HYDRO VISIONS

Volume 17, No. 3

GROUNDWATER RESOURCES ASSOCIATION OF CALIFORNIA

Fall 2008

Climate Change: Implications for California Groundwater Management

BY JON ROHRER, AQUI-VER

GRA's fourth Water Resources Series event, held in Sacramento on August 13, 2008 focused on how water resources managers and professionals can prepare for the projected impacts of climate change on California's groundwater resources. Regardless of the wide range of predicted impacts of climate change, the State of California is taking aggressive steps to reduce greenhouse gas emissions, monitor and optimize electrical generation and usage, and plan for impacts to water resources.

GRA assembled a wide range of distinguished state, federal, academic, legal and agency water resource experts to discuss recent developments in the technical, legal and planning arenas associated with climate change and groundwater resource management. Participants were brought up to date on legislative water resource developments through appearances by State Senator Michael Machado and Alf Brandt, consultant to the State Assembly. Senator Machado is a champion of responsible water planning and supporting water infrastructure, most notably by authoring Proposition 13, the Safe Drinking Water, Clean Water, Watershed Protection, and Flood Protection Bond Act, and assisting in the passage of Proposition 50, the Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002. Alf Brandt is the principal consultant to the Assembly Committee on Water, Parks and Wildlife and has been deeply involved in the inner workings of California and western water planning and bills for several decades.

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

INSIDE

DTSC Remediation Symposium – Highlights

BY JENNIFER NYMAN, MALCOLM PIRNIE, INC.

The California Department of Toxic Substances Control (DTSC) hosted a free, public Remediation Technology Symposium from May 14 through May 16, 2008, in Sacramento and via webcast. The event was co-sponsored by United States Environmental Protection Agency (U.S. EPA) Region 9. It was presented in cooperation with the Groundwater Resources Association (GRA) of California and the Geology Department of California State University, Sacramento, and was attended in person by over 200 environmental professionals and via webcast to over 100 participants.

The symposium was the result of a unique collaborative effort of industry, academia and government. **Brian Lewis** of DTSC, a GRA Director, led the organization of the symposium, which was initiated by DTSC Director Maureen Gorsen. He was supported by DTSC Chief Engineer Watson Gin, and industry representatives Steve Figgins of Brown and Caldwell,

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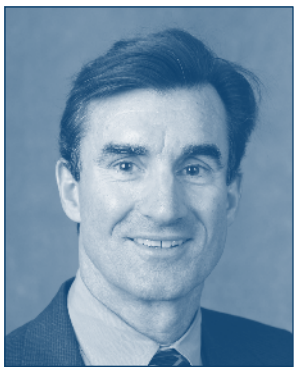

President's Message

BY JAMES STRANDBERG

GRA Board's Strategic Planning – September 2008

The GRA Board of Directors meets on a quarterly basis to address the day-to-day activities of the organization primarily through reporting and discussion led by each of the Committee Chairs. In addition, the Board holds an annual strategic planning meeting. During this meeting, the Directors, Officers, and Executive Director evaluate the association's overall progress in achieving its mission of being California's leading advocate and educator of its members and the public on managing and protecting California's groundwater resources through education and technical leadership. These planning meetings focus primarily on identifying and prioritizing new activities to enhance member benefits and further GRA's pursuit of its mission. The budgetary impacts of new and/or enhanced activities are weighed in conjunction with the development of the budget for the subsequent calendar year. This year the regular Board meeting and annual planning meeting were held at the law offices of Brownstein Hyatt Farber Schreck in Santa Barbara on August 16-17. I feel it's important to inform members of these activities and have provided a summary below.

During the 2008 strategic planning meeting, we focused on four key areas: (1) the recent membership survey results, (2) planning state-wide events such as symposiums, (3) legislative activities and GRA's engagement with the California Groundwater Coalition, and (4) enhancements to our communications and education activities.

On July 31, GRA emailed a survey to the full membership to solicit feedback on a number of topics including the degree to which GRA is achieving its mission, whether GRA is keeping its members informed, and activities the association performs or offers its members, including education through organizing and convening state-wide events, publishing *HydroVisions*, holding branch meetings, and the use of the web site. On behalf of the other Directors, Officers, and Executive Director, I extend my thanks to those who responded and provided valuable feedback. GRA's Membership Committee, in coordination with the Communications, Events and Education committees will review the survey results and provide the membership with a report in the next *HydroVisions*. The report will also be posted on the web site. In short, however, a few key outcomes of the survey were that an overwhelming number of members believe the association is achieving its mission and keeping members well-informed of its activities. Other interesting feedback pertained to members' preference for receiving information electronically rather than by hard copy (including *HydroVisions* and event binders) and, surprisingly, the infrequent use of the web site. It's very gratifying to receive confirmation that our dominantly volunteer efforts are effective and beneficial to our members.

The discussion of our events, the primary method of offering education to our members and the public, included our intent to continue offering multi-disciplinary

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

Registration is Open

Short Course & Symposium on

Applications of Optimization Techniques to Groundwater Projects

OCTOBER 15-16, 2008
RADISSON HOTEL
SACRAMENTO, CA

REGISTER AND VIEW THE FULL AGENDA AT WWW.GRAC.ORG/OPTIMIZATION.ASP

Hydrogeologists and groundwater engineers are increasingly applying optimization methods to help address complex groundwater management problems. GRA is sponsoring this event to provide an open forum to facilitate dialog among groundwater professionals about experiences with optimization methods and potential opportunities for new applications. The event will include a half-day short course on October 15th, and a one-day symposium on October 16th. For the short course, the methodologies employed in optimization analyses will be addressed theoretically and illustrated with example applications. The symposium will feature invited speakers from consulting, government, and academia, and will present case studies on a range of groundwater optimization applications, focusing on benefits derived at the project level. In addition, a poster session will be held on October 15th. The poster session will provide an excellent forum for the authors to present their work in an informal and interactive setting.

