

# HYDRO VISIONS

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GROUNDWATER RESOURCES ASSOCIATION  
OF CALIFORNIA

Summer 2005

## Artificial Recharge: Nexus of Quantity and Quality in California

BY TIM PARKER, CALIFORNIA DEPARTMENT OF WATER RESOURCES

### Introduction

Over 200 attendees flocked to the GRA March 16-17, 2005 workshop on artificial recharge in Sacramento, which focused on regulation and water quality issues related to aquifer storage recovery (ASR). The workshop, sponsored jointly by GRA, California Department of Water Resources, State Water Resources Control Board, Association of California Water Agencies, and U.S. Geological Survey, marked the first in the Series on Groundwater Resources, and was well represented by all sectors of the groundwater industry. This workshop was conducted to provide a public forum to help broaden stakeholder involvement and the nature of discussions on ASR projects, particularly in the Central Valley. There have been no long term ASR projects implemented in the Central Valley, although there are a number of such projects either in the planning or pilot development phase. The Central Valley Water Board is the lead oversight agency for ASR projects in the Central Valley.



GRA Field Trip attendees view the City of Roseville's first ASR well.

Currently, there is no adopted permitting policy for ASR either in the region or the state; strict basin plan water quality objectives and anti-degradation policy apply to any project, and injected drinking water has been considered a "waste" because it contains chemical constituents in excess of the basin plan water quality objectives. All of the above makes it a challenge to implement an ASR project involving drinking water, and provides a bit of a public perception nightmare: our drinking water is not a "waste."

*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	2
Upcoming Events	3
Technical Corner	5
California Legislative Corner	6
California Regulatory Corner	7
Federal Legislative/Regulatory Corner	8
Chemist's Corner	9
Education Corner	10
Alliance Corner	12
Organizational Corner	14
Branch Activities	27

### Aquifer Storage Recovery (ASR)

ASR systems are known to be operating in the United States, United Kingdom, Canada, Australia, South Africa and Israel. ASR development programs are also underway in several other countries, including the Netherlands, New Zealand, Thailand, Taiwan and Kuwait. This is a relatively new technology. In the U.S., the U.S. Geological Survey conducted small tests of well recharge systems beginning in the late 1940s, but none of these test sites were placed into operation. The first

*Continued on page 16*



# President's Message

BY TOM JOHNSON

## The Value of Water

Water is becoming an increasingly precious commodity. As I've noted previously, water issues are appearing on front pages of major newspapers across the country, and particularly in the southwest. A few weeks ago, I attended the National Ground Water Association (NGWA) Ground Water Summit in San Antonio, Texas. One of the primary sessions at the Summit, sponsored by GRA, was on the subject of the Groundwater Sustainability and the Tragedy of the Commons. In short, the tragedy of the commons occurs when users of a common resource, such as groundwater, naturally act in their individual best interests, thereby depleting that common resource in the absence of any other economic or management controls. The effects of groundwater depletion and overdraft are widespread in the southwest U.S., leading to increasing efforts and need to determine the value of the resource.

The increased value of groundwater was evident in the keynote speech in San Antonio by T. Boone Pickens, famous for his petroleum and business investments. Mr. Pickens owns thousands of acres of farmland in far northeastern Texas underlain by the prolific Ogallala Aquifer. However, the farmers in that part of Texas practice dry-land ranching and do not pump much groundwater for irrigation. Watching the increasing value of water in Texas, especially groundwater, Mr. Pickens recognized an opportunity to invest in groundwater as a marketable commodity. He knew that water is particularly important to San Antonio, one of the

largest U.S. cities that relies totally on groundwater. Mr. Pickens also knew that he and his neighboring farmers were not using the abundant groundwater resources underlying their properties, and that according to Texas law he had as much right to use that water as any other property owner. Except, he saw an opportunity to sell that water to those who needed it most, such as the City of San Antonio, more than 500 miles to the south. Investing more than \$30 million of his own funds, Mr. Pickens has formed an investment group to develop and market those groundwater resources, banking on the future of the water economy. In doing so, he has thoroughly evaluated and determined the costs of pumping and transporting that water through pipelines hundreds of miles; costs that are reportedly competitive with the current costs charged to groundwater users in San Antonio. Clearly, the value and real costs of water are becoming much more evident and important.

Back in California, the value of water is illustrated by efforts of the City of Roseville in the Sacramento area to implement aquifer storage and recovery (ASR) to supplement their water needs. However, Roseville is proposing to inject surface water that has already been treated for public water supply. Roseville currently relies totally on surface water, and is proposing to divert a portion of their allocated surface water to ASR during those times of the year when they do not need it. The City proposes to inject that water through recharge wells and withdraw groundwater as needed to meet

*Continued on page 20*

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# 25th Biennial Groundwater Conference and 14th Annual GRA Meeting

## Past Lessons and Future Prospects

**OCTOBER 25-26, 2005,  
SACRAMENTO, CA**

BY VICKI KRETSINGER

On October 25 and 26 at the Sacramento Convention Center in Sacramento, California, it's "back to the future" with the "25th Biennial Groundwater Conference and 14th Annual Groundwater Resources Association of California Annual Meeting and Conference." For 50 years, the Biennial Groundwater Conference has provided opportunities to learn about the current policies, regulations, and technical challenges affecting the use and management of groundwater in California. Sponsors of this year's conference include the University of California Center for Water Resources, California Department of Water Resources (DWR), California State Water Resources Control Board (SWRCB), Groundwater Resources Association of California (GRA), Water Education Foundation (WEF), and U.S. Geological Survey (USGS). Cooperating organizations include the International Association of Hydrogeologists (IAH), California Groundwater Association (CGA), Association of California Water Agencies (ACWA), and the National Ground Water Association (NGWA).

The two-day conference features a plenary session, concurrent sessions with technical and policy presentations on current and future challenges for groundwater resource management and increasing water quality issues, and a final general assembly on climate

*Continued on page 23*

# Upcoming Events

## GRA Groundwater Resources Series

### Joint GRA/DWR/USGS/ACWA Workshop on Basin Yield and Overdraft: State of the Science and Law

**SEPTEMBER 15-16, 2005 – PASADENA HILTON, CA**

The concepts and definitions of overdraft and safe yield are ingrained in industry, and at the same time debatable whether technical or legal in nature, and in many basins of California, we have insufficient information or lack of data coordination to ascertain just what the state of the basin is. More importantly, methods of hydrological trend analysis and evaluating basin yield vary greatly, along with the quality of the data used and results of the analysis.

This two-day workshop will provide the technical forum for local, state and federal public and private sector technical and legal professionals to meet and debate the appropriate and acceptable approaches and methods for conducting hydrologic trend analysis, and evaluating the yield of a groundwater basin. The focus of the workshop will be the main topics

outlined above, but will also include technical, policy and legal discussions on overdraft, perennial yield, and safe yield. Pasadena is the location of this workshop, in the heart of where much of the historic case law related to the topics of overdraft and safe yield has occurred. The workshop will also include a field trip, before the two day workshop, focused on some of the locations of historic case law on groundwater overdraft, safe yield, and adjudications.

Attendees will receive a notebook including abstracts of the speakers, with as many papers and presentations online as possible. A separate White Paper, summarizing the presentations, debates and outcomes will be prepared as an on-line document subsequent to the workshop.

Information will be posted on the GRA website closer to the event. 💧

## DNAPL Source Zone Characterization & Remediation

*The 15th Symposium in GRA's Series on Groundwater Contaminants*

**DECEMBER 7-8, 2005 – RAMADA PLAZA HOTEL, SAN FRANCISCO, CA**

Effective and efficient dense non-aqueous phase liquid (DNAPL) source zone remediation involves not only difficult technical issues, but policy challenges as well. Numerous

recent academic papers and regulatory documents underscore the ongoing interest in techniques and technologies for characterization, removal, and more

*Continued on page 21*

# Principles of Groundwater Flow and Transport Modeling

**NOVEMBER 7-9, 2005  
SEAPORT COMPUTER AND  
CONFERENCE CENTER,  
REDWOOD CITY, CA**

UNIV. OF CALIFORNIA  
COOPERATIVE EXTENSION  
CO-SPONSOR

## Course Description

The use of computer modeling tools has become a standard practice in many groundwater investigations. Groundwater resources evaluation, groundwater quality assessment, contamination site assessment and remediation, environmental impact review, and other groundwater-related activities frequently rely on computer models as a means of understanding groundwater flow and the fate of contaminants in the subsurface. The course objective is to demystify the use of groundwater models by providing solid understanding of the principles, methods, assumptions, and limitations of groundwater models, as well as hands-on experience with the planning, preparation, execution, presentation, and review of a modeling project. The first half of the course reviews the concepts of groundwater flow and transport, and of finite difference and finite element methods. It provides an overview of various software programs for groundwater flow and transport modeling and accompanying pre- and post-processing programs. The second half of the course features hands-on exercises based on the USGS MODFLOW flow model and a compatible transport model. Exercises include site-specific models as well as basin/watershed wide models. The course is taught by experienced instructors

# Upcoming Events

familiar with many aspects of groundwater modeling and California hydrogeology. At the end of the course, participants should be able to understand and actively engage in planning, supervision, and/or review of groundwater modeling projects.

## Who Should Attend

The short-course is intended for professional consultants, technical personnel in engineering/geology firms and irrigation/water districts, regulatory agency specialists and managers, and those in the legal community specialized on groundwater issues. Participants should have a working knowledge of the principles of groundwater hydrology and be familiar with the PC Windows 95 (or Windows 2000) environment. No formal training in computer programming is necessary.

## Course Topics

- principles and concepts of groundwater modeling
- overview of groundwater modeling software
- conceptual model development
- data collection and preparation
- model grid design
- boundary conditions: concepts and

application

- implementing rivers, lakes, recharge, drainage and other special situations
- modeling multiple aquifer systems
- sensitivity analysis, model calibration and verification
- contaminant transport modeling
- capture zone analysis

## Course Instructors

*Graham E. Fogg, Ph.D.*, Professor of hydrogeology with the Hydrology Program of the Department of Land, Air, and Water Resources, University of California, Davis.

*Thomas Harter, Ph.D.*, Chief of the University of California Cooperative Extension Groundwater Hydrology Program, and 1991 Harshbarger fellow for outstanding research in subsurface flow and transport modeling.

*Peter Schwartzman, M.S.*, Provides hydrogeologic consulting as an associate at Pacific Groundwater Group in Seattle, Washington.

