region. With that, the Board agreed to direct staff to meet with stakeholders on a bi-weekly basis and to develop a proposed workplan for the collaborative process. For updates go to www.waterboards.ca.gov/santaana. Thanks to David Aladjem and Krista Clark for their updates to the committee.

USEPA Happenings

BY JOHN UNGVARSKY

Federal Legislative/Regulatory Corner

New Class V Webpage for Large Capacity Septic Systems

The Office of Water's Underground Injection Control (UIC) Program has launched a new Class V webpage for Large Capacity Septic Systems. The page is designed to give owners and operators of Large Capacity Septic Systems an overview of the UIC Program and help them learn how to comply with Class V regulations. To learn more about Class V Large Capacity Septic Systems go to: http://www.epa.gov/safewater/uic/classv/class5_types_lcss.html.

Handbook for Small Noncommunity Water Systems: Total Coliform Rule

This new handbook, for Small Noncommunity Water Systems serving less than 3,300 persons, will help owners and operators of small drinking water systems, technical assistance providers, and state drinking water personnel to better understand the Total Coliform Rule provisions under the Safe Drinking Water Act (SDWA). EPA has developed this up-to-date reference handbook with the intent of enhancing system capacity for prolonged infrastructure sustainability. This document and additional tools to help small water systems are available on EPA's website at http://www.epa.gov/safewater/smallsys/ssinfo.htm.

Guidance Helps Small Drinking Water Systems Identify Affordable Treatment Options

The guidance document, Point-of-Use or Point-of-Entry Treatment Options for Small Drinking Water Systems, provides operators and water officials with valuable information about treatment devices that can be installed at Point of Use or Point of Entry. Owners and operators of small drinking water systems will find the guidance useful during the planning stage, including pilot testing, public education, and operation. Maintenance and other implementation issues are also covered. See the guidance at: http://epa.gov/safewater/smallsys/ssinfo.htm#two.

Tools Will Help Small Drinking Water Utilities Monitor Drinking Water

EPA has released a set of user-friendly multimedia products to help small drinking-water utilities determine federal monitoring requirements and prepare water compliance samples under the Safe Drinking Water Act. The tool kit features an interactive Rule Wizard website that provides a complete list of all of the federal monitoring requirements for a selected type and size of public drinking water system, such as a community water system serving 3,300 people using ground water as a source of supply. A companion tool, Interactive Sampling Guide for Drinking Water Operators, is also available. The CD-ROM is available through the Safe Drinking Water Hotline (1-800-426-4791) and to launch the RuleWizard, go to: http://www.RuleWizard.org.

Waterborne Disease Research Summaries Published

EPA's Office of Research and Development and the Office of Water have published a series of papers summarizing the research conducted on waterborne disease in the last 10 years. The work includes research supported by EPA and others and is limited to gastrointestinal illness as the health effect of concern. The papers also represent the most comprehensive review conducted in the last 25 years and the first publication of models and their results developed to estimate waterborne illness on a national level. The papers have been published in the July/August 2006 supplement of Journal of Water and Health. The publications and more information can be found at: http://www.epa.gov/nheerl/articles/2006/waterborne_disease.html.

John Ungvarsky is an Environmental Scientist at the U.S. Environmental Protection Agency, Region 9. He works in the Water Division's Ground Water Office and oversees source water protection efforts in CA. For information on any of the above topics, please contact John at 415-972-3963 or ungvarsky.john@epa.gov.

Chemist's Corner

Arsenic and Old Waste

BY BART SIMMONS

The 10 ppb Arsenic drinking water standard has prompted a search for sources of arsenic in groundwater, and a potential source has been found: chicken poop. An article in Environmental Science and Technology (May 1, 2006, Vol. 40, No. 9., pp 2951-2957) identified chicken waste contaminated with roxarsone (3-nitro-4-hydroxyphenylarsonic acid), an arsenical used to control infections and increase weight. An estimated 70% of the 9.1 billion broiler chickens produced in the U.S. in 2006 will be treated with roxarsone. Little of the pesticide is retained in the meat, and it is passed, mostly unchanged, into chicken waste. Every chicken produces a few kilograms of waste in its life span, resulting in an annual total of between 12 and 23 billion kilograms. This material becomes mixed with wood chips, feathers and urine to become poultry litter. The litter is rich in nitrogen and phosphorus, so it is used as a fertilizer. Current state and federal regulations allow for essentially free distribution of the litter. However, the litter also contains the untransformed roxarsone. According to the U.S. Geological Survey, a million kilograms of roxarsone and its degradation products are introduced into the environment each year. According to the authors of the ES&T article, the waste contains 14 to 48 mg/kg of arsenic. This overlaps the range of naturally occurring arsenic in soil, but that's not the whole story.

The anaerobic environment of the chicken waste is apparently converting the arsenical pesticide to arsenite, which is relatively mobile and carcinogenic. In a laboratory, the investigators found that in the presence of anaerobic sludge, roxarsone was converted to the corresponding aromatic amine, 4-hydroxy-3-aminophenylarsonic acid, which then slowly degraded to As(III). Once converted to arsenite, it could be leached into groundwater or run off with rainwater. The USGS partially sponsored the work, which was done by University of Arizona researchers. Other work by the USGS found that 75% of arsenic in chicken litter was soluble in water. The USGS has developed a method for roxarsone, 4-hydroxy-3-aminophenylarsonic acid by using solid phase extraction, followed by electrospray mass spectrometry.

Alternatives to land application of chicken litter are being explored, including its use as biomass. However, the arsenic in biomass incineration ash may prove to be a limitation to its use.

Some media have run the story of arsenic residues in chicken meat posing a threat to health. Perhaps the larger story is the roxarsone which does not accumulate in chicken flesh and is discharged to the environment, with consequences yet to be determined.

Bart Simmons can be reached at bartonps@aol.com.

Education Corner

Education Committee Launches New Initiative for University and College Outreach

BY VICKI KRETSINGER,
GRA DIRECTOR

Jean Moran, Education Committee Chair, has set the committee in motion to accomplish new goals. At the Groundwater Resources Association of California's (GRA) April Quarterly Board meeting, Board members carried out the nominal group consensus building technique and identified two major education initiatives upon which GRA would focus its efforts. These initiatives include:

- Increase GRA's interaction with California's university/college groundwater programs, and
- Develop a college scholarship program.