For questions about the Course or Symposium, please contact Rob Gailey (rob@rmgailey.com, 415-407-8407) or Chin Man Mok (cmmok@geomatrix.com, 510-663-4290).

Upcoming Events

SAVE THE DATE

GRA Presents the 21st Symposium in its *Series on Groundwater Contaminants*

Emerging Contaminants 2008

NOVEMBER 19-20, 2008 – HOLIDAY INN, SAN JOSE, CALIFORNIA

GRA is pleased to announce its upcoming symposium on Emerging Contaminants. Emerging chemical contaminants present numerous technical and institutional challenges to society and to environmental and public health professionals. Increasingly sensitive analytical techniques have detected the presence of previously unregulated chemicals in actual or potential sources of drinking water. In some cases, the impacts of these chemicals to human health and the environment are uncertain. Many of the emerging chemicals remain unregulated, but the number of regulated contaminants will continue to grow slowly over the next several decades.

GRA's one and a half day event will profile the latest developments in detection, risk assessment, remediation and regulation of emerging contaminants in groundwater. Experts from academia, regulatory agencies, consulting, industry, and the legal arena will participate in moderated speaker sessions, poster sessions, and round-table panel discussions. Symposium sessions will cover a variety of topics, including the following:

- Overview of emerging contaminant classes, and physical and chemical properties of key contaminants
- Occurrence and sources of emerging contaminants in water
- Regulation of emerging contaminants in the United States and Europe
- Environmental fate and transport of emerging contaminants
- Analytical techniques for quantifying emerging contaminants in environmental samples
- Modeling tools
- Natural attenuation of emerging contaminants
- Human health effects from exposure to emerging contaminants
- Environmental and human risk assessment and management
- Innovative and cost-effective remediation and treatment technologies
- Green chemistry and preventing the emergence of new contaminants

Emerging contaminants to be covered include, but are not limited, to the following:

- Nanomaterials
- Pesticides/herbicides (e.g., 1,2,3-TCP)
- Pharmaceuticals, including antibiotics
- Phthalates
- Personal care products (e.g., polycyclic musks)
- Disinfection byproducts (e.g., NDMA)
- Industrial additives and byproducts (e.g., 1,4-dioxane, 1,2,3-TCP)
- Flame/fire retardants (e.g., PBDEs)
- Fluorinated compounds (e.g., PFOS)

If you are interested in exhibiting your organization's services or products, or being an event sponsor, please contact Mary Megarry (mmegarry@nossaman.com; 916-446-3626). GRA welcomes co-sponsors as well as lunch, break, reception and student paper competition sponsors.

Principles of Groundwater Flow & Transport Modeling

SEPTEMBER 22-24, 2008
REDWOOD CITY, CA

CO-SPONSORED BY THE UNIVERSITY OF CALIFORNIA COOPERATIVE EXTENSION GROUNDWATER HYDROLOGY PROGRAM

LIMITED SPACE AVAILABLE!
TO REGISTER - HTTP://WWW.GRAC.ORG/MODREG.HTM

This course introduces the conceptual principles and practical aspects of groundwater modeling in an intuitive yet comprehensive manner. 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. 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.

Course Topics (partial list)

- principles and concepts of groundwater modeling
- data collection and preparation
- model grid design
- boundary conditions
- modeling multiple aquifer systems
- sensitivity analysis, model calibration and verification
- contaminant transport modeling
- capture zone analysis

Course instructors include Graham E. Fogg, Ph.D., Thomas Harter, Ph.D., and Peter Schwartzman, M.S. For more information, contact Mary Megarry at GRA, mmegarry@nossaman.com or 916-446-3626, or visit www.grac.org.

Upcoming Events

SAVE THE DATE

Groundwater Monitoring: Design, Analysis, Communication and Integration with Decision Making

FEBRUARY 25-26, 2009, ORANGE, CALIFORNIA

The goal of this GRA conference is to address groundwater monitoring for a range of scales from detailed monitoring of contaminant sites to very large-scale monitoring on a statewide to nationwide basis. Sessions are planned to include such topics as:

- methods to design monitoring networks on local and regional scales
- data management methods
- data use and analysis for regulatory compliance, trend assessment, characterizing groundwater conditions and changes in basin storage, and assessing aquifer and well contamination susceptibility
- monitoring and water resources management, analyzing remediation effectiveness
- model calibration
- data communication to the public and policy makers

Upcoming Events

MARK YOUR CALENDARS

for the University of California Center for Water Resources & Groundwater Resources Association of California Joint Conference:

"Groundwater Salinity: A Groundwater Dilemma"

MARCH 24-25, 2009
RADISSON HOTEL
SACRAMENTO, CA

Featuring topics such as:

- Trends and long-term projections of salinity impacts on groundwater
- Urban, agricultural, and industrial salt management
- Physical, chemical, biological, and economic impacts of salinity on ecologic, agricultural, and urban communities
- Salt attenuation and transport in the vadose zone, surface water and groundwater
- Characterizing and tracing sources of salinity in groundwater
- Seawater intrusion
- Regulatory management of salts
- Desalinization technologies

Abstracts are due December 9, 2008.

Look for the Call for Abstracts and further details on the UC Center for Water Resources website, www.waterresources.ucr.edu, and GRA website, www.grac.org.

For more information, contact Michael Steiger (510-452-1549; msteiger@EKICONSULT.COM), Jean Moran (925-423-1478; moran10@llnl.gov), or Laosheng Wu (Laosheng.Wu@ucr.edu).