For more information, contact Mary Megarry at GRA, [mmegarry@nossaman.com](mailto:mmegarry@nossaman.com) or (916) 446-3626. •

# MtBE and TBA: Comprehensive Site Assessment and Successful Groundwater Remediation

**AUGUST 10-12, 2005  
SAN FRANCISCO, CALIFORNIA**

Releases of oxygenated gasoline from leaking underground storage tanks, surface spills, and other sources have resulted in groundwater impacts requiring remedial action at sites throughout

California and the United States. While there is a wealth of scientific information and practical experience available for treating conventional fuel hydrocarbon constituents such as

*Continued on Page 22*

# Wells and Words

BY DAVID W. ABBOTT

## How is the yield or productivity of a well judged?

This new quarterly feature of HydroVisions will discuss various aspects of water well drilling, construction, development, pumping tests, and water wells. The first topic is the yield or productivity of a well and how to compare wells to wells. Wells are rated frequently according to the quantity of groundwater that can be pumped in gallons per minute (gpm). Rarely are the yield ratings coupled with a drawdown or any meaningful hydrogeologic or well information. One often hears:

- ◆ My well (A) does 100 gpm!
- ◆ I just installed a well (B) in bedrock that does 1,000 gpm!
- ◆ My well (C1) does 60 gpm while my neighbor's (C2) does 3 gpm!

These statements are extremely misleading and reveal little or nothing about the hydraulic or hydrogeologic framework under which the well yields operate. Given these statements, one could conclude that a ranking for the wells would be: B (most productive), A, C1, and C2 (least productive). However, each statement begs for additional information. When these statements are heard in this context, the next question one should ask is — “Wow that’s great! How much drawdown does your well use?” The drawdown (dd) in the well is the vertical distance between the static (non-pumping) water level and the pumping water level and represents a pressure drop that allows groundwater to flow toward the well. The correct way to state well performance in conversational (non-technical) language is:

- ◆ My well does 100 gpm with 20 feet of drawdown.
- ◆ I just installed a well in bedrock that does 1,000 gpm with 500 feet of drawdown.
- ◆ My well does 60 gpm with 12 feet of drawdown, while my neighbor’s does 3 gpm with 0.6 feet of drawdown.

Clearly, there are differences in the amount of drawdown used for each well to establish the stated well yield. A more concise statement of the productivity and yield of a well is represented by a normalized parameter called the specific capacity (SC). The SC is the yield or discharge of the well divided by the drawdown in the well at that specific discharge (and time). The SC is usually expressed as gpm per foot of drawdown (gpm/ft of dd) and usually ranges from 0.01 to 100 gpm/ft of dd. The SC normalizes the well yield data so that comparisons can be made between wells. In other words, the SC means that for every foot of drawdown, the well will

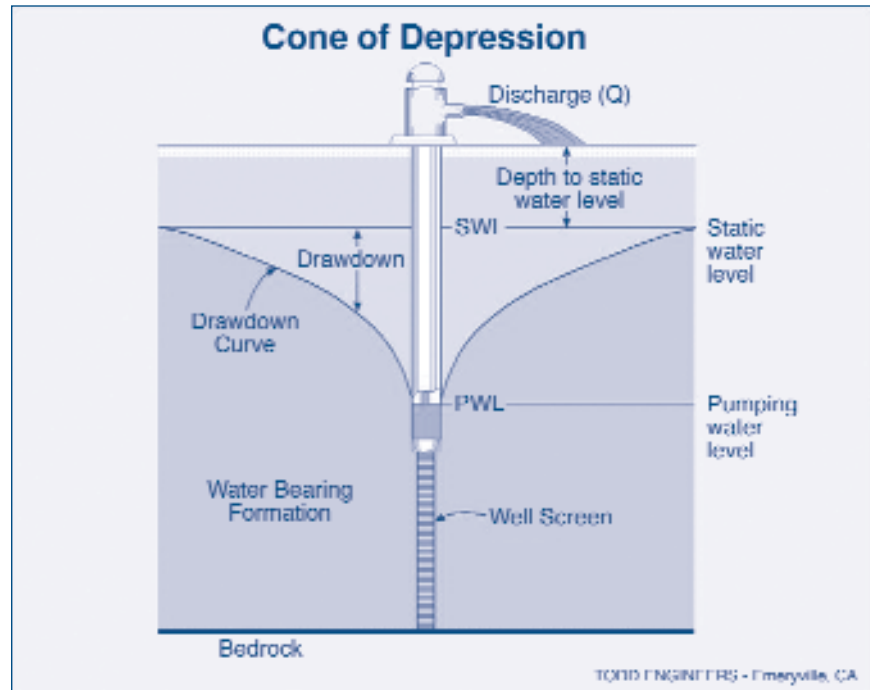
pump so many gallons per minute. Rephrasing the statements above yields:

- ◆ My well does 100 gpm with a SC of 5 gpm/ft of dd.
- ◆ I just installed a well in bedrock that does 1,000 gpm with a SC of 2 gpm/ft of dd.
- ◆ My well does 30 gpm with a SC of 5 gpm/ft of dd, while my neighbor’s well does 3 gpm with a SC of 5 gpm/ft of dd.

*Editor’s Note: Wells and Words complements GRA’s new Groundwater Resources Series, which included the recent Artificial Recharge Symposium in March (page 1 of this issue) and the upcoming symposium on Overdraft and Safe Yield in October (page 3). Alternative opinions and experiences from the reading audience on Wells and Words or any other HydroVisions articles may be submitted as letters to the editor or stand-alone articles to [editor@grac.org](mailto:editor@grac.org) according to the author guidelines at [www.grac.org](http://www.grac.org) under Publications.*

*Continued of page 26*

# Technical Corner



# California Legislative Corner

## Legislative Committee Update

BY CHRIS FRAHM AND JEFF VOLBERG, HATCH & PARENT, GRA LEGISLATIVE ADVOCATES

### Current Groundwater Bills in the California Legislature

There have been several bills related to groundwater introduced in the 2005-2006 legislative session. However, only four bills have been actively moving through the legislative process.

#### AB 290 (Leslie) Hard Rock Wells

AB 290 requires the Department of Health Services (DHS) to undertake a 5-year study of methodologies used to determine water source capacities in hard rock wells. The study should help to develop techniques for conducting pump tests and evaluating data, and to develop the most accurate and cost-effective prediction of long-term well capacity. The bill prescribes the composition of the 7-member study committee and the study methods.

The sponsor of this bill is the California Groundwater Association (CGA). As amended on April 19, this bill passed out of Assembly Environmental Safety & Toxic Materials Committee (ES&TM) with a vote of 7-0.

#### AB 371 (Goldberg) Water Recycling

Referred to as the Water Recycling Act of 2005, this bill removes recycled water from the local government regulatory scheme and creates a single statewide process for using, managing, and approving the use of recycled water. The bill raises issues of risks to groundwater quality from percolation or injection of recycled water. As amended on April 25, the bill allows local agencies that manage

groundwater basins to adopt and enforce regulations protecting groundwater quality. The bill also allows regional boards to impose additional conditions on permits for recycling projects to address local groundwater conditions.

The bill passed out of ES&TM with a vote of 7-0, and was referred to Assembly Water, Parks & Wildlife Committee (WP&W). It passed out of WP&W on April 26.

#### SB 773 (Cox) Artificial Recharge Using Drinking Water

This bill exempts any injection well used to inject drinking water from prohibitions on the release of hazardous waste into aquifers. The bill defines "waste" as not including drinking water that is percolated, injected, or conveyed into a groundwater aquifer. The bill also provides a reporting process that gives regional boards a chance to determine whether a project meets drinking water standards, and is consistent with the applicable water quality control plan.

The bill raises issues that illustrate the tension between the need to develop artificial recharge projects and the protection of groundwater quality. Regional boards in different parts of the state have taken different stances with regard to these issues. The bill provides a focus for debate of these issues, and may serve as an impetus for their resolution.

Senator Cox has agreed to leave SB 773 in the Senate Environmental Quality Committee as a two-year bill. The bill will not be brought up for hearing until January, 2006. SB 773

was the subject of GRA's May 18, 2005 Legislative Symposium and Lobby Day in Sacramento; Senator Cox was an invited speaker.

#### SB 820 (Kuehl) Water Management

This bill is very extensive and affects many areas of water law and management. With respect to groundwater, it requires that any person who extracts more than 25 acre feet of groundwater per year file an annual notice of extraction with SWRCB. Failure to file an annual notice on time would be considered equivalent to non-use of the water for that year for purposes of water rights determinations. The bill also requires that any local agency that has adopted a groundwater management plan update that plan every five years beginning in 2008, and file the update with specified entities.

The bill's author is the chairperson for the Senate Natural Resources & Water Committee (NR&W). The bill is on a list of priority water and environmental bills that have been endorsed by the President pro tem of the Senate. SB 820 passed out of NR&W on April 26, with a vote of 7-3. While the author has pledged to continue to work with interested parties on drafting a bill everyone can live with, there are still some difficult issues to resolve and it is possible not everyone will be happy at the end of the day.

*Contributors to the Legislative Corner include Chris Frahm and Jeff Volberg of Hatch & Parent, GRA Legislative Advocates, and Tim Parker, GRA Legislative Committee Chair. ♠*

# California Regulatory Corner

## CCGO Highlights

BY JANE H. GILL-SHALER, CCGO EXECUTIVE DIRECTOR

### CCGO Supports Focus Group to Review CA Specific Exam

The California Specific Exam (CSE) tests new applicants for Professional Geology Registration in California on the knowledge unique to geologic practice in California. Some opponents indicate that a state-specific test, which is not required in all states, is irrelevant and ineffective, while proponents find that there are definite “competencies and knowledge unique to practice in California.” In a letter to Craig Copelan, Board of Geologists and Geophysicists (BGG) Board President, Jason Preece, President of CCGO, and Charles Nestle, CCGO Vice-President, strongly support the Department of Consumer Affairs recommendations that the CSE be evaluated by a focus group consisting of subject matter experts and facilitated by a test development expert. CCGO believes that most, if not all, of the writers of the letters and emails received by the BGG in support of or against the CSE have never seen the exam, and therefore the validity of their positions is questionable. In its May 20 meeting, the BGG unanimously voted to form the focus group, and an announcement will go out soon to solicit candidates. The two-day workshop for the focus group is scheduled for October 6-7, 2005. The BGG will select up to 9 candidates at their July 15 2005 meeting in Sacramento. For a copy of the CCGO letter to BGG, see [www.ccgo.org](http://www.ccgo.org).