As a first step, the Education Committee is focusing on the first initiative – increased interaction with academic institutions and students. A database has been initiated consisting of a list of faculty from California colleges and universities where groundwater is a focus of their specific research or teaching interests, or they have a recent groundwater-related publication. More than 60 faculty members at 20 California colleges and universities are represented. The database is envisioned for such purposes as: 1) communicating information about GRA and its services and programs to faculty and students, 2) providing a list of potential speakers for GRA events or branch events, and 3) locating experts with research and discipline interests related to groundwater. This list is also "dynamic," i.e., it will be expanded upon as the committee receives suggested additions. The committee also encourages ideas and suggestions for its application.

Initial contacts with four campuses resulted in enthusiastic responses to the program planned to increase interaction between GRA and academia. Possible outcomes of these initial discussions include GRA representatives speaking at fall campus lectures, possible internship opportunities, GRA representatives meeting with students at established on-campus chapters, informing students of careers in hydrogeology, and providing information on GRA's educational programs that would supplement students' academic curricula.

The committee is proceeding with campus outreach, including distributing information on upcoming events, providing contact information for Branch representatives located nearest their campus, inviting faculty and students to local Branch meetings (as attendees and/or for speaking invitations), and identifying possible GRA speakers for campus functions and lectures as a list is developed.

The Education Committee welcomes your feedback on the new education initiatives. Your participation as a GRA representative to meet with faculty or students is also encouraged. Please send your ideas or indication of interest in being a GRA representative to Jean Moran at moran10@llnl.gov.

Earth Science Week

Earth Science Week is only three weeks away! You can organize your own activity or become involved in one of the events already being planned for the week of October 8-14. For how to participate, see ideas for planning, fundraising, and advertising your event at http://www.earthsciweek.org/forplanners/index.

Alliance Corner

Water Well Information – What's Needed?

NGWA AGWSE DIVISION
GROUND WATER NEWS & VIEWS

The question of what's needed in water well completion reports is the subject of an ongoing joint effort by the California Groundwater Association (CGA) and the Groundwater Resources Association of California (GRA). In mid-December 2005, representatives of CGA and GRA met at the NGWA Expo to explore ways to improve interaction between CGA and GRA. There was consensus to further discuss well report information use, transmittal methods, and quality of information.

Task Force Efforts Underway

Both CGA and GRA Boards supported a Joint Water Well Information Task Force, which was subsequently formed in early 2006. Comprised of water well contractors, technical consultants, local regulatory officials, USGS staff, and association representatives, the Task Force plans to develop a report that covers the broad subject of well information with a focus on quality of information, current uses of information, and transmittal methods. The Task Force has developed a list of uses by the types of users including the driller, owner, consultants, Department of Water Resources (DWR) and other government agencies.

Quality of Information is Critical

The Task Force has reviewed the various well completion report forms used by DWR and felt the current form DWR 188 (11/97) does provide for the minimum information needed for any well. The Task Force is supportive of DWR efforts to develop electronic submittal, as it could lead to better quality data, and supports the use of drop-down boxes to allow for more detail. There could be calculation safeguards to prevent the insertion of illogical or obviously incorrect data, and there should be emphasis on full disclosure of accurate information. It was noted that well completion report instructions are key to quality well info. There are variable skills in doing forms – this affects quality. The instructions should provide a check list for use by drillers. The process of how the info is collected in the field and then placed on the form in the office needs to be considered when devising data requirements and instructions.

Well Information Rights and Release of Data

In California, information contained in well completion reports (well logs) is confidential unless released by the well owner or unless the information is needed for a study conducted under the direction of a government agency. In the past there have been differences of opinions on the use of well log information. While CGA supports release of well log information for groundwater studies, it has concerns about proprietary rights and misinterpretation of information. In 2005 GRA conducted

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NGWA Helps Foster Next Generation of Groundwater Scientists

Many of today's ground water scientists are concerned about who will follow in their footsteps—concerns fueled by the relative de-emphasis on Earth sciences in school curricula throughout the United States. The National Ground Water Association shares these concerns and is moving in several directions to address them. Significantly, the NGWA Board of Directors endorses the National Science Education Standards by all public and private school systems, recognizing that a science-literate citizenry is vital to the nation's well-being and security.

NGWA is helping in other ways as well. For the 21st time, NGWA sponsored special awards for groundwater projects at the International Science and Engineering Fair in May sponsored by Intel®. Winning projects for 2006 include research on the effect of sulfur springs on water quality in Utah, radionuclides in aquifers in Georgia, and nitrate levels in Minnesota. These projects and others are described on NGWA's website, www.NGWA.org.

Held annually, the international science fair brings together more than 1,500 students from 40 nations to compete for scholarships, tuition grants, internships and scientific field trips. Additionally, NGWA has provided information for educators seeking to teach groundwater related science on the Educator Resources page of NGWA.org. And NGWA has a separate Web site, featured in the last issue of *Hydrovisions*, called Groundwater Adventures (www.groundwateradventures.org). This site provides fun activities and experiments for children K-12.

NGWA has other initiatives in the works intended to address the issue of Earth systems science education with the goal of helping to ensure the groundwater scientists of tomorrow.

Call for Nominations for GRA Director Seats Open in 2007

The Association is now soliciting nominations for GRA Board of Director candidates to run for six (6) seats that commence service January 1, 2007. The Nominating Committee has established the following criteria for nominating and selecting candidates for the final ballot that will be presented to the GRA membership for voting.

Minimum Qualifications for Director Nominees

- Active Regular Member of GRA at the time of nomination.
- Recognized leader in a groundwater-related field, which may include regulation, evaluation, development, remediation or investigation of groundwater, groundwater supplies or related technology; science education; and groundwater law or planning.
- Significant contributor to the field of groundwater resources in California.
- Prior contributions and leadership role in a GRA Branch, GRA committees or GRA program activities, or like experience with a similar organization.

Nominating Guidelines and Procedures

1. Directors and members of GRA may nominate themselves or another member as prospective candidates to run for the Board as described below.
2. Nominations must be submitted in writing to GRA and accompanied by:
   - A statement from the nominee addressing the following questions: *Why are you interested in serving on the GRA Board of Directors? What qualifications and experience do you have for serving as a Board member? What specific skills or expertise do you bring to GRA and the GRA Board (e.g., leadership skills, fund-raising, financial management, etc)? What experience do you have serving on similar boards of directors? What level of time commitment can you make to GRA?*
   - Current curriculum vitae.
   - A letter of recommendation from a current Director or Regular Member.
3. The Nominating Committee will review all nominations and evaluate the nominees based upon on their response to the questions in number two and on their qualifications. The Committee will conduct interviews, if deemed necessary.
4. The Nominating Committee shall recommend a slate of nominees for presentation to the GRA Board of Directors for approval. The recommended slate of nominees shall correspond to the number of available Director openings each year.
5. The approved slate of nominees shall be presented to the GRA membership in ballot form in accordance with the GRA bylaws.