CALL FOR ABSTRACTS

for the University of California Center for Water Resources & Groundwater Resources Association of California Joint Conference:

"Groundwater Salinity: A Groundwater Dilemma"

MARCH 24-25, 2009
RADISSON HOTEL, SACRAMENTO, CA

Almost every time water is used, released water has higher salt content than intake water, thus contributing to a growing salinity problem. This phenomenon is illustrated in many groundwater basins, such as California's Tulare Lake Basin in the Central Valley, which have a very limited ability to discharge salts. Salts generated in and imported into these basins are accumulating in soil and water, and salinity impacts are gradually increasing. Impacts of groundwater salinity are being felt throughout California, the semi-arid lands of the southwest, and globally. Effects include increasing chloride concentrations in groundwater used for municipal supplies, retirement of hundreds of thousands of acres of agricultural land due to saline-sodic soils, and drainage problems from highly saline shallow groundwater. Meanwhile, more and more resources are directed toward monitoring, treatment, and management of salinity by agricultural, industrial, and municipal dischargers.

The University of California Center for Water Resources and the Groundwater Resources Association of California seek to provide a forum for various stakeholder groups to express their perspectives and gain an appreciation of other groups' interests on issues related to groundwater salinity. The focus will be on shared interests in assessing the scope of the problem and finding solutions, and on current practices for regulating and managing groundwater salinity.

Join us **March 24 and 25, 2009** at the Radisson Hotel in Sacramento, California for a UC Center for Water Resources & Groundwater Resources Association joint Conference "*Groundwater Salinity: A Groundwater Dilemma*."

This Conference is the 22nd event in GRA's *Series on Groundwater Contaminants*. Conference sessions will cover a variety of topics, including but not limited to:

Impacts:

- the nature and distribution of salt impacts
- trends and long-term projections
- salt balances and budgets for individual basins
- data sources, data gaps, and data quality
- impact of CVP and SWP on salinity

Continued on page 6

Call for Abstracts: "Groundwater Salinity: A Groundwater Dilemma"

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- impacts of increasing salinity on agriculture, urban water users, natural resources, industry, water providers, governments, regulators, policy makers
- impacts from food processing, the dairy industry, agriculture, land application of wastewater, ponds and lagoons

Characterization and fate and transport:

- tracing sources of salinity in groundwater
- anthropogenic vs. natural sources of salts
- fate and transport of salts in the vadose zone
- movement of salts
- salinity toxicity to crops
- salt accumulation in soils
- seawater intrusion
- groundwater monitoring at dairies

Regulatory management strategies:

- implementation of basin plans
- water quality objectives
- WDRs/permits
- defining the "salt inventory"
- anti-degradation policy, effluent limits

Technical management strategies:

- brine lines and brine management
- integrated on-farm drainage management
- nutrient management
- source reduction
- land application
- desalinization technologies
- centralized treatment (POTWs)
- deep well injection
- water softener control programs
- conjunctive use

Experts from academia, consulting, regulatory agencies and industry will participate in moderated speaker sessions and posters sessions. The combination of invited speakers and experts from key areas, along with talks chosen from submitted abstracts, will make this an important event for all professionals grappling with salinity issues in groundwater applications.

Abstracts for Papers and Poster Presentations

GRA welcomes submittals of abstracts for papers and poster presentations on any topic related to salinity in groundwater. The deadline for submitting an abstract for an Oral or Poster Presentation is December 9, 2008. Please contact Michael Steiger (510-452-1549; msteiger@EKIconsult.com) or Jean Moran (925-423-1478; moran10@llnl.gov) if you would like to discuss your topic for this conference before submitting your abstract, or if you have any questions.

Guidelines for submitting an abstract for a Paper or Poster Presentation

- Word 9.0 documents are preferred.
- Indicate the preferred presentation method (paper or poster) and the topic of the abstract
- Abstracts must be one page in length or less, and should be titled and include all contributing authors' names and affiliations. Please identify the name of the person who will be presenting the paper or poster, and add biographical sketches of the authors as a second page. The sketches should be 50 words or less in paragraph form, and full mailing and e-mail addresses and phone and fax numbers must be included.
- Margins should be 1-inch top, bottom, and right side and 1 ¼-inch left margin. The text should be single-spaced, 10-point size, Times-Roman font, with no pagination, footers and headers. Paragraphs should be justified.
- Major headings should be 12-point bold; minor headings should be 10-point italicized not bolded. There should be one blank line above and below all headings, except above major headings, which should have two blank lines.
- Graphics should not be used in Abstracts.

By virtue of submitting an abstract, the submitter(s) grants GRA the right to publish any accepted abstract or the right to decline any abstract. Please submit your abstract by email to: Mary Megarry, Groundwater Resources Association, mmegarry@nossaman.com no later than December 9, 2008. The Symposium Committee will review abstracts and make final selections.

Exhibitors and Sponsors

If you are interested in exhibiting your organization's services or products, or being an event sponsor, please contact Mary Megarry at mmegarry@nossaman.com or 916-446-3626. UC Center for Water Resources and GRA welcome co-sponsors, lunch, refreshment and reception sponsors.

Upcoming Events

Upcoming Events

CALL FOR ABSTRACTS

for Oral or Poster Presentations
(The deadline for submitting an abstract is October 15, 2008.)