### CCGO Hires Judy Wolen, Lobbyist and Legislative Analyst

CCGO has taken the step at last of hiring Judy Wolen, an experienced

lobbyist and legislative analyst in Sacramento, as our official lobbyist. Judy has over 15 years of experience lobbying for geoscience and engineering firms in Sacramento, and has been the lobbyist for the three California sections of AEG for several years. Among other clients is CGEA, the California Geotechnical Engineers Association. Judy’s expertise, experience, and numerous friendships and contacts in Sacramento will be of great value to CCGO, and we heartily welcome her into our family.

### SB 228 and SB 246 Headed for the Assembly

Both of these bills, which respectively extend the BGG and Board of Professional Engineers and Land Surveyors (BPELS) until 2012, have passed out of the Senate and been sent to the Assembly. CCGO supports SB228 and SB246 very strongly. More information, links to the bill information, and the CCGO letters of support, may be found on our website <http://ccgo.org/>.

### SB 228 (Figueroa) Board for Geologists and Geophysicists: Sunset Date

**Summary:** Existing law, the Geologist and Geophysicist Act, provides for the regulation of geologists and geophysicists by the Board for Geologists and Geophysicists, in the Department of Consumer Affairs. Under existing law, the provisions creating the board and authorizing the board to appoint an executive officer will become inoperative on July 1, 2006, and will be repealed as of January 1, 2007. This bill would instead make these provisions

inoperative and repealed on July 1, 2011 and January 1, 2012, respectively. This bill contains other related provisions.

### SB 246 (Figueroa) Board for Professional Engineers and Land Surveyors

**Summary:** Existing law establishes the Board for Professional Engineers and Land Surveyors in the Department of Consumer Affairs. Existing law requires the board to appoint an executive officer. Existing law authorizes the board to make and enforce rules and regulations that are reasonably necessary to carry out the provisions of law regulating land surveyors. Existing law provides that these provisions are to become inoperative and are repealed on July 1, 2006, and January 1, 2007, respectively. This bill would instead make these provisions inoperative and repealed on July 1, 2012 and January 1, 2013, respectively.

### CCGO Fundraisers and Awards in Northern and Southern California

Several CCGO Awards were presented to California Geologists on May 12 at our annual Northern California Fundraiser in Oakland, hosted by the San Francisco Section of AEG. Awardees included Tor Nilsen, CCGO California Geoscientist Hall of Fame, Living Legend Award; Lou Gilpin, CCGO Community Geoscientist Award; Dr. Lisa White, CCGO Founders’ Award; Corinne Stewart, CCGO Gold Award; and Senator Liz Figueroa, CCGO Legislator Award. Everyone agreed that the featured

*Continued on page 24*

## Current Happenings at the Federal Government

BY JOHN UNGVARSKY, US EPA

### EPA Newsletter

Notes from Underground is not only a famous novel but also a newsletter published by EPA Region 9's Ground Water Office. The newsletter brings information about source water protection, Underground Injection Control (UIC), and related compliance and public water supply issues to injection well operators, the public water supply industry, other regulators, and the general public in the Southwest and Pacific Islands. Requests for subscriptions, ideas for articles, and article submissions should be directed to Kate Rao at (415) 972-3533, or [rao.kate@epa.gov](mailto:rao.kate@epa.gov). To view the current version, go to: <http://www.epa.gov/region09/water/underground/notes/index.html>.

### Ground Water Rule

In late March, EPA withdrew the Ground Water Rule from review at the Office of Management & Budget. First proposed in 2000, the rule is designed to determine which drinking water systems that draw ground water are at high risk for fecal contamination, requiring action to eliminate bacteria or viruses from the water. EPA will use the additional time to develop further analysis of the pending rule and intends to publish the final rule by the end of 2005.

### New Underground Injection Control Poster

Did you know that the UIC Program regulates over 800,000 wells nationally? To learn more about the

UIC Program, check out *The Underground Injection Control Program: 30 Years Protecting Ground Water Through the Safe Drinking Water Act*, a new poster recently posted at [http://www.epa.gov/safewater/uic/pdfs/poster\\_uic\\_30years.pdf](http://www.epa.gov/safewater/uic/pdfs/poster_uic_30years.pdf).

### Source Water Protection Report

Over the past five years, EPA helped fund five national nonprofit organizations to launch source water demonstration projects around the country. The purpose was to build on Source Water Assessment Programs and move communities from planning to implementing protection for drinking water sources. The Trust For Public Land recently published *Path To Protection*, a compilation of the organizations' efforts, including case studies and corresponding protection strategies. The document can be downloaded at [http://www.tpl.org/tier3\\_cd.cfm?content\\_item\\_id=19077&folder\\_id=175](http://www.tpl.org/tier3_cd.cfm?content_item_id=19077&folder_id=175).

### Office of Inspector General Report

In March, EPA's Office of Inspector General (OIG) completed its report determining how well the Source Water Assessment Program and the voluntary Source Water Protection Program are helping to protect public drinking water quality. The OIG found that while States continue to make progress on completing source water assessments and many are developing and implementing source water protection strategies, there are several obstacles

that hinder States' efforts to protect source water. The report is available at: <http://www.epa.gov/oig/>.

### Drinking Water & Ground Water Educational Tools

For the kid in you (or at least teachers and kids you know), EPA has a new web site designed for teachers and kids to help educate about drinking water and ground water. Thirstin, EPA's new mascot for safe drinking water, guides viewers through animated games and activities, including "Build Your Own Aquifer," to test water knowledge. For more info, go to: <http://www.epa.gov/safewater/kids/index.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](mailto:ungvarsky.john@epa.gov).*



## Free the Cyanides!

BY BART SIMMONS

Cyanide still maintains its reputation as a popular poison, a useful industrial reagent, and a common environmental contaminant. Extensive cyanide groundwater contamination exists near mines and former manufactured gas plants, and also can be formed during disinfection at wastewater treatment plants. Recent developments have improved the ability to measure cyanide species of potential toxicity, but we still rely on test methods that measure groups of cyanide compounds.

Cyanide can exist in various forms in water, including free cyanide (CN<sup>-</sup> or HCN), weak complexes (e.g., complexes with zinc, copper, and nickel), strong complexes (e.g., ferro- and ferricyanide complexes), and organics (nitriles). Interestingly, one study of cyanide in groundwater near manufactured gas plants, using electrospray ionization mass spectroscopy, tentatively identified a major cyanide constituent as a complex of cyanide with iron and methylamine: [Fe(CN)<sub>5</sub>NHCH<sub>3</sub>]<sup>4-</sup> (Ghosh et al, *Env Eng Sci*, vol 21, No 6, 2004). The toxicity of the cyanide species varies, of course, thus complicating the process of measurement and risk assessment at sites with cyanide contamination. Because of the inherent toxicity of cyanide to a wide variety of organisms, it often can become the risk driver for remediation activities.

**Criteria:** The 1984 EPA Ambient Water Quality Criteria (U.S. EPA, 440/5-84-028) for cyanide were based on free cyanide, and suggested that the measurement of free cyanide may be adequate in some receiving waters. The criteria were included in the 2002

criteria (EPA-822-R-02-047), with the statement that the acute and chronic marine water quality criteria of 1 µg/L applied to free cyanide. However, there is still no generally accepted method for free cyanide in water.

**Test Methods:** Common cyanide tests include: total cyanide, cyanides amenable to chlorination, weak acid dissociable (WAD) cyanides, and available cyanide. Total cyanide measurement includes distillation of the sample with strong acid and a catalyst followed by testing of the distillate trapped in alkaline solution. The rigorous conditions measure all but the most stable complexes, e.g., platinum and cobalt complexes. Industries have long argued that the common cyanide methods, particularly total cyanide test, overestimate the concentration of potentially available free cyanide. The cyanides amenable to chlorination test measures free cyanides plus readily dissociable cyanide complexes. The WAD cyanide test also measures readily-dissociable complexes, but does not detect the strong metal-cyano complexes, such as CoCN, PdCN and AuCN. There is some uncertainty about whether the WAD cyanide test measures the ferro- and ferricyanide complexes. Ghosh et al found that the WAD test unexpectedly recovered some of the iron complexes in groundwater samples.

**Who's Available?:** In 1999, EPA approved Method OIA-1677 "Available Cyanide by Flow Injection, Ligand Exchange, and Amperometry," as an additional test for "available cyanide." under Section 304(h) of the Clean Water Act. In the sample pretreatment step, ligand-exchange

reagents displace cyanide ions from weak and intermediate strength metallo-cyanide complexes. Then a flow injection technique forms HCN, that then diffuses through a selective membrane, is converted back to cyanide ion, and is measured amperometrically. Although relatively few laboratories have the flow injection equipment required by Method 1677, the method potentially provides a means to measure free cyanides and dissociable cyanide complexes more accurately than other approved methods. EPA included performance data indicating that Method 1677 was more accurate and precise than other existing methods.

**Bottom Line:** Some speciation methods, such as liquid chromatography – electrospray ionization mass spectrometry, can identify the actual cyanide species in groundwater and wastewater, but the WAD cyanide test and the newer available cyanide test are still used in monitoring plans to estimate the potentially dissociable cyanide complexes.

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

## Field Methods in Groundwater Education

BY JOHN M. SHARP, JR.

The U.S. National Chapter of the International Association of Hydrogeologists (IAH) and the Geological Society of America (GSA) co-sponsored a very informative and thought provoking session on “Groundwater Education: Field vs. Classroom” at the Association of Ground Water Scientists and Engineers (AGWSE; Division of the National Ground Water Association) 2005 Ground Water Summit. This session, co-convened by Richard Laton of the California State University at Fullerton, Vicki Remenda of Queen’s University in Canada, and Alan Dutton of the University of Texas at San Antonio, included presentations on the many innovative methods instructors have developed to engage students in active learning. Such approaches, whether in the field or the classroom, stimulate student’s enthusiasm for learning “by doing” and increase their ability to synthesize many forms of information as they tackle educational and research problems.