To declare your desire to be nominated or to nominate someone other than yourself, please follow the guidelines in section number two and forward the material to Kathy Snelson, GRA Executive Director, via email (executive_director@grac.org), fax (916-442-0382) or mail (915 L Street, Suite 1000, Sacramento, CA 95814) **no later than October 9, 2006**.

Should you have any questions or need additional information about the GRA Director Call for Nominations, please contact Kathy Snelson at (916) 446-3626.

Organizational Corner

2006 Contributors to GRA — Thank You

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GRA Extends Sincere Appreciation to its Chair and Sponsors for its June 2006 *Groundwater Contaminants Series* Symposium, "Emerging Contaminants in Groundwater: A Continually Moving Target?"

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GRA Welcomes the Following New Members

MAY 9, 2006 THROUGH AUGUST 23, 2006

Bins, Peter	Columbia Analytical Services, Inc.
Boorse, Howard	Columbia Analytical Services, Inc.
Borkovich, John	State Water Board (SWRCB)
Borrego, John	Yolo Co. Dept. Planning Resources & Public Works
Brown, Jason	Blaine Tech Services
Cahoon, Brad	MWH Labs
Carlton, Grayson	The RETEC Group, Inc.
Casagrande, Deborah	URS Corporation
Constantinescu, Valentin	Ahtna Government Services Corporation
Curran, Megan	Shaw Environmental, Inc.
Dunbar, Sean	Holdrege & Kull
Edlund, Lynn	Trihydro Corporation
Gorman, Caitlin	ERRG, Inc.
Graham, James	Siemens Water Technologies
Hanson, Randall	U.S. Geological Survey
Holkenbrink, Mary	ERRG, Inc.
Huang, Judy	Alameda County Water Districts
Huybregts, Jessica	Kennedy/Jenks Consultants
Jones, Paul	Winzler & Kelly Consulting Engineers
King, Mark	Sunstar Laboratories, Inc.
Kirk, Tony	Water Replenishment District
Legaspi, Michelle	Pace Analytical Services, Inc.
Lenox, Art	The Boeing Company
Leonhardt, Elizabeth	Lancaster Laboratories
Lincoln, George	Sonoma County Water Agency
Long, Stephanie	Layne Christensen Company
Meyer, Brenda	Tetra Tech, Inc.
Miller, Cindy	RBF Consulting
Nettles, Sandy	N.S. Nettles & Associates, Inc.
Padberg, Matt	Kennedy/Jenks Consultants
Peters, Dean	Torrent Laboratory
Peterson, John	Peterson Environmental Services
Rajapakse, Ruwan	Water Resources Board, Sri Lanka
Randall, Patrick	Vironex
Ranmadugala, Sajeewa	Water Resources Board, Sri Lanka
Redman, Eric	Severn Trent Laboratories
Renfroe, Tracie	King & Spalding LLP
Rochette, Michael	RWQCB
Santos, Robert	
Schmitz-Leuffen, Sven	Shaw Environmental
Sherman, Marne	Brown & Caldwell
Shrum, Noel	Tetra Tech EM Inc.
Snyder, Scott	Ninyo & Moore
Sourial, John	ERRG, Inc.
Steinberger, Rachel	ARCADIS Geraghty & Miller, Inc.
Strickland, Kathleen	Greenberg Trauig, LLP
Sutarwala, Seema	ENVIRON International Corporation
Taranik, Nick	Layne Christensen Company
Tomczyk, Thomas	HydroGeoLogic, Inc.
Tryon, Thea	Central Coast Water Board
Wanigasekara, Indunil	Water REsources Board, Sri Lanka
Wells, Barbara	CDM

Nitrate in California Groundwater Symposium 2006: Are We Making Progress? — Continued from Page 1

In the technical sessions, some key themes emerged. New tools for characterization of nitrate source, transport and distribution are now available to the community. Several talks featured the use of GIS for visualization of nitrate distribution in relation to land use and soil type and as input for models of nitrate loading and evaluations of assimilative capacity. Isotope geochemistry is increasing being used to constrain nitrate source, transport and degradation in the subsurface. Simulations of nitrate loading and transport at the field, basin and regional scale are becoming more sophisticated in their use of probabilistic methods. Several approaches to nitrate management were also highlighted, ranging from field-scale precision agriculture, to county-level multi-agency working groups, to innovative implementation of nitrate management in adjudicated basins. Finally, surveys are filling in some of the gaps in our knowledge of the distribution of groundwater nitrate, including domestic wells and the history of contamination in the Central Valley.

The first technical session on ***Nitrate Occurrence, Impacts and Vulnerability,*** moderated by ***Jean Moran*** and ***Brad Esser*** *(LLNL),* highlighted several different approaches to assessing groundwater vulnerability to nitrate contamination, and documenting historical changes in groundwater nitrate occurrence. ***Laosheng Wu*** (UC-Riverside) has developed a web-based index method to estimate nitrate leaching potential. His method is interactive and uses crop type, soil type, and irrigation practice to calculate a relative hazard index. ***Steve Carle*** (LLNL) uses a geostatistical approach to develop high-resolution groundwater transport models on the field- to basin-scale. These models are conditioned by drill log and geophysical data, and validated against nitrate distribution and groundwater age. ***Jennifer Shelton*** (USGS) made use of current NAWQA datasets and historic USGS, California DHS and EPA datasets to document increases over the past 50 years in groundwater nitrate concentrations in the eastern San Joaquin Valley, and to correlate these trends to synthetic fertilizer usage. ***Thomas Harter*** (UC-Davis) has developed, calibrated and validated a probabilistic vulnerability assessment for shallow groundwater in a dairy area in Merced County. He used this study as a springboard for a discussion of the challenges and importance for monitoring and assessing groundwater impacts from nonpoint sources.

The second technical session on the ***Geochemistry and Transport of Nitrate*** moderated by ***Thomas Harter*** *(UC-Davis)* brought together several speakers working on nitrate transport at a variety of scales. ***Christian Kropf*** (Department of Water Resources, Washoe County, Nevada) examined trends in nitrate concentrations in a suburban area north of Reno that is impacted by septic system leakage. ***Carol Kendall*** (USGS, Menlo Park), an international leader in her field, reviewed the basics of isotope geochemistry and its use in identifying sources of nitrate in agricultural basins. Her talk was followed by ***Mike Singleton*** (LLNL) who presented a combined method of isotope and noble gas tracing to provide insights on the source, fate and transport of nitrate at dairy sites in the Central Valley. ***Chris Green*** (USGS, Menlo Park) used geochemical tracing, geophysical exploration, and numerical modeling to evaluate sources and fate of nitrate in groundwater at the urban/agricultural interface in the Central Valley.