Micropol & Ecohazard 2009

6th IWA/GRA Specialized Conference on Assessment and Control of Micropollutants/ Harardous Substances in Water

JUNE 8-10, 2009
SAN FRANCISCO, CALIFORNIA

CO-ORGANIZERS
MALCOLM PIRNIE, INC.,
UNIVERSITY OF CALIFORNIA AT BERKELEY
FEDERAL INSTITUTE OF HYDROLOGY, GERMANY,
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Micropollutants and hazardous susbstances, including pharmaceuticals, biocides, fluorinated compounds and ingredients of personal care products in wastewater, surface water, sediments, soils, ground water and drinking water present numerous technical and institutional challenges to society and environmental and public health professionals. In June 2007, the Micropol & Ecohazard 2007 Conference in Germany provided an international platform for drinking water and wastewater engineers, environmental chemists, water and wastewater utility managers, hydrogeologists, and ecotoxicologists to discuss the effects of micropollutants and hazardous substances and their removal from water systems. Because of the tremendous success of the 2007 conference, the International Water Association (IWA) has partnered with the Groundwater Resources Association of California (GRA) to invite you to attend Micropol & Ecohazard 2009 to be held in June 2009 in San Francisco, California. This three-day event will profile the latest developments in the detection, risk assessment, treatment and regulation of micropollutants and hazardous substances in water systems.

Conference Topics

- **Environmental Chemistry**
  - Advances in analytical methods
  - Occurrence, fate and transport, process studies
  - Modeling approaches
- **Toxicity and Risk Assessment**
  - Biological effects of micropollutants and hazardous chemicals in the environment
  - Mixture toxicity
  - Exposure and hazard assessment
  - Ecological risk evaluation and assessment criteria for effluents
  - Approaches to determine the toxicological relevance of micropollutants in drinking water
- **Wastewater Treatment and Water Reuse**
  - New concepts and methods to reduce and/or remove micropollutants and hazardous chemicals from water
  - Fate, transport, process kinetics, and modeling in wastewater treatment plants
  - Treatment efficiencies, costs and resource/energy requirements
  - Fate and removal in reuse and reclamation facilities, and soil aquifer treatment, groundwater recharge and surface water replenishment efforts
  - Stormwater overflow and sewer exfiltration
- **Drinking Water Treatment**
  - Fate and removal of micropollutants and hazardous chemicals during water treatment (and relevant water processes such as flocculation, ozonation, AOPs, GAC, PAC, nanofiltration, reverse osmosis and bank filtration)
  - Formation of emerging disinfection byproducts during water treatment including those from the reaction of micropollutants with disinfectants
- **Regulations and Management**
  - Wastewater, recycled water, ground water, surface water, drinking water
  - Urban water management
  - River basin management
  - Source control
- **Emerging Issues**
  - Nanotechnology related industrial applications and environmental implications

Call for Abstracts

Abstracts are invited for oral or poster presentations relevant to the session topics listed above. By virtue of submitting an abstract, the submitter grants IWA/GRA the right to publish any accepted abstract or the right to decline any abstract. The Technical Program Committee will review abstracts and make final selections for both oral and poster sessions.

Submit abstracts by e-mail to Mary Megarry (mmegarry@nossaman.com) no later than October 15, 2008.

For guidelines for submitting an abstract, please see the call for abstracts at www.grac.org

Exhibitors

GRA and IWA are pleased to invite participants to exhibit at the Conference. Exhibits should demonstrate recent and cutting-edge technologies related to environmental chemistry, wastewater treatment, drinking water treatment, potable reuse, ecotoxiciology, environmental risk assessment and human toxicology related to micropollutants. Participants

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Wells and Words

Technical Corner

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

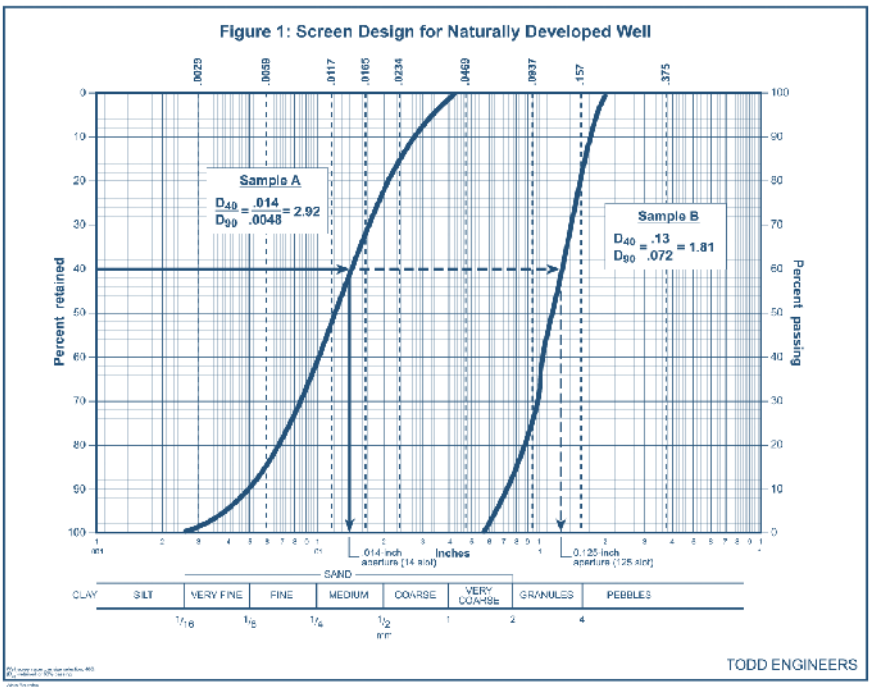
Well screen aperture size selection for a naturally developed well, 40% (D_{40}) retained or 60% passing rule

This article is the first of two parts. Part 1discusses well screen aperture size selection for a naturally developed well, while Part 2 will discuss selection for a well packed with an artificial filter. Choosing the correct well screen design is vitally important to the construction of a successful, sand-free, turbid-free, and operationally efficient production well and to the collection of reliable water quality samples from monitoring wells. Well screen design involves more than choosing the screen aperture size, including selection of construction materials, screen specifications, screen geometry, and pipe- or screen-based perforations.