An excellent way to incorporate interactive learning in the educational program is by putting theory into practice. Field methods are integral to the science of hydrology and to the education and training of hydrogeology students. Both field and theoretical studies of groundwater hydrology rely on data, and it is important that students appreciate how data are obtained, the uncertainties that arise in data collection and interpretation, and the need to define the critical data needs in a project. Field studies provide a break from the theoretical analyses learned in the classroom and, more importantly, can amplify the concepts taught. Students enjoy this time where

they can practically apply their classroom knowledge and join with their peers to understand the function of natural systems and perform real-time problem solving. For example, when they conduct a pumping test and plot drawdowns as a function of time, they find the Theis and Cooper-Jacob methods of pumping test interpretation more meaningful.

Instructors at the University of Texas have taught hydrogeological field methods classes at the senior undergraduate/graduate student level since 1985. The Field Methods class includes 2 weeks where instructors teach a variety of field methods, followed by about a week where the students apply some of the methods learned to address a real field hydrogeology problem and prepare a formal written report on their findings. Field methods taught have included: hydrogeological mapping; pumping and infiltrometer tests; field geochemistry and sampling techniques; vadose zone analyses; stream and stream sediment gauging; fracture mapping; surveying; tracer tests; grain-size analyses; and geophysical methods (down hole, seismic, GPR, resistivity, EM, VLF, and gravity). Projects have included: hydrogeological analyses of Padre Island; urban hydrogeology in Pecos and Austin; studies of USEPA remediation sites; evaluation of the hydrogeology of abandoned coal mines; and hydrogeologic maps of various aquifers. In some cases, these studies have provided unique data sets that have been used subsequently by hydrogeology graduate students, state agencies, and consulting firms.

Although field classes should be an integral part of all geoscience and engineering educational programs, there are obstacles. The field equipment is expensive, and students are rough on the equipment. Correspondingly, field classes are expensive, and declining budgets at the Texas campus and elsewhere limit their incorporation into educational programs. Other administrative factors also limit support for these vital programs, including perceived risk factors, limited faculty time and energy, and limitations on class credit transferability between institutions.

Nevertheless, the integration of applied methods with classroom theory is instrumental to enhanced problem solving skills and critical for addressing society’s future groundwater resources issues. We need to continue to promote the value of these programs, and as academicians, researchers, and practicing geoscientists and engineers, we need to join efforts to identify ways to promote the value of geoscience education and be increasingly inventive to overcome the obstacles.

*Jack Sharp is the Carlton Professor of Geology at the University of Texas. He also Chairs the US National Chapter of the International Association of Hydrogeologists. ♠*

## Education Committee Identifies Water Websites

BY JIM STRANDBERG, MALCOLM PIRNIE; COMMITTEE CHAIR

The Education Committee is pleased to offer the following list of websites that provide up-to-date information on various aspects of groundwater. Listed below are the organizations, a brief description of the type of work that they do and their website address. This information is also available on GRA's website.

**The Water Education Foundation (WEF)** A non-profit organization that tries to create a better understanding of water issues and help resolve water resource problems through a variety of K-14 programs. <http://www.water-ed.org>

**The Groundwater Foundation (TGF)** A non-profit organization dedicated to educating and motivating people to care for and about groundwater. Publishes "The Aquifer" to provide up-to-date information on groundwater-related issues and new technological developments. <http://www.groundwater.org>

**The American Ground Water Trust** A non-profit education organization that acts as an independent authority on the hydrologic, economic and environmental significance of groundwater. <http://www.agwt.org/index.htm>

**The Association of California Water Agencies (ACWA)** Respected advocate for California's public water agencies. ACWA's involvement at the state and federal level has helped shape laws and policies that affect ACWA's member agencies and customers. <http://www.acwanet.com/aboutacea>

**The California Groundwater Association (CGA)** A non-profit organization that is devoted to continuing education to its members and providing accurate information to

the public regarding California's groundwater resources. <http://www.groundh2o.org>

**The National Ground Water Association (NGWA)** Provides information and guidance on scientific, economic, and beneficial development, protection and management of the world's groundwater resources. Publishes Water Well Journal, Ground Water Monitoring & Remediation and Ground Water. <http://ngwa.org/index.html>

**The National Ground Water Research and Education Foundation (NGWREF)** Public foundation focused on conducting educational, research and other charitable activities related to a broader public understanding of groundwater. <http://ngwa.org/ngwef/ngwef.html>

**The U.S. Geological Survey (USGS)** Recognized as the sole science agency in the Department of the Interior, and one of the lead agencies that solve complex natural resource problems across the country and around the world. <http://www.usgs.gov>

**California Department of Water Resources (DWR)** Operates and maintains

the State Water Project including the California Aqueduct, provides dam safety and flood control services, assists local water districts in water management and conservation activities, promotes recreational opportunities, and plans for future statewide water needs. <http://www.water.ca.gov/>

**The Water Resources Center Archives (WRCA)** Collects, preserves and provides access to historical and contemporary water-related materials that support the instructional and research programs of the University of California and the needs of the people of the State. <http://www.lib.berkeley.edu/WRCA/>

**U.S. Environmental Protection Agency (EPA)** Federal agency tasked with the protection of human health and the environment. <http://www.epa.gov/enviroed/neeact.html>

**University of California Davis – Center for Water Resources** Research focusing on conservation, development, management, distribution, and utilization of water resources with a view to the optimum present and future use. <http://www.waterresources.ucr.edu/>

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# NGWA's AGWSE Division Co-Sponsors Two Sessions at October 2005 GSA Annual Meeting

BY VICKI KRETSINGER

As an Associated Society of the Geological Society of America (GSA), the Association of Ground Water Scientists and Engineers (AGWSE), division of the National Ground Water Association (NGWA) is co-sponsoring two sessions at the 2005 GSA Annual Meeting and Exhibition, "Science - Learning - Colleagues," October 16-19, 2005 in Salt Lake City, Utah. One of the co-sponsored sessions is "Groundwater Quality and Quantity Interconnections: The Effects of Natural and Anthropogenic Contamination on Groundwater Availability", which is being co-convended by Mike Moran of the USGS and Vicki Kretsinger of Luhdorff and Scalmanini, Consulting Engineers and AGWSE Division Chair. This session (Topical Session T15) will focus on the interconnections between groundwater quality and quantity, including the effect that quality can have on the volume of groundwater that is effectively available for present and future human and ecological needs. Invited speakers presenting in this session include Graham Fogg of the University of California at Davis, Kevin Dennehy of the US Geological Survey (USGS), Jean Moran of Lawrence Livermore Laboratories, and Paul Squillace of the USGS. The conveners welcome papers on topics such as: understanding the vulnerability of groundwater systems to quality/quantity degradation, identifying criteria for assessing the

*Continued on page 23*

## Alliance Corner

### California Groundwater Association Notes

BY MIKE MORTENSSON, CGA EXECUTIVE DIRECTOR

#### AB 290 Proposes Study on Hard Rock Well Tests

AB 290, introduced by Assemblyman Tim Leslie, would establish a five-year study of well testing methodologies in hard rock environments. The bill establishes a study committee with representatives from CGA and GRA, government agencies and the general public. The legislation is a result of cooperative efforts of CGA, GRA, DHS and other stakeholders. The bill was passed out of Committee on a 7-0 vote in April and is now in the Appropriations Committee for action. The CGA/GRA Task Force continues to work with DHS on study details and other aspects of this matter. Contact CGA or GRA if this issue is of concern to you.

#### CGA Plans Technical Session on Water Well Destruction

CGA has expanded its educational offerings at the 57th Annual Convention and Trade Show on November 3-5 in Sparks, Nevada. This year there will be a Water Well Destruction technical workshop on Thursday November 3rd as well as an OSHA refresher course. There will also be expanded seminars and demonstrations on Friday and Saturday. The CGA convention is being held at John Ascuaga's Nugget. Watch for details later this year.

#### Congratulations, GRA!

CGA congratulates GRA on the publication of California Groundwater Management, second edition, 2005. The handbook contains expansive information on our groundwater

resources and will be a valuable tool for groundwater professionals and water organizations for years to come. We know it is a long process to prepare such a resource. Thanks for persevering - the results are well worth your effort!

#### Groundwater Awareness Opportunities

During National Groundwater Awareness Week (March 13-19, 2005) CGA issued a news release on the need and desirability of an annual water well checkup. The Legislature has declared May as Groundwater Awareness Month and GRA has celebrated that through the issuance of California Groundwater Management. CGA has asked the Governor to continue to declare California Groundwater Week in November. We can all use these special times to get information to the public. CGA has long been a co-sponsor of the California Water Awareness Campaign (CWAC). This year we will be doing a booklet on water use efficiency and are promoting the protection of groundwater as a way to build water use efficiency. Visit CWAC's website at [www.wateraware.org](http://www.wateraware.org) for more info. As another example of educational efforts, CGA provided information to a group of students in Illinois for use in preparing for participation in "Awesome Aquifers" in the 2005 Science Olympiad (see the GRA website - resources, education corner - for more info). CGA also provided video footage used in the Science Seekers Safe Water CD-Rom available from Tom Snyder Productions ([www.teachtsp.com](http://www.teachtsp.com)). Let us know if we can assist you in your educational efforts. 💧

# International Association of Hydrogeologists 2005 Theme Issue Released – “The Future of Hydrogeology”

BY LENNY KONIKOW, PAST CHAIR  
US NATIONAL CHAPTER OF IAH

The first issue each year of the International Association of Hydrogeologists (IAH) Hydrogeology Journal is devoted to a special theme. IAH is especially proud of the recently released 2005 theme issue on “The Future of Hydrogeology,” which was planned and edited by U.S. member Cliff Voss. This largest ever issue includes 30 articles in a book-like total of 349 pages, and includes liberal use of color illustrations. The authors include many internationally recognized experts and leaders in groundwater studies. The issue includes two types of articles: regular papers and short essays (4 page limit). Table 1 (modified from Voss’ Preface to the issue) lists the authors and subjects of the articles. Voss states that the issue is intended “... to instigate discussion and to inspire creative thinking about hydrogeology.” He also groups the articles into six general topics: (1) history and philosophy, (2) geology and environment, (3) heterogeneity, (4) methods and data, (5) quantity and quality, and (6) society and health. Among the articles are several by leading California hydrogeologists, including “Hydrogeology in North America: past and future” by Dr. T.N. Narasimhan (University of California,

*Continued on Page 26*

## Alliance Corner

# Groundwater Needs More Study, National Ground Water Association Tells U.S. Senate Committee

BY CLIFF TREYENS, NGWA PUBLIC AFFAIRS MANAGER

Last year, the National Ground Water Association (NGWA) produced a white paper and call to action concerning water sustainability. On April 5, NGWA had a strategic opportunity to present some of its key findings and recommendations in testimony before the U.S. Senate Energy and Natural Resources Committee.