> *"New tools for characterization of nitrate source, transport and distribution are now available"*

Steve Silva *(USGS, Menlo Park)* moderated the first session of the second day on ***Nitrate Loading and Sources***, which continued the theme of using new approaches to characterizing nitrate contamination in groundwater. ***Tom De Sutte***r (USDA Soil Tilth Laboratory, Ames, Iowa) summarized an extensive dataset on lagoon seepage rates in Kansas, and discussed geochemical and operational factors that limit the impact of seepage to groundwater for well-constructed, sited and maintained lagoons. ***Bill Showers*** (North Carolina State University) used an innovative combination of nutrient mapping, stable isotope techniques, and GIS to assess the impact of biosolids application on North Carolina surface and ground waters. Bill found that nitrate accumulation in groundwater was largely controlled by the distribution of hydric soils, and discussed how sustainable biosolid land applications could be achieved through application practice and engineered solutions. ***Jan Stepek*** (SWRCB) described the GAMA Program's voluntary domestic well assessment project and gave a summary of the results of over 760 domestic wells sampled in El Dorado, Yuba, and Tehama counties. Of the analyzed constituents, the species of primary concern were total and fecal coliform bacteria and nitrate. Coliform bacteria were present in about 25% of the wells tested.

Two sessions were devoted to ***Regulation, Management and Treatment***. ***Sarah Raker*** *(Mactec)* moderated the first of these sessions which focused on the development of new tools for nutrient management. Over 90% of the farms in California use commercial fertilizer. ***Kent Kitade*** (California Department of Food and Agriculture) discussed the Fertilizer Research and Education Program and its goal of promoting the efficient use of fertilizer through research and education projects (including nutrient management and education outreach). ***Thomas Harmon*** (UC-Merced) discussed the development and use of wireless field sensor networks to monitor soil moisture, temperature, and nitrate levels at a reclaimed water irrigation site. The eventual goal of this approach is to use sensor input in feedback-control models to minimize nitrate loading to groundwater by optimizing irrigation timing and rate. ***Marsha Campbell Mathews*** (UC Cooperative Extension) presented the results of 10 years of nutrient management studies at dairies in the Central Valley. Her studies have shown that while careful management of manure can significantly improve groundwater quality while sustaining crop yield, the approach is difficult to sustain over long periods of time and the typical dairy farm lacks the necessary infrastructure.

Matt Zidar *(WRIME)* moderated the second session, which focused on implementation of nitrate management plans.

Continued on page 16

Kathy Thomasberg (Monterey County Water Resources Agency) discussed one of the oldest and most focused nitrate management efforts in California, the Salinas Valley Nitrate Management Program. Kathy described program catalysts and challenges from 1989 to present. ***Mark Wildermuth*** (Wildermuth Engineering) presented both the technical and policy approach to nitrate and salt management in the Chino Basin. The Optimum Basin Management Program uses a maximum benefit paradigm to mitigate degradation of basin water quality. ***Susan Shaw*** (Tulare County Environmental Health Department) showed the conference how her department is using GIS to evaluate temporal trends and spatial patterns in nitrate contamination in groundwater, and to relate those distributions to geology, hydrology and land use.

The Symposium's closing panel discussion, moderated by ***John Ungvarsky*** *(US EPA)* provided an economic, regulatory, and sociological perspective on the question of "***Are We Making Progress?***" Five panelists, representing agriculture, public interest, and government, discussed views on progress made, lessons learned, and areas needing more work. ***Bob Martin*** (Rio Farms) described nitrate management successes involving industry-regulator partnerships in Monterey County. ***Martha Guzman*** (California Rural Legal Assistance Foundation) emphasized the need to protect the drinking water of vulnerable immigrant communities in the Central Valley. ***Ron Rowe*** (Merced County Environmental Health) and ***David Sholes*** (Central Valley Regional Water Quality Control Board) described current local and state regulatory efforts to manage nitrogen loading, especially from the dairy sector, and ***Paul Martin*** (Western United Dairymen) stressed the need for collaboration in the development of regulations affecting the dairy industry. The panelists then fielded a variety of spirited questions from the audience.

Two adjunct meetings were similarly successful and informative. The preconference workshop on "***Dairy Groundwater Monitoring: Regulations, Monitoring Network Design, and Data Interpretation,***" was packed with nearly 100 participants. The workshop, moderated by ***Thomas Harter*** *(UC Davis)*, began with a concise overview by ***Rudy Schnagl*** (RWQCB) on groundwater monitoring guidelines and regulations currently being developed by the Central Valley RWQCB (Region 5). The current draft of the new Waste Discharge Requirements for dairies foresees a phased-in groundwater monitoring requirement on all dairies. High risk dairies (e.g. close to public supply wells, high nutrient loading, shallow depth to groundwater, etc.) would be first to have required groundwater monitoring, at the discretion of the RWQCB's executive officer. Three county representatives, ***Bill Zumwalt*** (Kings County), ***Rowe Barney*** (Stanislaus County), and ***Ron Rowe*** (Merced County), complemented the state's perspective with updates on dairy permitting options and requirements in their respective counties. ***Philip Ross*** (Geomatrix Consultants) provided a review of groundwater monitoring well construction options, which was followed by ***Thomas Harter***, who talked about his research group's groundwater monitoring experiences on dairies in Merced and Stanislaus County, and by ***Brad Esser*** (LLNL), who discussed new techniques for assessing denitrification and nitrate transport in dairy groundwaters.

The GRA San Joaquin Valley Branch held a mid-symposium meeting that featured ***John Menke*** (SWRCB), a senior environmental scientist who represents the State Board on issues involving dairies. John discussed California confined animal facilities with respect to groundwater impacts, water quality regulations, and best management practices to mitigate nitrate contamination. The question and answer period that followed was lively and substantive.

So are we making progress? The consensus in the final panel discussion and in the comments of those who attended the symposium is that we have come far in our ability to characterize and understand the sources and history of nitrate contamination in California groundwater. However, we still have a hard road ahead in successfully managing nitrate sources to curb ongoing groundwater contamination. The development of effective nutrient management methods at both the field and basin scale is a clear need. Such methods, which range from site-specific improvements in the timing of fertilizer application to regional water management, need to be demonstrated to be effective and need to be practical if they are to have an impact. Active dialog and creative thinking from all stakeholders at the regional scale is another need. Such an approach can lead to clear and sensible regulatory guidance that allows all parties to move forward. Multi-agency working groups and stakeholder partnerships are beginning to emerge and offer hope for the future.