The well screen and casing supports the borehole, preventing collapse of formation materials. The screen permits groundwater to enter the well so the pump can deliver water. The screen also protects the pump from falling debris and entrained solids. Proper design of well screen aperture size is critical to the efficient operation of the well and pump. Too small of an aperture will result in an increase of the entrance velocity, promote turbulent flow, and reduce well efficiency. Too large of an aperture will allow sand and suspended solids to enter the well reducing well and pump longevity, decreasing well efficiency, and inviting catastrophic land subsidence around the well.

A naturally developed well design calls for no filter pack; the screen is placed in direct contact with aquifer materials. Representative formation samples must be collected from known and reliable depths to successfully complete a well with a natural filter pack. Commonly, the naturally developed well design is installed using cable-tool drilling methods; rotary drilling requires a filter pack because of the uncertainty of formation textures and sample locations.

Figure 1: Screen Design for Naturally Developed Well



The screen aperture for a naturally developed well is based on particle-size distribution analysis of aquifer materials. During sample collection, the coarse fraction of the sample (greater than 0.5-inch) is removed while the finer fraction is used in the mechanical or sieve analysis conducted using a sequence of graduated sieves that evenly spans the particle size range of the sample. Each sieve fraction is weighed on a balance scale. Cumulative weights are then calculated and normalized to the sample's total weight. The data are plotted on semi-logarithmic graph paper. The X-axis (logarithmic scale) ranges from 0.001- to 1.0-inch grain size corresponding to silt to pebbles, while the Y-axis (arithmetic scale) corresponds to cumulative weight percent of the sample retained (or alternatively, percent passing) ranging from 0 to 100%.

Figure 1 shows two examples. Sample A is fine-medium sand and Sample B is granules with very coarse sand. The right side scale is percent passing while the left is percent retained. Typically, semi-logarithmic graphs of cumulative grain-size distribution curves appear "S-shaped." To facilitate plotting, the graduated sieve sizes are identified by vertical dashed lines and labeled on the top of Figure 1. Observe that the more vertical the distribution curve (Sample B) - the more uniform the sample.

The screen aperture is estimated from the 40% retained (D_{40}) or 60% passing grain size. A horizontal line is drawn from the D_{40} position on the Y-axis to the sample cumulative distribution curve. A vertical line is dropped to the X-axis. The corresponding D_{40} particle size is the recommended well screen aperture size. For example, Sample A has a D_{40} of 0.014-inch (14 thousandths of an inch or 14 slot) while Sample B has a D_{40} of 127 slot.

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Legislative Update

California Legislative Corner

BY CHRIS FRAHM, PAUL BAUER, AND JAMES RALPH, BROWNSTEIN HYATT FARBER SCHRECK; AND TIM PARKER, SCHLUMBERGER WATER SERVICES

The political environment in Sacramento has become increasingly contentious as the legislature has failed to pass a budget. While the statewide water crisis has brought renewed focus to efforts to address the state's water needs, efforts to place a water bond on the November ballot are largely dependent on a successful outcome of the budget negotiations.

In June, Governor Schwarzenegger signed an Executive Order expediting aid to the Central Valley to address their water shortage and then proclaimed a State of Emergency in nine Central Valley counties due to drought conditions.

In July, Governor Schwarzenegger and U.S. Senator Diane Feinstein announced a water bond proposal and asked the legislature to place their proposal on the November ballot. In response to the Schwarzenegger/Feinstein proposal, Senate President pro Tem Don Perata and Assembly Speaker Karen Bass proposed that bond funds which have already been passed by the voters be appropriated before any additional water bond measures are placed on the ballot. Their legislative package calls for passage of SB 1XX by Senator Perata and AB 2175 by Assembly Member Laird. SB 1XX implements Proposition 84, and AB 2175 is a water conservation measure. Senator Mike Machado has also introduced a water bond proposal SB 6XX.

The budget crisis is the central issue in Sacramento and for the "Big 5" budget negotiators, who include the majority and minority leadership of each house and the Governor. Their challenge is how to close the state's estimated $15 billion deficit.

Legislators on both sides of the aisle have taken firm negotiating positions creating a stalemate which threatens the fiscal stability of the state. To pass a budget, the Democratic majority needs the support of Republican legislators to meet the two-thirds majority required by the state's constitution. Democratic legislators have proposed a combination of budget cuts and tax increases, while Republican legislators are seeking to eliminate the deficit by budget cuts alone. Governor Schwarzenegger has proposed a variety of solutions ranging from borrowing against the state lottery to a sales tax increase. In addition to eliminating the current budget deficit, Governor Schwarzenegger has stated that he wants long-term budget reform, possibly including a rainy-day reserve fund and a spending cap, as part of any budget agreement. However, the Governor's proposals have been greeted with skepticism from both the Republican and Democratic leadership.

The Big 5 appear to be frustrated with the direction of negotiations. The Governor has attempted to cut the pay of state employees to reduce cost and threatened not to sign any legislation until a budget is passed. Meanwhile, legislative leaders have each held press conferences blaming the other side for the lack of progress in negotiations. The clock is ticking on legislation as September 30th is the last day the Governor can sign a bill into law.