NGWA was among 22 groups selected by the Senate committee to present and discuss solutions to the challenges of meeting the nation’s ever-increasing demand for water at a half-day Bipartisan Water Conference. NGWA was chosen to speak specifically on the topic, “Knowledge of Water Resources.”

In exploring this matter, the inevitable conclusion to which NGWA gave voice is that significantly more study is needed of the largest source of available fresh water – groundwater – and that the federal government should support such a study.

Although groundwater makes up roughly 95 percent of the earth’s fresh water supply, “Few states have sufficient information necessary to adequately understand the potential yield of their aquifers,” NGWA’s David Wunsch told the committee. Wunsch is a member of NGWA’s Regional Ground Water Management Task Force that developed the water sustainability white paper and call to action. In a survey of 28 states, “NGWA members consistently stated that the most useful and efficient action

the federal government could take would be to increase federal funding for cooperative groundwater programs and data collection” Wunsch said. The National Cooperative Geological Mapping Program was given as a good example of a successful program.

Specific activities meriting additional discussion include:

**Data Gaps** – there is a need for a national clearing house for groundwater information and data to maximize everyone’s data-gathering efforts.

**Research Priority Areas** – Top priorities for development of long-term groundwater sustainability plans include research on water reuse and conservation; alternative treatment systems; development of brackish groundwater supplies; aquifer storage and recovery or artificial recharge; emerging contaminants and the development of remediation technologies; and the development of models and data standards.

**Education** – We need to educate the public nationwide so they will understand the urgent need for exercising responsible water use.

“No study of our nation’s water supplies can be complete without a clearer picture of our groundwater resources. One key to success is a vigorous federal role in funding cooperative efforts with state and local governments to address data gaps,” Wunsch said. ♠

# Organizational Corner

## 2005 CONTRIBUTORS TO GRA – THANK YOU!

GRA Extends Sincere Appreciation to its Co-Chairs and Sponsors for its March 2005 *Groundwater Resources Series* Workshop, "Artificial Recharge: Nexus of Quantity and Quality in California"

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# Organizational Corner

## 2005 GRA Annual Awards Program Nominations Requested for the GRA Lifetime Achievement and Kevin J. Neese Memorial Awards

BY BRIAN LEWIS, GRA AWARDS COMMITTEE CHAIR

The GRA Awards Committee is accepting nominations for GRA's 2005 Lifetime Achievement and Kevin J. Neese Memorial Awards (see descriptions below). Nominations for either award should indicate the reason you are making the nomination, a brief statement of qualifications of the nominee and your full contact information. Email nominations to Brian Lewis at [blewis@dtsc.ca.gov](mailto:blewis@dtsc.ca.gov) by July 15th, 2005. Nominations will be reviewed at GRA's August 6th, 2005 Board meeting, and the awards will be presented at GRA's Annual Meeting on October 25-26, 2005, in Sacramento. Should you have any questions about the nomination process, please contact Brian Lewis at (916) 255-6532.

**Goal:** The purpose of the GRA Awards Program is to recognize noteworthy projects and unique individual contributions related to the protection and management of groundwater in California.

**Objectives:** The objectives of the Annual Awards Program are:

- ▲ To provide recognition to individuals who have demonstrated leadership and continuous dedication in the field of groundwater management;
- ▲ To provide recognition for unique contributions to the field of groundwater management in 2005; and,

- ▲ To provide recognition to GRA (as an organization), whose mission is dedicated to resource management that protects and improves groundwater through education and technical leadership.

**Lifetime Achievement Award:** presented to individuals for their exemplary contributions to the groundwater industry, and for contributions that have been in the spirit of GRA's mission and organization objectives. Individuals that receive the Lifetime Achievement Award have dedicated their lives to the groundwater industry and have been pioneers in their field of expertise. Previous winners include:

- ▲ 2004 – John Bredehoeft
- ▲ 2003 – Rita Schmidt Sudman
- ▲ 2002 – Thomas W. Dibblee, Jr.
- ▲ 2001 – Carl Hauge
- ▲ 2000 – Joseph H. Birman
- ▲ 1999 – David Keith Todd
- ▲ 1998 – Eugene E. Luhdorff, Jr.

**Kevin J. Neese Award:** recognizes significant accomplishments by a person or entity within the most recent 12-month period that fosters the understanding, development, protection and management of groundwater. Previous Kevin J. Neese Award winners include:

- ▲ 2004 – California Department of Water Resources for publishing the updated Bulletin 118: "California's Groundwater."
- ▲ 2002 - Glenn County Water Advisory Committee for formulating a significant groundwater management ordinance that was adopted by the Glenn County Board of Supervisors.
- ▲ 2001 - American River Basin Cooperating Agencies and Sacramento Groundwater Authority Partnership for fostering the understanding and development of a cooperative approach to regional planning, protection and management of groundwater.
- ▲ 2000 - Board of Directors of the Chino Basin Watermaster for delivering a remarkable OBMP that created a consensus-based approach for making water supplies in the Chino Basin more reliable and cost effective.
- ▲ 1999 - Governor Gray Davis for his work and leadership in addressing MTBE. ▲

## Artificial Recharge: Nexus of Quantity and Quality in California – Continued from Page 1

drinking water ASR well began operation at Wildwood, New Jersey in 1969; this system, since expanded to four wells, is still in operation. The first California ASR well was constructed for the Goleta Water District in 1983. Currently, about 70 ASR sites are in operation around the United States, ranging from a single well to 30 wells, with recovery capacities ranging from 2 million liters per day, or ML/d (0.5 million gallons per day, or MGD) from single wells to 400 ML/d (100 MGD) from wellfields. In the planning stages is a very large ASR program for South Florida to restore the Everglades. At such time as this program is completed, it is expected to have over 300 ASR wells storing and recovering water at combined rates of up to 8000 ML/D (2 billion gallons per day, or BGD).

Several factors have contributed to the widespread and increasing implementation of ASR including:

- ◆ **Proven track record** – There are about 70 wellfields in 18 states operating 300 fully permitted wells, and about 100 more ASR wells are in development;
- ◆ **Low development cost** – Economically, ASR well systems typically require less than half the capital and operating cost of alternative water supply development, ASR programs can be implemented in phases, and cost pricing is marginal;
- ◆ **Low operating cost** – Annual average operating cost is approximately \$15,000 per year per million gallons per day recovery capacity, plus or minus \$10,000;
- ◆ **Water quality benefits** – Environmental and water quality benefits include water quality improvements, groundwater level restoration, and aquatic ecosystem maintenance;
- ◆ **Adaptability** – ASRs are adaptable to different applications such as fresh, brackish or saline receiving water, and drinking water, reclaimed water, stormwater, and groundwater storage sources.

For planning and implementing an ASR project a number of factors need to be considered, including site hydrogeology, water quality and water rights. Sufficient hydrogeological analysis is required to evaluate possible effects on the hydrogeological system, including changes in water levels in nearby wells, rate of movement of stored water, location and spatial distribution of aquifer recharge and recovery points, recovery efficiency, seasonal versus long-term operations, and subsidence control. Evaluation of source water and receiving water quality characteristics is essential to understand potential changes in the stored zone water quality and recovered water quality. Legal ownership and management of the storage space, the stored water, and protection of the stored water all need to be evaluated and resolved.

The continuing trend of evolving water quality standards is a significant consideration in planning and implementing an ASR program, and the potential for future loss of cost-effectiveness due to having additional

treatment expenditures. Pretreatment of ASR recharge water and post-treatment of recovered water are possible alternatives to control disinfection byproducts (DBPs), arsenic, microbiota and other constituents of concern, such as emerging contaminants. In most cases, subsurface natural treatment in the ASR storage zone is efficient and far more cost-effective, without threatening the highest possible beneficial use of water. The regulatory framework should balance ASR risks and benefits.

The solution to achieving a balance of risks and benefits is by understanding how ASR works. In an ASR well, a target storage volume of water is injected into the subsurface. Typically, there is a zone near the wellhead where natural treatment and degradation of many of the constituents of concern occurs. Detailed hydrogeologic characterization and monitoring on a site-specific basis is required to evaluate the particular constituents of concern and degradation processes of proposed and pilot scale ASR projects.

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*The continuing trend of evolving water quality standards is a significant consideration in planning and implementing an ASR program*

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## Regulation of Artificial Recharge in the Santa Ana Basin

The Santa Ana Water Board recently completed a 7-year program to amend the 1975 Santa Ana Basin Plan, using historical information to re-evaluate water quality objectives for groundwater total dissolved solids (TDS) and nitrate as nitrogen. The program, conducted by the Nitrogen/TDS Task Force, was initiated to consider the accuracy of the 1975 Basin Plan assimilative capacity findings, existing stringent discharge limits, and limitations on reclamation and recycling. Implications of the assimilative capacity, or the ability of the water resources to absorb various natural and anthropogenic effects without exceeding existing water quality objectives, is that if current ambient quality equals or exceeds water quality objectives, there is no capacity, and that discharge limits must be at or below sub-basin water quality objectives.

The result of the 7-year program was the preparation and subsequent adoption of the Nitrogen/TDS Basin Plan Amendment, which included a revision of sub-basin boundaries, re-creation of objectives from a previous 20-year period (1954-1973), determination of current ambient water quality based on a recent 20 year period (1978-1997), and comparison of current ambient quality to objectives to determine whether assimilative capacity exists. In many cases, historic water quality was very good and calculated anti-degradation objectives were found to be overly restrictive, with little or no assimilative capacity for discharge of recycled water or even imported water.

Three agencies (Chino Basin, Yucaipa, and Beaumont) requested TDS and nitrogen objectives less stringent than the scientifically-derived antidegradation objectives. Less stringent objectives would allow lowering of the water quality, so in order to do so, these objectives must satisfy

state's antidegradation policy (SWRCB Resolution 68-16) by demonstrating that beneficial uses would continue to be protected, and water quality consistent with the maximum benefit to the people of the state would be maintained.