"We have come far in our ability to characterize and understand the sources and history of nitrate contamination, but we still have a hard road ahead in successfully managing nitrate sources"

Meetings like this are not possible without the generosity of our sponsors. Both Geological Technics and Geomatrix Consultants stepped up to the plate and co-sponsored the conference. Brown and Caldwell sponsored lunch; Calgon Carbon Corporation sponsored the reception, and Layne Christensen sponsored refreshments. Equally necessary is a strong organizing committee. The committee, chaired by Sarah Raker (MACTEC) and Bill Pipes (Geomatrix Consultants), included Tracy Hemmeter (Santa Clara Valley Water District), Jean Moran (LLNL), John Ungvarsky (USEPA, Region 9), Thomas Harter (UC-Davis), Brad Esser (LLNL), Paul Sousa (Western United Dairymen), Krista Clark (Association of California Water Agencies), Laosheng Wu (UC-Riverside), Ray Kablanow (Geological Technics), Steven Silva (USGS), and Angela Schroeter (SWRCB). Mary Megarry, GRAC program coordinator, did an extraordinary job of making sure that everyone was in the right place at the right time. Join us in giving a hearty thank you to our sponsors, speakers, poster presenters, moderators, and committee.

Brad Esser is Scientific Capability Leader of Environmental Radiochemistry at Lawrence Livermore National Laboratory.

TABLE 1

Typical $\delta^{15}N$ and $\delta^{18}O$ Values in Dissolved Nitrate (NO_3^-) From Different Nitrate Sources

Potential Contaminant Source	$\delta^{15}N$ (‰)	$\delta^{18}O$(‰)
Commercial fertilizer	–4 to +4	+18 to +26
Animal or human waste	> + 10	–4 to +12
Precipitation	–3	+18 to +60
Organic nitrogen in soil	+4 to +9	+1 to –4

ratios in water can be used to identify a nitrate source and its fate in vadose zone soil and in groundwater. Nitrogen has two stable isotopes: ^{14}N, with a natural abundance of 99.63% and ^{15}N, with a natural abundance of 0.37%. The wide difference in the isotopic abundance allows for the determination of distinctive isotopic signatures to define specific natural and anthropogenic sources. In analyzed samples, the ratio of $^{15}N/^{14}N$ is compared with a standard (atmospheric nitrogen) to provide $\delta^{15}N$ (NOTE). The abundance of ^{15}N in the atmosphere remains relatively constant because of the inert character of atmospheric nitrogen, resulting in a $\delta^{15}N$ of zero. Nitrogen isotopes also fractionate, largely by biochemical processes. These include:

- **Nitrification:** where nitrogen compounds are oxidized.
- **Denitrification:** in which nitrate is reduced to molecular nitrogen; and,
- **Nitrogen fixation:** where dissolved molecular nitrogen is converted to nitro-organic compounds.

The above processes occur mostly from bacterial action in which the lighter nitrogen isotope (^{14}N) is more easily reacted resulting in more positive $\delta^{15}N_{nitrate}$ values. Known ranges of $\delta^{15}N_{nitrate}$ and $\delta^{18}O_{nitrate}$ have been published (Table 1). Although $\delta^{18}O_{nitrate}$ values are more difficult to determine, obtaining $\delta^{18}O_{nitrate}$ can lead to defining nitrate source fields. Figure 1 (page 5) graphically shows the relationship between $\delta^{18}O_{nitrate}$ and $\delta^{15}N_{nitrate}$, which can be used to fingerprint nitrate sources.

Conclusions

Analysis of nitrogen-oxygen isotopes of dissolved nitrate provides an excellent technique for fingerprinting nitrate sources. However, as in any forensic investigation it is important to have more than one line of evidence and the technique should be combined with a complete understanding of the local environment or land use history and hydrogeology, including groundwater geochemistry. The technique should be combined with other isotopic methods such as $\delta^{18}O$ and delta deuterium (δD) of water for determining water sources and "age" dating groundwater using tritium/helium-3 ratios ($T/^3He$).

William E. Motzer, Ph.D., PG, is a Senior Geochemist at Todd Engineers in Emeryville. He may be reached for comment at 510-595-2120 or by email at bmotzer@toddengineers.com.

NOTE: By established convention, isotopic ratios are defined as delta (δ) values, which is obtained by the equation: δ **(isotope)** $= \{[R_{(sample)} - R_{(standard)}]/R_{(standard)}\}$ **–1 (1,000)**.

Where: δ (isotope) = values in per thousand (‰) or per mil and $R_{(sample)}$ = the ratio of the first and second isotope such as $^{18}O/^{16}O$, and $R_{(standard)}$ = the ratio of $^{18}O/^{16}O$ used in international or other standards. For example, the standard for $^{18}O/^{16}O$ is Standard Mean Ocean Water (SMOW). A positive (+) δ value indicates that the heavier isotope (i.e., ^{18}O) in the sample is enriched when compared to the standard. A negative (–) value indicates that the sample has more of the lighter (^{16}O) isotope. The International Atomic Energy Agency (IAEA) and the National Institute of Standards and Technology (NIST) have established and published these standards.

President's Message – Continued from Page 2

higher than the concentration involved in the first advisory, and a thousand times higher than the Action Level. Of course, the CCR contained a typo on the units, but thousands of homeowners received it, and not one inquired with the water utility for two months, until one nosy hydrogeologist found it on the internet and called to ask, "What's up with that?" The first group was very concerned; the second group was not at all worried – no one told them they should be. People's reactions to emerging contaminants are in large part a reflection of how technical experts answer, "Should I be worried?"

The context of risk from contaminants is difficult to put into perspective. It's tempting to contrast the incremental - if at all quantifiable – risk from the trace presence of an emerging or well-known contaminant with substantially higher everyday risks from familiar sources. But the consumer's viewpoint is often, "I shouldn't have to worry." So, when measuring indoor air contamination at levels comprising 1/100th the risk from exposure to the same contaminant in ambient urban air, it's disrespectful to deny the occupant's claim that there should be no involuntary exposure to toxic contaminants in his home at any level. To the exposed party, that 1/100th incremental risk will seem like the proverbial straw that broke the camel's back. What's missing is a frame of reference. We all know in an instant that news of magnitude 3.1 earthquake on the Hayward fault hardly warrants our attention. But we lack a similar, universally understood risk scale for toxic contaminants in environmental media.