GRA's stance on Senate Bills

SB 1XX (Perata) is a Proposition 84 implementation bill, which has been amended to include the language of AB 1654 (Huffman) on IRWMP. The bill is now part of the legislative package which was announced by Senate President pro Tem Perata and Assembly Speaker Bass in response to the Schwarzenegger/Feinstein water bond proposal. It is likely that this bill will be amended further before passage. *GRA is neutral on SB 1XX (Perata).*

SB 1391 (Padilla) began as an aggressive measure to allow the California Department of Public Health to set statewide standards for the use of recycled water for groundwater recharge in lieu of the current regulatory scheme under nine regional water quality control boards. The bill was controversial and was amended to allow the State Water Resources Control Board (SWRCB) and interested stakeholders an opportunity to develop solutions that will have broad acceptance. The current amended bill requires the SWRCB to adopt a statewide recycled water policy by January 31, 2009 and make recommendations for any statutory changes necessary to implement that policy. *GRA is in support of the concept of SB 1391 (Padilla).*

GRA's stance on Assembly Bills

AB 1654 (Huffman) would repeal the Integrated Regional Water Management Act of 2002 and enact the Integrated Regional Water Management Planning Act. This bill is modeled on AB 1489, introduced in 2007 by the same author. GRA sought and obtained amendments to the bill in an earlier version. While the bill previously appeared to be stalled, the language has recently been included in the amended version of SB 1XX, as discussed above. *GRA is neutral on AB 1654 (Huffman).*

AB 2046 (Jones) initially excluded contaminated groundwater from water supply assessments in city and county development determinations and urban water management plans. This bill has been amended to require the identification of the amount of contaminated groundwater. The bill would authorize the inclusion of contaminated groundwater that does not meet applicable regulatory standards for the proposed use without treatment,

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The Federal Corner

BY JOHN UNGVARSKY

Federal Legislative/Regulatory Corner

Requirements for Geologic Sequestration of Carbon Dioxide

On July 25th, the Environmental Protection Agency (EPA) proposed in the Federal Register new requirements under the Safe Drinking Water Act (SDWA) for the underground injection of carbon dioxide for the purpose of long-term underground storage, or geologic sequestration. The proposed regulation is intended to ensure protection of underground sources of drinking water from injection related activities. The comment period ends on November 24, 2008. The proposed rule would establish a new class of injection well (i.e., Class VI) and relevant technical criteria for protecting underground sources of drinking water. For more information, go to: http://www.epa.gov/safewater/uic/wells_sequestration.html#regdevelopment.

Ground-Water Availability in the United States

This US Geological Survey (USGS) report examines what is known about the Nation's ground-water availability and outlines a program of study by the USGS' Ground-Water Resources Program to improve our understanding of ground-water availability in major aquifers across the Nation. The approach is designed to provide useful regional information for State and local agencies who manage ground-water resources, while providing the building blocks for a national assessment. The report is written for a wide audience interested or involved in the management, protection, and sustainable use of the Nation's water resources. For more information, see: http://pubs.usgs.gov/circ/1323/.

Ground-Water Rule Guide and Fact Sheets

In June, EPA released a Quick Reference Guide and a series of fact sheets relating to the Ground Water Rule. These documents provide a simple and straightforward description of the rule, critical deadlines and requirements for drinking water systems and states, and information on monitoring requirements. For more information, see: http://www.epa.gov/safewater/disinfection/gwr/compliancehelp.html.

EPA Report on the Underground Storage Tank Program

For nearly a quarter of a century, EPA, states, tribes, and other partners have made significant progress in preventing, detecting, and cleaning up petroleum leaks from underground storage tanks (USTs). This report provides a snapshot of program activities conducted in Fiscal Year 2007 and the advances made in preventing releases, conducting clean-ups, and enhancing communication and information sharing efforts. The success and progress of the program during the past year are due to the support and dedication of EPA's partners to further protect human health and the environment from UST releases. For more information, see: http://www.epa.gov/oust/pubs/OUST_FY07_Annual_Report-_Final_4-08.pdf.

Enhanced Anaerobic Bioremediation

The Department of Defense has identified perhaps thousands of sites where groundwater is contaminated with chlorinated solvents, perchlorate, and explosive compounds. Permeable mulch biowalls and in situ bioreactors hold great promise as a remedy. The Air Force Center for Engineering and the Environment (AFCEE) contracted Parsons Inc. to prepare "Technical Protocol for Enhanced Anaerobic Bioremediation Using Permeable Mulch Biowalls and Bioreactors." This protocol provides guidance on the use of permeable mulch biowalls and bioreactors for enhanced in situ bioremediation. For more information, see: http://www.afcee.af.mil/shared/media/document/AFD-080630-091.pdf

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, HI, and NV. For information on any of the above topics, please contact John at 415-972-3963 or ungvarsky.john@epa.gov.

Chemist's Corner

When Accumulation is not the Solution

BY BART SIMMONS

The environmental behavior of metals generally involves dilution and/or attenuation in soil or in a water body. However, many documented cases have shown that toxic elements can be concentrated in the environment. Selenium accumulation at the Kesterson Wildlife Refuge, and the resultant birth deformities in wildlife, is one notorious example. Efflorescence formation on the surface of soil or concrete is another. At the McColl site in Orange County, efflorescences on the surface of the sumps contained up to 10,000 ppm of arsenic, although samples of waste from the sumps had only about 100 ppm. Recent research (*Environ. Sci Technol.,* 42,(12), 2008) has found that lead pipe scale in drinking water distribution systems can be a significant accumulator of metals, including mercury, barium, vanadium, and cadmium. This also points out the problem of monitoring at the drinking water source, since changes in water flow and chemistry could mobilize metals from pipe scale. Previous work had found that aluminum, arsenic, and barium accumulate in pipe scale, and now there is evidence that high concentrations of other regulated metals can also accumulate. Scale forms because of a combination of water quality and the type of pipe used.

The scale was collected from lead piping, digested, and analyzed for total metal concentration. Samples were analyzed with a combination of Inductively-coupled plasma atomic emission, and powder x-ray diffraction. Two types of corrosion were found: one was a two-layer scale, with lead oxide (PbO_2) primarily forming one layer. The other system was a complex scale rich in manganese, iron, and aluminum oxyhydroxides. The concentrations were remarkable: aluminum, iron, manganese, and lead were found in average concentrations exceeding 10,000 mg/kg (1%). Copper, sulfur, tin, zinc, and vanadium were found at an average of over 1,000 mg/kg. Arsenic was found up to 426 mg/kg; other studies have found higher concentrations of accumulated arsenic in iron pipe.