As an example, the Chino Basin Agency's commitments to the "maximum benefit" water quality objectives program

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*The solution to achieving a balance of risks and benefits is by understanding how ASR works*

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comprises: implementing surface water and groundwater monitoring programs; construction of desalters; implementing a water softener improvement program; increasing recharge of high quality water (stormwater and imported water); management of recycled water quality at specified TDS and nitrogen concentrations; and maintaining hydraulic isolation. Benefits of these programs include promoting water recycling and reuse, increases in quantity and reliability of local water supplies, reduced reliance on imported water (additional Bay-Delta environmental benefits), and eliminating the need for costly POTW treatment plant upgrades that would not provide enhancement of beneficial uses.

Overall, these programs promote a comprehensive watershed approach of management of TDS and nitrogen.

The Santa Ana Water Board strongly supported the TDS/Nitrogen Task Force effort, and the basin plan amendment incorporating maximum benefit objectives was adopted at the Santa Ana and State Water Boards without dissent or objection. The amendment was approved by the Office of Administrative Law without comment. Maximum Benefit Objectives are currently

being implemented, with additional recycled water recharge projects planned, WDRs issued to Chino Basin agencies, and monitoring programs have been developed and are being implemented. A regular, periodic review of salt management in the Santa Ana Basin is planned.

## Regulation of ASR in the Central Valley

According to the Central Valley Water Board, the California Water Code requires a Report of Water Discharge (RWD) for ASR projects: under Water Code Section 13260, any entity proposing to discharge waste that may affect waters of the state must file a RWD and can't discharge until Board issues a waiver, adopts waste discharge requirements (WDRs), or 140 days have elapsed after submitting a complete RWD. According to the Central Valley Water Board, because ASR projects involve water from one resource being mixed with another resource and the



*A panel discussion of various Water Board's current or proposed regulation of ASR projects featuring panelists from left to right: Jon Marshack, Wendy Wyels and Jack Del Conte of the Central Valley Region; Hope Smythe of the Santa Ana Region; and Harold Singer of the Lahontan Region.*

potential to degrade the aquifer, the Water Board needs to determine whether regulation of the project is necessary to protect beneficial uses of affected water resources. Most ASR projects propose to use an existing drinking water treatment and distribution system as the source of injected water. While the injected water meets drinking water standards, it may contain substances that exceed basin plan water quality objectives, the standards that protect current and future beneficial uses of groundwater,

*Continued on page 18*

## Artificial Recharge: Nexus of Quantity and Quality in California – Continued from Page 17

including agricultural, municipal and industrial uses. In other words, injected water may degrade the quality of the groundwater to a degree that future beneficial uses are impaired.

Disinfection of drinking water with chlorine creates byproducts including Trihalomethanes (THMs - such as Chloroform), Haloacetic Acids, and NDMA, chemicals which are not present in most groundwater; many of these substances are also considered to cause cancer in humans. The drinking water maximum contaminant level (MCL) for total trihalomethanes is 80 ug/l, while the basin plan water quality objectives are on the order of 1 to 4 ug/l or less for individual THMs. An additional consideration is that there may be substances in the injection water that came from the raw source water. Upstream waste discharges, and

*A “bubble” or “zone of injected source water” around the well would be defined to facilitate water quality characterization for beneficial uses*

agricultural and urban runoff, may have added substances, such as pesticides, personal care products, pharmaceuticals, endocrine disruptors and salt that are not removed by conventional water treatment processes; many of these substances are not regulated in drinking water. MCLs may not be the most relevant limits to protect current and future beneficial uses of groundwater, because they assume that the water has been chlorinated to remove pathogens, and that there is significant cost to change disinfection methods. MCLs for trihalomethanes accept some cancer risk from the byproducts, in order to achieve the benefit of pathogen removal. However, according to the Central Valley Water Board, injecting chlorinated water into an aquifer would subject users of that water to cancer risk, without providing them any benefit. The groundwater quality impacts

from ASR projects are controllable water quality factors. Those impacts can be reduced or eliminated:

- Source water quality can be optimized by selecting the intake location and the timing of water withdrawals to minimize impacts from upstream pollution sources
- Disinfection methods can be changed from chlorine to chloramine, UV, ozone, or ultrafiltration, which produce fewer disinfection byproducts
- Readily available treatment technologies, such as granular activated carbon or air stripping, can be used to remove pollutants before injection.

The Central Valley Water Board recognizes that there are costs associated with each of these approaches. Approaches should be found that do not stifle artificial recharge projects while limiting water quality impacts to levels that comply with Water Board plans and policies that protect all beneficial groundwater uses. Facing

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these issues early-on with the Water Boards will help all involved work together with project proponents to achieve mutually beneficial solutions. In reality, Central Valley Water Board recommends project proponents start working with staff at least 9-12 months prior to the target date for commencing the project. Further recommendations include meeting with staff very early in the process.

### Since the Workshop – Update on ASR Regulation in the Central Valley

Since the GRA workshop in March 2005, the Central Valley Water Board staff has developed a proposed modified regulatory strategy to address proposed ASR projects, which incorporates Water Board water quality concerns while not impeding the ability of ASR projects to increase water supplies. The Board would not consider the injection of drinking water to be a “discharge of waste” under the California Water Code because the injection is not “for purposes of disposal.” As such, the Board would be concerned only with residual effects of the ASR project on groundwater quality. The regulatory mechanism to implement the proposed modified regulatory strategy would consist of two parts; a waiver of waste discharge requirements including the conditions outlined below, and a monitoring and reporting program for compliance.

A “bubble” or “zone of injected source water” around the well would be defined. Within the bubble, only Department of Health Services drinking water regulatory requirements would be applied. Central Valley Water Board standards to protect groundwater quality (basin plan water quality objectives) would be applied outside the bubble. The project proponent would be required to characterize the quality of injected source water, including disinfection byproducts and constituents in the raw source water, and to develop receiving water (aquifer) quality baseline conditions to assess potential changes over time. A survey of current groundwater users would also be required to assess the project proponent’s ability to control groundwater use within the bubble.

Outside the bubble, groundwater may have other users and beneficial uses. To limit the extent of possible groundwater quality

impacts, the project proponent would be required to delineate the size of the bubble and to demonstrate control over groundwater within the bubble. This would reduce the potential for water quality impacts from adversely affecting other groundwater users and uses outside the bubble.

The project proponent would also need to demonstrate that degradation or dilution would reduce constituents in the injected source water to below Central Valley Water Board groundwater quality standards as it leaves the bubble. Pilot studies would be required to provide site-specific data to support the project. To verify control of the bubble and compliance with water quality objectives, the project proponent would be required to monitor groundwater quality within and at the edge of the bubble. The project proponent would also be required to develop and implement a contingency plan to address potential residual groundwater quality impacts from the project that might impair other uses of groundwater.

On May 16, 2005, the Central Valley Water Board received a report of waste discharge from the City of Roseville for the second pilot study of their ASR project. The submittal incorporates the Board proposed modified regulatory strategy to address ASR projects. In August of this year, Board staff intend to bring tentative orders to implement our proposed strategy to our Board for their

consideration. These proposed orders for Roseville will be posted on the Boards’ web site at [www.waterboards.ca.gov](http://www.waterboards.ca.gov) in early June for public comment.

Another element to the City of Roseville’s regulatory approach was to draft legislation to help them work around what was perceived as a regulatory barrier to implementing an aquifer storage recovery project in the Central Valley using drinking water. The bill, Senate Bill 773, Groundwater Aquifers and Injection Wells, is being carried by Senator Cox. It contains language which would modify the Porter Cologne Act to exempt “drinking water” from the definition of “waste,” and would amend the Water Code with the incorporation of reporting requirements for groundwater injection-storage projects. While the Senator agreed to carry the bill, we also understand that the Central Valley Water Board was provided direction to find an administration solution to the issue. The bill is now a two-year bill, and will be revisited next legislative session, pending the outcome of ASR project implementation in the Central Valley.

For an expanded version of this article, which more fully summarizes issues of artificial recharge in California, please visit the GRA website at [www.grac.org](http://www.grac.org), under publications.

*Tim Parker is with the California Department of Water Resources, and is GRA’s Legislative Committee Chair.* ♪



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## President's Message – Continued from Page 2

peak demands, typically in summer months. Certainly, recharge of surface water sources, including treated wastewater, recycled water and stormwater, into groundwater basins, typically through spreading basins, has been used for decades to replenish groundwater basins. However, since the water to be injected has been treated to eliminate pathogens prior to public use, the water contains residual quantities of disinfection byproducts (DBPs), such as chloroform or other trihalomethanes, and haloacetic acids. This has raised concerns by the Central Valley Regional Water Board over the potential impacts of injecting such DBPs and other possible surface-water constituents, and consideration of whether treatment of DBPs might be required prior to injection. The most recent direction from the Water Board regarding the ASR pilot proposed by City of Roseville is that under a waiver of waste discharge requirements, including compliance reporting, a detailed hydrogeological characterization and

monitoring of the constituents of concern (DBPs) in the “bubble” of stored water, a demonstration may be made that through degradation and dilution the constituents do not leave the “bubble” and the beneficial uses of the groundwater resources are protected. This situation has led to lively discussions regarding water rights, the needs of a growing community, the need to protect groundwater quality, the real value of that water, and the need for consistent statewide regulatory policies.

The value of water is particularly important in Southern California, where the tragedy of the commons has led to adjudication of most of the groundwater basins in the Los Angeles area. This may have resolved (for now) disputes over rights to pump groundwater in those basins. However, one of the most contentious groundwater issues in the Los Angeles area involves lengthy litigation between cities, water districts and water agencies over who has the rights to store groundwater in the basin. The fundamental water management concept,

simple but complex, is taking surplus surface water in wet years (this year, for example), and storing it underground for use in the dry years. A group of cities, including Downey and Lakewood, are attempting to assert their right over the vacant aquifers for underground reservoir space, with the rationale that it will cost less money to pump imported water into the ground than pay for expensive surface water storage system and transmission facilities. But just who controls the valuable aquifer storage space is a matter of legal dispute. The Water Replenishment District of Southern California (WRD) also claims authority over the aquifers. WRD officials are concerned that cities or private water companies want to use the aquifers to generate revenue by storing water and then selling to the highest bidder. While some cities have indicated they have no plans to use the aquifers to generate much needed revenue to pay for police departments or other city services, other cities have said that there would be nothing wrong with it. Water is a limited resource that is needed by all, and as Mark Twain once said, “whiskey is for drinking and water is for fighting;” unfortunately, in this case continued fighting has resulted in the loss of surplus wet year water that could have been stored. The value of water has become extremely important and very evident to each of those parties.