We could improve how we explain risks from individual contaminants, but we still lack the means to reliably assess, much less communicate, the synergistic effects of multiple toxicants through multiple routes of exposure. Models to predict the fate of contaminants in our bodies are improving, but we still can't confidently predict the combined actions of a tumor initiator and a tumor promoter, or other combinations of chemicals which when taken together, may have an effect that is more than additive. That leaves us to deal with each new contaminant individually.

Water utilities tend to shy away from voluntary testing for new contaminants for which lack of clear guidance confounds explanation of test results to the public. The same hesitation applies to testing for regulated contaminants at ultra-low levels. Can the data be shared with the public without inciting hysteria? The answer should be "yes" – but careful consideration of consumer concerns must go into crafting well-written communication and consumer education plans that are developed before the sampling plan is finalized.

Decades after concerns for worker exposure to TCE were first raised in the 1960s, there is a new effort to re-assess the cancer risk from this ubiquitous contaminant. And, after decades of effort in which millions of dollars were spent to bring plumes of TCE's breakdown product to below its 6 ppb MCL, the Office of Environmental Health Hazard Assessment has released a new draft Public Health Goal, at 100 ppb for cis- and 60 ppb for trans-1,2-DCE. What we were confident we knew has been wrenched from our shrinking list of things we know with certainty, and added to our growing list of things we really ought to know. The 'terra firma' of our knowledge base has begun to resemble a melting ice sheet.

Navigating the shifting landscape of emerging and familiar contaminants has grown increasingly complex. None of this makes it any easier to clearly explain emerging contaminant issues to the consumers of the water we seek to protect. Lowered standards, low draft standards followed by higher final standards, and draft standards that span a range of exposure levels – these moving targets all erode the public's confidence. But we nevertheless have an obligation to help those outside our profession to understand these confusing issues; otherwise, the relevance of our work is diminished.

In the last year, I have experienced a few moments of clarity at GRA's symposia on these topics, in the areas of perchlorate (is it natural, or from a new, new source?), nitrate ("educate, then regulate"), and emerging contaminants (give those bored chemists something to do!). These mini-epiphanies aren't planned. The chemistry that emerges among GRA's conference participants when experts from a variety of perspectives are brought together seems to just happen. And incrementally, our understanding is advanced. What I really know is that GRA's symposia keep on delivering excellence and those unexpected nuggets of clarity. Make it your priority to attend the next symposium relevant to your work, or better still, join the planning committee!

Thomas Mohr is GRA's President and a Hydrogeologist at the Santa Clara Valley Water District. Your comments are welcome: tmohr@grac.org.

North Gualala Decision –

Continued from Page 6

groundwater basins, even where pumping may have an impact on a surface stream.

Despite this, the Court did support the SWRCB's loose application of the four-part Garrapata test. In particular, the SWRCB's interpretation of the second part of the test appears to have pushed the concept of "relatively" impermeable bed and bank to include water bearing sediments. In addition, the court supported the SWRCB's position that the groundwater could be said to be flowing in a channel even if its movement is perpendicular to that of the surface stream.

Michael Fife is a partner in Hatch & Parent's Water Law Practice Group.

Wells and Words – Continued from Page 4

ated with apparent excessive concentrations of metals such as iron, manganese, and trace metals. Excessive trace metal concentrations can be a result of the analytical method and measurement of both the undissolved and dissolved fractions in the liquid; the analytical method cannot distinguish between the two. Accordingly, elevated turbidity levels may be accompanied with elevated trace metal concentrations, even if samples are filtered prior to laboratory analysis. Without a turbidity measurement reported from the laboratory, it is difficult to evaluate the relevancy of elevated metal concentrations.

Government health professionals are interested in the dissolved fraction of the metals in water that is ingested rather than the suspended or colloidal fraction, while acknowledging the dual importance of the associated effectiveness of potable water treatment with chlorine and reduced turbidity. Recommended primary federal and state drinking water goals for turbidity concentrations are less than 1.0 NTU. A secondary standard of 5.0 NTU is based on the level at which the human eye can detect turbidity. Collecting a representative groundwater sample from a pumping production well entails pumping for a long period of time at high discharge rates to reduce the turbidity of the pumped groundwater sample. Collecting groundwater samples with elevated turbidity will not determine the native groundwater quality with respect to dissolved minor or trace metals. Major ions, total dissolved solids, and specific conductance are generally not affected by elevated turbidity.

Water Well Information – What's Needed? – Continued from Page 11

a survey that showed their membership in favor of releasing well log information. This issue has also been a subject of past legislation. In November 2005, the subject was raised at a hearing in Southern California by the California Assembly Select Committee on Air and Water Quality. While there is no pending legislation regarding the release of well logs, Senate Bill 1640 would establish monitoring wells in all CA groundwater basins and provide for free release of data obtained from them.

Task Force Members

The newly established Joint Well Information Task Force members include David Abbott, Todd Engineers; Mike Duffy, Santa Clara Valley Water District; John Hofer, Geoconsultants Inc.; Tom Johnson, LFR Levine Fricke; Dave Landino, Landino Drilling Co.; Jim Loughlin, Weeks Drilling & Pump; Mike Mortensson, CGA Executive Director; Tim Parker, Schlumberger Water Services; and Steve Phillips, USGS. For further information, contact Task Force Leader Mike Mortensson of CGA at 707-578-4408; fax: 707-546-4906 or email: wellguy@groundh2o.org.

San Francisco Bay Branch Highlights

BY KATRIN SCHLIEWEN, BRANCH SECRETARY

April Meeting (by Katrin Schliewen) The well-attended (88 members, nonmembers and students) April meeting was held at Spenger's Restaurant in Berkeley. Ms. Dawn Zemo, Principal Hydrogeologist at Zemo & Associates LLC, presented a talk on Environmental Forensics, which focused on existing and evolving environmental forensic tools used to investigate the composition, source, and age of petroleum hydrocarbons and chlorinated solvents. One of the more promising forensics tools is the use of stable isotopes which, for example when dealing with petroleum hydrocarbons, can reveal the signature of a crude oil because stable isotopes are unaffected by refining processes. In the case of chlorinated solvents, stable isotopes can be used to differentiate between sources because isotope ratios will differ between individually manufactured solvents, although biodegraded solvents may tell a different story. Ms. Zemo emphasized the importance of understanding the limitations of individual tools. Ms. Zemo recommended two textbooks as excellent references, both by Brian L. Murphy and Robert D. Morrison, *Introduction to Environmental Forensics* (2001) and *Environmental Forensics: Contaminant Specific Guide* (2005). Ms. Zemo can be contacted for more information at 775-831-6179 and dazemo@msn.com.