The accumulation of these high levels of contaminants raises the issue of release into drinking water with changes in flow, pH or other disturbances. This area has had little study, although the potential for contamination at the tap is high.

Water quality monitoring is done at the drinking water source, with the exception of lead, copper, and asbestos. Most water quality monitoring assumes that the concentrations at the source are the same as concentrations at the tap. Monitoring at the tap is problematic. In one case, I was involved in tap sampling for potential plastic pipe permeation, only to discover contamination with organic solvents because of cross-connections with the PVC irrigation system. However, the levels of accumulated metals in pipe scale indicate that additional tap sampling should be used to better estimate actual exposures.

Most environmental models assume dilution of contaminants, but accumulation of toxic elements should also be considered.

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

CGA Update

BY MIKE MORTENSSON, CGA EXECUTIVE DIRECTOR

CGA Celebrates 60th Anniversary

The California Groundwater Association will celebrate its 60th Anniversary in 2008. The year's big event will be the CGA Convention and Trade Show at John Ascuaga's Nugget in Sparks, Nevada. We're planning a trade show, a mix of networking and fun activities, and multiple seminars and workshops. There will be all-day workshops on Well Destruction and CPR/First Aid; two-hour seminars will present business topics, an introduction to lobbying, pump analysis and motor controls, and well chemistry and rehabilitation. The NGWA McElhiney Lecture will be presented by F. Michael Krautkramer on "*How Much is Enough? Making Decisions in the Water Well Industry.*" This will be one of CGA's earliest shows; the dates are October 30–November 1. We hope to see GRA members in attendance – it's a chance for us to work together to promote groundwater protection and wise use. You'll find a bit more information at CGA's website, www.groundh2o.org.

CGA Holds A Day At The Capitol

As part of a NGWA advocacy grant to CGA to implement a grassroots legislative and public awareness program, CGA recently held a Day at the Capitol. CGA members heard from numerous speakers including Assemblymembers Jared Huffman, Jean Fuller, Bill Maze, Joel Anderson, Tom Berryhill, Doug LaMalfa, Mike Villines, Senators Dave Cogdill and Denise Ducheny, Secretary Mike Chrisman of the CA Resources Agency and Kasey Schimke, DWR Assistant Director of Legislative Affairs. Theresa Schilling from Senator Pat Wiggins' office presented CGA members with a Resolution honoring CGA on its 60th Anniversary. Phil Nails, Consultant for the Assembly Water, Parks and Wildlife Committee also spoke to the group. The members spent the afternoon making over 30 visits to Legislators and their staff conveying the message that CGA is each Legislator's resource on all groundwater matters. All the legislators visited expressed appreciation for CGA efforts.

CGA Sues Water District

CGA has filed a complaint in Superior Court of Kern County against the Semitropic Water Storage District (SWSD) in Wasco for the unlicensed drilling of water wells on their property. CGA contends that the California Water Code requires anyone drilling a well in California must hold a valid C-57 Water Well Driller's license. The CSLB has notified CGA that public agencies are not exempt from this requirement. SWSD declined to cease and desist their unlicensed activity in response to a demand from CGA in spring 2008. The complaint was filed in May. The Court has denied a Temporary Restraining Order and denied a Preliminary Injunction request. A further hearing is scheduled later this month. CGA's action is a result of a long and complex investigation responding to a member's alert to the District's drilling activity. CGA's efforts included contacts with the CSLB, rig manufacturer, CIFAC, drilling contractors, health department officials, Caltrans, and SWSD staff.

CGA Joins CIAQC

CGA has joined the Construction Industry Air Quality Coalition (CIAQC) in an effort to deal with the impacts of current and pending CARB regulations. These regulations may have serious impacts on the ability of the groundwater industry to supply groundwater to meet the needs of a growing state population. The regulations require significant changes to engines in various pieces of equipment used in well drilling. For more information, contact the CGA office at 707-578-4408.

Alliance Corner

NGWA International Conferences Spotlight Managing Water Resources

BY CLIFF TREYENS, NGWA

This fall is a pivotal time for two National Ground Water Association (NGWA) international conferences—the first regarding nonrenewable ground water resources and the second about managing ground water resources in Latin America.

NGWA's International Conference on Nonrenewable Ground Water Resources will take place in Portland, Oregon, October 13-14, 2008. Its focus is on aquifer systems for which replenishment rates are so small that their development is unsustainable. The conference seeks to facilitate sharing of information and management approaches among water professionals grappling with this issue from around the globe.

NGWA is hosting the conference in association with the Institute for Water and Watersheds at Oregon State University; the International Hydrological Programme of the United Nations Educational, Scientific, and Cultural Organization; and The World Bank.

To view the conference program or register, visit www.ngwa.org, and go to the Education and Events tab

Separately, NGWA is accepting abstracts until November 28, 2008, for Groundwater for the Americas, a conference to take place in Panama City, Panama, June 8-10, 2009. This conference seeks to foster dialogue among people of the Latin American region about how they can best manage water resources in the context of socio-economic and cultural realities.

Once considered a virtually endless or renewable source of supply, many recent examples of contamination and overdraft have cast doubt on the sustainability of groundwater use in the region. Efforts to protect groundwater from further degradation and extend its period of use traditionally have focused on improved water management. However, as enunciated in the United Nations International Hydrology Programme IHP-VII themes and the proposed actions of the Alicante Declaration, effective groundwater management must also take into consideration the broader socioeconomic and cultural conditions that affect societal well-being.

A three-day event, Groundwater for the Americas is an opportunity for all who work in the groundwater community to address the broad spectrum of issues and concerns that inhibit efficient and effective groundwater management strategies. It is ideal for policy makers, consulting firms and international water companies.