Often, the value of water is not truly apparent until the undesired results of groundwater depletion are felt by all concerned. Consequently, the tragedy of the commons continues to be a challenge in California and elsewhere. Perhaps one



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## DNAPL Source Zone Characterization & Remediation – Continued from Page 3

of the only ways to address this challenge, outside of a court solution, is through comprehensive, active groundwater management programs. It is no simple task to develop and implement an effective regional or basin-wide groundwater management plan. To facilitate plan preparation by local water agency managers and others, GRA has recently published the outstanding book, *California Groundwater Management*. This completely updated and expanded second edition of the book provides a comprehensive overview of technical, legal and management aspects of groundwater in California, and provides outstanding guidance for developing groundwater management plans. The book can be purchased through the GRA website: [www.grac.org](http://www.grac.org).

I welcome any feedback or comments at [tom.johnson@lfr.com](mailto:tom.johnson@lfr.com) or you can call me at (510) 596-9511. 💧

effective management of DNAPL source zones, including chlorinated solvents, creosote, and coal tar. There is also growing interest among many groundwater researchers, consultants, and regulators in exploring the potential advantages of evaluating the effectiveness of source zone remediation based on reductions in the rate of contaminants emanating from the source (referred to as contaminant mass discharge or mass flux) rather than concentration reduction. Since no DNAPL remediation technology has been proven to remove 100% of the contaminant mass in a DNAPL source zone, partial mass removal is a topic of intense debate among academic researchers and policy makers alike.

This Symposium, the 15th in GRA's popular Contaminants in Groundwater Series, will focus on DNAPL source zones and the technical and regulatory challenges faced by professionals working with these sites. Symposium sessions will cover a variety of topics, including:

- 💧 DNAPL source zone characterization techniques
- 💧 Dissolution and diffusion effects on source zone composition
- 💧 Source controls and remedial technologies
- 💧 Modeling advances
- 💧 Pros and cons of partial mass removal
- 💧 Regulatory and legal issues
- 💧 Mass flux determination/implications
- 💧 Remediation performance assessment
- 💧 Case studies/lessons learned

Experts from academia, regulatory agencies, consulting, industry, and the legal arena will participate in moderated speaker sessions, posters sessions, and a closing panel discussion. The combination of invited speakers and experts from key areas of the DNAPL field make this an important event for all professionals involved in decision-making on DNAPL projects.

GRA welcomes submittals of abstracts for papers and poster presentations on the topics listed above. Details on the symposium and requirements for abstract submittal may be found at [www.grac.org](http://www.grac.org). The deadline for submitting an abstract for a Paper or a Poster Presentation is August 26, 2005. Please feel free to contact Bettina Longino (510-663-4213) or Sarah Raker (510-622-2377) if you would like to discuss your topic for this Symposium before submitting your abstract or if you have any questions. 💧

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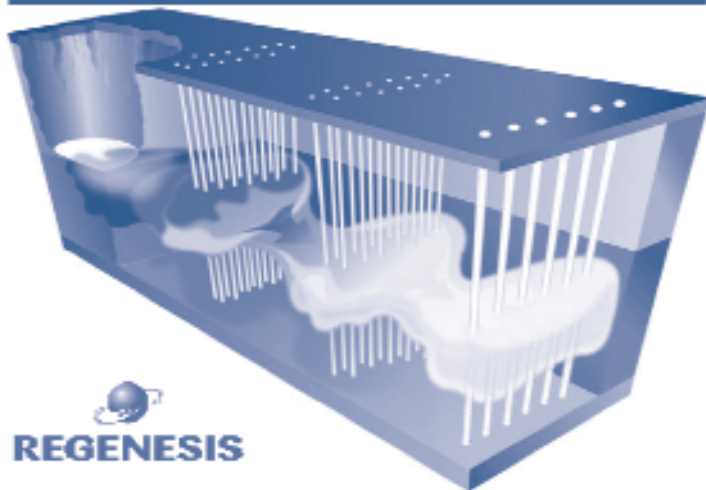
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## MtBE and TBA: Comprehensive Site Assessment and Successful Groundwater Remediation – Continued from Page 4

benzene, toluene, ethylbenzene, and xylenes, substantially less information and experience is available for the fuel oxygenates methyl tert butyl ether (MtBE) and tert butyl alcohol (TBA). Groundwater remediation technologies shown to be effective for the treatment and removal of MTBE and TBA include ex-situ technologies (pump and treat) and in-situ technologies (air sparging, bioremediation, chemical oxidation, phytoremediation, and monitored natural attenuation). Under favorable conditions and when properly applied, these technologies can treat both MTBE and TBA to concentrations currently acceptable in all States. However, the technologies cannot be applied equally to all contaminants or sites.

The Interstate Technology & Regulatory Council (ITRC) MtBE and Other Fuel Oxygenates Team has designed this two-day training course (with optional additional half-day technology selection workshop) to enhance your professional awareness of these technical issues, and augment your ability to characterize a site and select the most appropriate and cost-effective remedial technology. The course has been approved in fulfillment of selected continuing education units (CEUs), and is a companion to the recently-released ITRC document “Overview of Groundwater Remediation Technologies for MtBE and TBA” (available as a free download at <http://www.itrcweb.org/Documents/MTBE-1.pdf>.) The class is designed primarily for state regulators and their immediate management and technical support staff. However, other professionals will benefit greatly from the in-depth technical and case study-based curriculum.

The course fee is \$495 for the two-day course and \$595 for the 2.5-day course. Note that these fees are waived for state and U.S. EPA regulators; other federal agency representatives will be charged \$100. Register early to ensure your participation; online registration is preferred, and is available at [www.itrcweb.org](http://www.itrcweb.org) under the classroom-training menu. For registration via telephone, fax or US Mail; contact Steve Hill at 208-442-4383 or [srhill1@mindspring.com](mailto:srhill1@mindspring.com). A limited number of travel scholarships are available for regulatory agency attendees on a first-come, first-serve basis. Information on accommodations may be found at <http://www.epa.gov/region9/hotels.html>. This course is co-sponsored by the GRA, the American Petroleum Institute, the Long Island Groundwater Research Institute, and the U.S. EPA.

*Submitted by Eric Nichols, ITRC team member and co-instructor, LFR Inc., 78 Piscassic Road, Newfields, NH, 03856. (603) 773-9779, [eric.nichols@lfr.com](mailto:eric.nichols@lfr.com).*

## NGWA's AGWSE Division Co-Sponsors Two Sessions at October 2005 GSA Annual Meeting – Continued from Page 12

quality/quantity of ground water; and water quality/quantity management objectives and methods for sustainability.

The other session, "Innovations and New Frontiers in Hydrologic Modeling," which is being co-sponsored by GSA's Hydrogeology Division, NGWA/AGWSE, the US National Chapter of the International Association of Hydrogeologists (IAH), and GSA's Engineering Geology Division is being organized by Frank Schwartz of Ohio State University and Motomu Ibarki of the University of Waterloo. This session (Topical Session T18) will explore how models have grown from a mathematical curiosity to an indispensable analytical tool, and will also examine innovative new developments in groundwater and hydrologic modeling.

### Abstracts Deadline: July 12

Abstracts for Topical Sessions T15 or T18 must be submitted electronically on GSA's web site at [www.geosociety.org](http://www.geosociety.org) (instructions are posted at the site) by July 12, 2005 (11:59 pm Pacific Time). Electronic abstracts will be archived and remain searchable on the site for at least two years. For further information about Topical Session T15, please contact Mike Moran at [mjmoran@usgs.gov](mailto:mjmoran@usgs.gov), or Vicki Kretsinger at [vkretsinger@lcse.com](mailto:vkretsinger@lcse.com). For further information about Topical Session T18, please contact Frank Schwartz at [frank@geology.ohio-state.edu](mailto:frank@geology.ohio-state.edu).

*Vicki Kretsinger is with Luhdorff and Scalmanini Consulting Engineers; she is also AGWSE Division Chair and a GRA Director.*

## 25th Biennial Groundwater Conference and 14th Annual GRA Meeting – Continued from Page 3

change and the potential impact on California's water resources. On October 25, the featured luncheon speaker is Rita Schmidt Sudman, Director of the Water Education Foundation. Rita's presentation will highlight the history of Western Water, including feature stories that captured California's evolving water issues, and also the historical coverage of these issues by the media. An evening reception on October 25 provides networking opportunities with exhibitors and poster presenters. The luncheon program on October 26 includes a brief overview of GRA's annual activities and an update of California's legislative activities relating to groundwater by Chris Frahm, Legislative Advocacy Group Leader with Hatch and Parent. Following the luncheon, GRA's annual awards will be presented.

Concurrent session topics and planned subject matter include: Septic system discharge issues, Groundwater management plan; Salinity issues; Modeling California's groundwater; Unregulated groundwater; Unregulated contaminants in groundwater; Groundwater's groundwater; Groundwater's role in stream systems and renaturalization efforts; Groundwater tracers and age dating; Groundwater law and policy; Groundwater quality and recycled wastes; Emerging issues

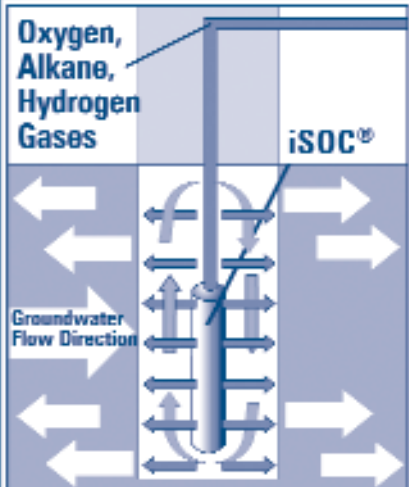
in groundwater resources; and Climate change and California's water resources. A complete description of the topics is on the GRA website.

**Call for Posters (Abstracts Due August 1, 2005):** Abstracts are limited to a maximum of one page and should include a title, author's name and affiliation, contact information and subject area. Additional information on abstract and presentation policy and formatting requirements are available at <http://www.waterresources.ucr.edu>. Submit abstract and submittal form by email to: Julie Drouyor, UC Center for Water Resources at [cwres@ucr.edu](mailto:cwres@ucr.edu).