May Meeting (by Bill Motzer) The May SF Branch meeting, also at Spenger's, had 50 members and non members attending. Brian Lewis, Senior Engineering Geologist with the California Department of Toxic Substances Control (DTSC) and GRA Board Member, gave us an update of the current efforts at DTSC under its new Director, Maureen Gorsen. He also described the U.S. EPA's Triad Approach to site cleanup and the new vapor intrusion interim final guidance, released in January 2005 (http://www.dtsc.ca.gov/AssessingRisk/index.cfm). In addition to vapor intrusion guidance information, the document discusses naturally-occurring asbestos in California and its impact on school sites. Mr. Lewis also gave an update to current legislation, including best management practices for perchlorate, recycling of mercury, and a proposal to update groundwater regulations. Another important topic was the California Land Reuse and Revitalization Act of 2003 (AB 389) that provides liability immunity to qualifying property owners or purchasers of Brownfield sites. Finally, he discussed EnviroStor (which replaces Calsites), a web site that allows the user to find DTSC involved cleanup sites. Brian Lewis can be contacted at 916-255-6532 and blewis@dtsc.ca.gov.

June Meeting (by Katrin Schliewen) The June SF Branch meeting was held in conjunction with GRA's "Emerging Contaminants in Groundwater Symposium" which took place at the Hilton Hotel in Concord, on June 7. The evening panel discussion was entitled "Regulating Emerging Contaminants: National Research Council (NRC), EPA, and CA State Perspectives." The panelists were: Dr. Rhodes Trussell of Trussel Technologies, Inc., Dr. Bruce Macler of the U.S. EPA, and Dr. Bob Howd of California's OEHHA. The panel discussion began with brief presentations by each of the panelists providing a state and a federal perspective of how emerging contaminants make it onto the EPA's contaminant candidate lists (CCLs), and how regulatory levels are established for emerging contaminants. Lively discussions erupted both during the presentations and prompted by audience comments and questions following the presentations. Topics explored included: the difficulty of establishing regulatory levels for new chemicals developed for which typically there is little toxicological information available; the question of how human health risk should really be evaluated (for example only for high production chemicals, or based on public interest and sense of safety, or maybe using precautionary principals); and the frustrating fact that individual state and federal agencies may establish different regulatory levels for the same contaminant, in part because there is little cooperation between agencies (e.g., pharmaceutical concentrations tolerable to human health may be harmful to aquatic populations at much lower concentrations, but the FDA is not in business to lower chemical concentrations to protect fish populations!).

San Joaquin Valley Branch Highlights

BY WILLIAM PIPES,
BRANCH PRESIDENT

We combined our May and June branch meeting dinners into one, and our speaker for the evening was Mr. Timothy Parker, Principal Hydrogeologist at Schlumberger Water Services. Mr. Parker is a Past President of GRA, currently serves on the GRA Board of Directors, and is a co-author of GRA's book "California Groundwater Management." His presentation was titled "*Oilfield-Developed, High-Resolution Subsurface Characterization Tools and Technologies Applied to Groundwater,*" and described in detail wireline logging tools, seismic and magnetotelluric methods, modeling, and multi-phase flow simulation technologies applied to groundwater development and management.

Our meetings are dinner meetings and generally 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.

Southern California Branch Highlights

BY PETER MURPHY,
BRANCH PRESIDENT

On June 28, Mark Wildermuth spoke to twenty four members of the Southern California section about total dissolved solids (TDS) and nitrate management in the Chino basin, a subbasin of the Santa Ana basin located in western San Bernardino County. Mr. Wildermuth first described the transition of land use in the basin from agriculture to urban, with an emphasis on the patterns of dairy development. Much of the groundwater in the Chino Basin has been degraded with nitrates and TDS caused by agriculture and dairies, and TDS and nitrates in the vadose zone continue to affect groundwater long after agriculture left the valley. Beneficial use of this groundwater requires treatment that will be provided by a series of desalters. A management strategy for the basin was described to include recharging surface water flow and active pumping/treatment of water near the downgradient edge of the basin, to provided additional groundwater resources in the basin and prevent degraded groundwater from discharging to the Santa Ana River.

The Southern California section looks forward to hosting dinner meetings in association with the GRA annual meeting in San Diego in September and the High Resolution Site Characterization and Monitoring seminar in Long Beach in November. We are also pleased to assist members in the San Diego area as they consider initiating a new GRA section.

Introduction to Groundwater & Watershed Hydrology: Monitoring, Assessment & Protection

OCTOBER 2-3, 2006 – GLENDALE, CA

COSPONSORED BY THE UNIVERSITY OF CALIFORNIA COOPERATIVE EXTENSION GROUNDWATER HYDROLOGY PROGRAM

Course Description

Groundwater and watershed monitoring, assessment and protection are an integral part of many California water programs at the local, state, and federal level designed for sustainable development and protection of water resources. Today, through the implementation of programs such as groundwater management plans, source water assessments, and conjunctive use agreements, professionals, executives, and employees in private, non-profit, and government positions are involved in the management and assessment of groundwater and surface water. Yet, many find themselves lacking the multidisciplinary background, expertise, or knowledge to meet the technical and regulatory challenges related to water resources management. The amount of technical information available is often overwhelming.

This course will review the fundamental principles of groundwater and watershed hydrology, water quality, and water contamination. It will provide an overview of the most common tools for measuring, monitoring, and assessing groundwater and surface water resources. The course is specifically geared towards an audience that is involved in the management, assessment, and protection of water resources. Course attendees who may have some experience with, but no formal training in hydrology or related engineering or science fields, will benefit from the basic and intuitive, yet comprehensive approach of this course.

Course topics include:

- Surface Water Hydrology and Watersheds
- Groundwater Hydrology
- Water Rights and Water Law
- Groundwater Management
- Surface Water Quality
- Groundwater Quality, Sampling, and Monitoring
- Surface Water Contaminants
- Groundwater Contamination
- Defining Watersheds and Groundwater Recharge Areas
- Vulnerability Assessments
- Understanding Potentially Contaminating Activities
- Protecting Water Resources

Who Should Attend

This shortcourse is directed toward consultants, and technical and management personnel in private and public water supply companies, irrigation districts, water districts, local and state agencies, and in resource conservation districts. The course also serves as an excellent introduction to hydrogeology, water resources assessment and monitoring for watershed advisors, watershed group participants, and members of environmental and other stakeholder groups and citizens alliances.

Course Instructors

Randy A. Dahlgren, Ph.D., is a professor of Soil Science and Biogeochemistry in the Department of Land, Air and Water Resources at the University of California, Davis. His research program in biogeochemistry examines the interaction of hydrological, geochemical, and biological processes in regulating surface and ground water chemistry. He is currently involved in water quality research spanning the scale from hillslopes and vernal pools to small headwater catchments (<10 ha) to the combined Sacramento-San Joaquin watersheds. Randy received his Ph.D. and M.S. in forest soils from the University of Washington and his B.S. in soil science from North Dakota State University. He was a post-doctoral research associate in the Department of Civil and Environmental Engineering at Syracuse University before coming to UCD in 1989. He has served as Chair of the Hydrologic Science Graduate Group, vice-chair in the Department of Land, Air and Water Resources, and is currently director of the TMDL Research and Technical Support Program for the Sacramento and San Joaquin Rivers.

Thomas Harter, Ph.D., received a B.S. in hydrology from the Universities of Freiburg, Germany and a M.S. in hydrology from the University of Stuttgart, Germany. He received his Ph.D. in hydrology (with emphasis on subsurface hydrology) at the University of Arizona, where he became the 1991 Harshbarger Fellow for outstanding research in subsurface flow and transport modeling. In 1995, Dr. Harter joined the faculty at the University of California, Davis, where he is in charge of the Groundwater Hydrology Cooperative Extension program. His research focuses on characterizing and assessing nonpoint-source pollution of groundwater, on the statistical and hydrodynamic evaluation of groundwater resources where data are limited, on groundwater modeling, and on a better understanding of contaminant transport processes at a wide range of spatial and temporal scales – from the laboratory scale to the field, farm, and regional scale.

Kenneth W. Tate, Ph.D., is the Rangeland Watershed Specialist in the Department of Plant Sciences at the University of California, Davis. He received his B.S. and M.S. in range ecology and management from Oklahoma State University. As a USDA National Needs Fellow, he earned his doctoral in water resources from OSU in 1995. He has developed and implemented a suite of research projects to address a wide range of contemporary watershed issues across California's 40 million acres of rangeland. His overall focus includes the: 1) quantification of land management impacts on water resources, 2) evaluation of management

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Geology Board Enforcement Actions

BY FLOYD FLOOD,
HYDROVISIONS EDITOR

The Summer 2006 Newsletter of the California Board for Geologists and Geophysicists (www.geology.ca.gov/publications/summer_2006.pdf) includes descriptions of 13 citations and fines of $2,500 each between May 2005 and February 2006. Eight citations and fines were issued for the practice of geology without legal authority (unlicensed practice). Five citations and fines were issued to Professional Geologists for actions such as negligence and incompetence, misrepresentation of data and its relative significance, and misinterpretation of geologic materials. The cases make for some interesting reading. One PG reported that local groundwater was under confining conditions but then discussed soil in the capillary fringe in contact with groundwater. Another signed and stamped a report for which he later admitted he was not maintaining responsible charge. A third misidentified the geologic formations underlying a proposed Caltrans bridge project. Thanks to the Board for being an effective watchdog!

Book Review

BY CHRISTIAN E. PETERSEN, MWH AMERICAS

Aquifer Storage Recovery, A Guide to Groundwater Recharge through Wells (Second Edition)

By David G. Pyne

David Pyne's original book, *Groundwater Recharge and Wells: A Guide to Aquifer Storage Recovery*, was published in 1995. The second edition includes approximately 620 pages of new and updated information obtained from a rapidly growing number of ASR wellfields globally, and delves more deeply into the scientific and technical aspects of feasibility assessment. A compact disk containing supplemental material accompanies the book, including well design and operation software, and other files for which periodic updates are planned for distribution to consumers. This book will benefit a wide audience, including practicing engineers, hydrogeologists, wellfield operators, regulators, water managers, students, and others charged with the planning, design, or implementation of ASR wells or wellfields.

The authors' vision of ASR is presented as a powerful and cost effective water management tool to alleviate growing water supply problems around the world. ASR is a relatively new global water management tool with many different potential applications. A proven, successful approach for ASR system development is presented, including a series of development phases leading to system operation and expansion. The book discusses the design of ASR wells, wellhead facilities and wellfields, and exhibits an understanding of the many technical and geochemical issues that are unique to ASR. Non-technical considerations, such as legal, regulatory, public perception and economics, are discussed at length. Alternative ASR applications for storage of water from other sources (reclaimed water, partially treated surface water), with several case studies illustrating the range of potential ASR applications, are provided. The book offers future directions for ASR, including foreseeable technical and regulatory developments. A more comprehensive description of the table of contents is provided by David Pyne at: http://www.asrforum.com/secondedition/tableofcontents.htm.

The book is especially applicable for scientists and engineers involved in water supply planning in California. The CalFed process, begun in the 1990s, has identified increased groundwater storage and conjunctive use as a key component to meeting California's future water demand, while protecting the environment. Many of these programs include dual purpose wells and wellfields that both inject and extract water into and out of the underlying aquifers. To my knowledge this is the only book published on the subject of design, construction, operation and maintenance of wells and well fields and related non-technical issues.

About the Author: For over 35 years, David Pyne has worked as a professional engineer in the water supply, wastewater and water resources fields, pioneering the development and implementation of aquifer storage and recovery technology throughout the United States and in several other countries. For more information about the author, the book, or to order a copy, visit http://www.asrforum.com.

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measures to restore water resources, and 3) development of assessment and monitoring tools to determine management impacts on water resources. His research targets multiple water resource problems (e.g., microbial pollution of surface drinking water, degradation of critical habitat for endangered terrestrial and aquatic species) at multiple scales (e.g., ranch management unit, watershed, ecosystem) using scientific approaches to examine the interactions between land management and water resource degradation, restoration, and protection.

Continuing Education Credits

MCLE credit for 13 hours is approved. Continuing education credits are also available for DHS Drinking Water Treatment and Distribution Operators.

Online Registration and Additional Information

Register for this course online at www.grac.org. For additional information, contact Mary Megarry at GRA, mmegarry@nossaman.com or 916-446-3626.

Dates & Details

GRA Meetings and Key Dates

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

- **GRA Course** — October 2-3, 2006, Glendale, CA
  Introduction to Groundwater & Watershed Hydrology: Monitoring, Assessment & Protection
- **GRA Symposium** — November 14-16, 2006, Long Beach, CA
  High Resolution Site Characterization & Monitoring
- **GRA Board of Directors Planning Meeting** — January 13-14, 2007, Irvine, CA
- **GRA Conference** — March 2, 2007, San Francisco, CA
  Groundwater Law & Policy

HYDRO VISIONS

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