**Registration:** The special early registration fee is \$295 for those registering by October 10, 2005. Late (after October 10) and on-site registration is \$350. The registration for students will be \$100. The conference is at the Sacramento Convention Center located at 1030 15th Street, Suite 100, Sacramento, California. Special hotel room rates are available at the Hyatt Regency Sacramento at Capitol Park, located at 1209 L Street across from the convention center. For hotel reservations, call 1-800-233-1234, or you can log onto

*Continued on page 24*

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## CCGO Highlights – Continued from Page 7

presenter, Dr. Joyce Blueford, was a powerful and dynamic speaker. We are very grateful to her and to AEG for hosting these fundraisers.

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### State Mining and Geology Board Seeks A New Executive Officer

With John Parrish, former director, taking on his new job as California State Geologist, the SMGB is seeking a new Executive Director. The links to the required state application form can be found on their web site: [www.conservation.ca.gov/smgb](http://www.conservation.ca.gov/smgb). ♣

## 25th Biennial Groundwater Conference and 14th Annual GRA Meeting – Continued from Page 23

[www.hyatt.com](http://www.hyatt.com). Until October 5, 2005, we have secured a special room rate of \$129 a night (plus taxes and surcharges). By phone, mention that you are attending the 2005 Biennial Groundwater Conference.

**Conference Program Information and Updates:** Visit the University of California Center for Water Resources Center web site, <http://www.waterresources.ucr.edu>, for more details as they develop. For more information, contact Julie Drouyor at the UC Center for Water Resources, (951) 827-4327. Exhibit and sponsor information and order forms are posted at [www.grac.org](http://www.grac.org). ♣

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## International Association of Hydrogeologists 2005 Theme Issue Released — “The Future of Hydrogeology” — Continued from Page 13

Berkeley), “The conceptualization model problem—surprise” by Dr. J.D. Bredehoeft (The Hydrodynamics Group), and “Marine hydrogeology: recent accomplishments and future opportunities” by Dr. A.T. Fisher (University of California, Santa Cruz).

Table 1. Contents of 2005 *Hydrogeology Journal* Theme Issue

Author	Subject	Article type
Narasimhan	Historical perspective	Paper
Schwartz et al.	Evolution of research	Paper
Bredehoeft	Conceptual modeling	Paper
Lachassagne	A future hydrogeologist	Essay
Baker et al.	Extraterrestrial hydrogeology	Paper
Fisher	Marine hydrogeology	Paper
Hancock et al.	Ecological hydrogeology	Paper
Stober & Bucher	Deep fluids	Essay
Simmons	Variable-density fluids	Essay
Post	Coastal groundwater	Essay
Neuman	Fractured rock hydrology	Paper
Bakalowicz	Karst groundwater	Paper
de Marsily et al.	Spatial heterogeneity	Paper
Noetinger et al.	Upscaling	Paper
Hunt	Percolation theory	Essay
Carrera et al.	Inverse modeling	Paper
Orr & Meystel	Optimization	Paper
Hoffman	Satellite remote sensing	Essay
Guerin	Hydrogeophysics	Essay
Divine & McDonnell	Applied tracers	Essay
Renard	Well hydraulics	Essay
Glynn & Plummer	Geochemistry	Paper
Barcelona	Remediation technologies	Paper
Kalf & Wooley	Sustainable yield determination	Paper
Dillon	Aquifer recharge management	Essay
Konikow & Kendy	Groundwater depletion	Essay
Godfrey & Smith	Groundwater risk assessment	Essay
Evans & Maslia	Human exposure assessment	Essay
Mukherji & Shah	Socio-ecology & governance	Paper
Smith & Marin	Water and poverty	Essay

This theme issue is available separately for \$35 (including packaging and shipping). To reserve a copy and receive instructions for payment, you can e-mail Christine Watson at [cwatson@iah.org](mailto:cwatson@iah.org). A subscription to *Hydrogeology Journal* is included with annual membership in IAH. If you haven't been a member of IAH within the last two years, you can join IAH at a substantial discount for first-year membership through GRA's special joint membership plan (the discounted IAH first-year membership rate is \$70; see additional information at <http://www.grac.org/jointmembership.html>). If you join after some 2005 issues of the journal have already been distributed, you will receive all back issues (including the 2005 theme issue) after your membership has been processed. If you joined IAH last year through this special GRA/IAH joint program, you should renew your IAH membership directly with IAH. Check out the IAH web site at: [www.iah.org](http://www.iah.org) or e-mail the U.S. Secretary-Treasurer (Dr. Todd Halihan) at [halihan@okstate.edu](mailto:halihan@okstate.edu) for more information. 💧

## Wells and Words — Continued from Page 5

Now we see a completely different ranking of the productivity between the wells: Wells A, C1, and C2 have equivalent SC (5gpm/ft of dd) and are 2.5 times more productive than Well B. A word of caution: well efficiency, available draw-down, aquifer boundaries, discharge rates, and time at which the drawdown is measured can and often do influence the SC and perceived productivity of a well. These topics will be discussed in future articles.

*David W. Abbott, P.G., C.Hg. has over 30 years of active experience in the drilling, construction, design, development, and testing of water supply wells. Since 1986, David has been a senior geologist with Todd Engineers, Emeryville, CA. and is a GRA Director. 💧*

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## Central Coast Branch Highlights

BY BRADLEY J. HERREMA,  
ACTING VICE PRESIDENT

At the May 4, 2005 meeting, Timothy H. Robinson of the Bren School of Environmental Science and Management, University of California at Santa Barbara, presented his research on Nutrient Export of Carpinteria Valley Creeks, Santa Barbara County. Mr. Robinson is a doctoral candidate at the Bren School, teaching and conducting research in modeling and quantifying nutrients that are washed into local creeks. Since 2001, he has been a member of the terrestrial team of the Santa Barbara Coastal LTER project at UC Santa Barbara, which monitors and analyzes stream discharge and nutrient export in catchments flowing into the northern side of the Santa Barbara Channel. His presentation focused on modeling nutrient export from specific land use classes on a watershed scale and on the manner in which such findings will significantly contribute to the monitoring and modeling of nutrient loading in hydrologically flashy climates. Mr. Robinson discussed the creation of a modeling tool for evaluating development scenarios from a water quality perspective. The recent flooding events of January 2005 were included in the research, and demonstrated that the potential nutrient load in some areas is so extensive, that even extreme runoff events do not reduce nitrates and phosphates in stream flow during later events. In other areas, the extreme events were found to reduce nutrient loading of later runoff events.

The next meeting of the Central Coast Branch is scheduled for July 6 at the offices of Hatch & Parent in Santa Barbara. Russell McGlothlin, co-author of the recent update of GRA's California Groundwater Management, will speak on the book's updating, as well as to discuss the law and regulation surrounding groundwater management within California. 


## San Francisco Bay Branch Highlights

BY BILL MOTZER, BRANCH  
SECRETARY AND DAVID ABBOTT,  
BRANCH TREASURER

The February 23rd meeting convened at the Oakland Marriott attended by 63 members, nonmembers, and students. Our speaker was Mr. David Kill, the fifth McEllhiney Distinguished Lecturer, who spoke on Well Efficiency is Not a Myth. In his introductory comments Mr. Kill noted that well inefficiencies are caused by improper drilling practices, poor well and intake design, and/or poor development methods. Descriptions included how limited open area intake may be compromised by screen type; how to determine proper grain size distribution with percent retained; and other contributions to increased well efficiency. Those interested in copies of his PowerPoint slides can e-mail Bill Motzer at [bmotzer@toddengineers.com](mailto:bmotzer@toddengineers.com).

The March 24th meeting was held at the Biltmore Hotel in Santa Clara. Mr. Mark Smolley, Calpine Corporation, presented a talk entitled Horizontal Directional Drilling (HDD) for the Installation of a Natural Gas Pipeline, which described the use of technically challenging HDD methods for a 1,700-foot horizontal borehole through sandy gravel prior to the installation of the 16-inch diameter, one mile long natural gas pipeline. Because portions of the pipeline pass under sensitive riparian habitat bordering Coyote Creek, Highway 101 and Monterey Road, and Union Pacific railroad tracks, a non-invasive drilling method such as HDD was required.

The April 27th speaker was Dr. Philip B. Duffy, Ph.D., Leader of the Climate and Carbon Cycle Modeling Group, Atmospheric Science Division at the Lawrence Livermore National Laboratory. Dr. Duffy's talk was entitled An Introduction to the Science of Climate

Change and Introduction for Water Availability in California. Dr. Duffy noted that during the last century the Earth's surface has warmed about 0.60 C with the 1990s as the warmest decade in the instrumental record. The current sea level rise is attributed to thermal expansion of warming sea water; he gave other evidence for warming, such as local precipitation increases, increased height of the troposphere, shrinking sea ice cover and less snow in California. This warming is attributed to both natural and anthropogenic (human) causes; both source inputs agree with current modeling. Dr. Duffy's preliminary predictions, for California are that we will get wetter winters with precipitation increases largely as rain rather than snow. More of Dr. Duffy's work can be seen at: <http://eed.llnl.gov/cccm/index.html>. 

### *Editor's Note:*

*Current GRA branch officers may be found at [www.grac.org](http://www.grac.org) under Directors & Committees; upcoming branch events may be found under branch web pages.*

# Dates & Details

## GRA MEETINGS AND KEY DATES

(Please visit [www.grac.org](http://www.grac.org) for detailed information, updates, and registration unless noted)

- **GRA Board of Directors Meeting** August 6, 2005  
Pt. Richmond, CA
- **GRA Workshop** September 15-16, 2005  
*Basin Yield & Overdraft:  
State of the Science & Law*  
Pasadena, CA
- **GRA 14th Annual Meeting** October 25-26, 2005  
Sacramento, CA
- **GRA Course** November 7-9, 2005  
*Principles of Groundwater  
Modeling & Transport Flow*  
Redwood City, CA
- **GRA Board of Directors Meeting** November 12, 2005  
Sacramento, CA
- **GRA Symposium** December 7-8, 2005  
*DNAPL Source Zone  
Characterization &  
Remediation*  
San Francisco, CA

### GRA Sponsored Programs

- **ITRC Course** August 10-12, 2005  
*MTBE & TBA:  
Comprehensive Site  
Assessment & Successful  
Groundwater Remediation*  
San Francisco, CA
- **NGWA & API Conference** August 17-19, 2005  
*Petroleum Hydrocarbons  
& Organic Chemicals in  
Groundwater: Prevention,  
Detection & Remediation*  
Costa Mesa, CA



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