The scope of the conference will be determined by people of the Latin American region and is expected to include such topics as:

- Environmental and ecological impacts on groundwater sustainability
- Groundwater, rain forests, and watersheds
- Saltwater encroachment conditions caused by natural and man-made activities
- Identifying potable water supplies
- Groundwater contamination resulting from natural and man-made activities
- Pollution prevention of water resources and remedial solutions
- Transboundary groundwater issues including groundwater/surface water interaction
- Proper water supply well construction and well development
- North, South, and Central American country-by-country summaries of specific groundwater issues (successes and failures)
- Community-based water resources management planning
- Managed aquifer recharge and conservation as components of sustainable water resources management.

Workshops and expert table sessions will be integrated into the conference and be designed specifically for practitioners. These sessions will be crafted to maximize networking and discussion by all engaged in groundwater activities. The complete program offers participants opportunities to enjoy special attractions and experiences native to Panama.

To learn more or submit an abstract electronically, visit www.ngwa.org and go to the Events and Education tab.

Organizational Corner

Call for Nominations for Director Seats Open in 2009

The Association is now soliciting nominations for GRA Board of Director candidates to run for five (5) seats that commence service January 1, 2009. The Nominating Committee has established the following criteria for nominating and selecting candidates for the final ballot that will be presented to the GRA membership for voting.

Minimum Qualifications for Director Nominees

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

Nominating Guidelines and Procedures

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

To declare your desire to be nominated or to nominate someone other than yourself, please follow the guidelines and forward the material to Kathy Snelson, GRA Executive Director, via email (executive_director@grac.org), fax (916-442-0382) or mail (915 L Street, Suite 1000, Sacramento, CA 95814) no later than October 9, 2008.

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

GRA Extends Sincere Appreciation to its Co-Chairs and Sponsors for its August 2008 *Climate Change* Symposium

Co-Chairs
Tom Mohr, Santa Clara Valley Water District
Dr. Jean Moran, CA State University, East Bay
Jon Rohrer, AQUI-VER, Inc.

Luncheon
MWH

Refreshment
Daniel B. Stephens & Associates, Inc.

2008 Membership Satisfaction Survey

Thanks to everyone who was able to take part in GRA's 2008 Membership Satisfaction Survey. We received excellent feedback on how to make improvements for the benefit of GRA members. The input on Events, *HydroVisions*, Branch Meetings, the Web Site, and GRA in general will be taken to heart as we review and analyze the results. Soon, both the Web site and *HydroVisions* will present the results for members to view. The Board of Directors is discussing the results to initiate implementation of the changes you suggested to improve the Association. Thanks again for taking the time to help us make your Association a better experience.

2008 Contributors to GRA — Thank You

FOUNDER ($1,000 AND UP)
Brownstein Hyatt Farber Schreck

PATRON ($500-$999)
DrawingBoard Studios

CORPORATE ($250-$499)
David Abbott
AMEC Geomatrix
Luhdorff & Scalmanini, Consulting Engineers
Malcolm Pirnie

CHARTER SPONSOR ($100-$249)
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Jay Boughter
James Brown
BSK Associates
Kate Burger
Steve Campbell
Joyce Clark
Bob Cleary
Nova Clite
Thomas Cooper
Jim Crowley
Daniel B. Stephens & Associates, Inc.
Jessica Donovan
Robert Dougherty
Scott Dressler
Bill Dugan
David Dunbar
Earth Tech
EMAX Laboratories
Nasrin Erdelyi
Larry Ernst
Alicia Falk
John Farr
Fred Flint
John Fortuna
Avram Frankel
Alvin Franks
Laura Frost
John Gallinatti
GEI Consultants, Bookman-Edmonston Div.
Laurie Glantz-Murphy
Martha Guzman Aceves
Davis Harnish
Pat Havard
Erik Hendrix
Patrick Hourican
Iris Environmental
Sachiko Itagaki
Ted Johnson
Bob Joyce
Erica Kalve
John Karachewski
Carol Kendall
George Kenline
Christy Swindling Kennedy
Josh Kerns
Arthur Kidman
Mark King
Randy Kirby
Taras Kruk
Lawrence & Associates
Monique Lepine
Brian Lewis
LFR Inc.
Tara MacHarg
Gerald Marasovich
Robert Martin
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Peter Mesard
Greg Middleton
Jean Moran
MWH Americas, Inc.
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Aaron O'Brien
William O'Brien
Daniel Osornio
Frederick Ousey
John Pacetti
Susan Panttaja
John Peterson
Roger Pierno
Peter Quinlan
John Reay
Eric Reichard
Yvonne Reyes
Matthew Rhoades
Roscoe Moss Manufacturing Company
Jane Gill-Shaler
Robert Sawyer
Heather Shannon
Shaw Environmental
Mel Simons
Cody Smith
James Specht
Linda Spencer
Robert Stettler
Eric Strahan
Robert Strahan
Susan Trager
Francis Thie
Jose Vergara
Brian Wagner
Ed Wallick
Donald Weir
Welenco, Inc
Brandon Whitehead
John Williams
Gus Yates
Anthony Zampiello
William Zavora

SUPPORTER
James Malot
Gabriel Sabadell
Frank Yeamans

Organizational Corner

Climate Change: Implications for California Groundwater Management – Continued from Page 1

Technical Predictions:

Technical experts invited to speak at the symposium detailed how climate change in California is predicted to primarily: 1) result in higher temperatures through most of the State; 2) cause earlier and more intense snowpack runoff; 3) reduce the snowpack as precipitation shifts from snowfall to rainfall; 4) increase sea level; and 5) result in potentially longer and more severe periods of drought. DWR has done extensive work to estimate what these predicted changes portend for surface water resources. In parallel, others are studying the climate change issue and developing additional guidance. Predicting the impacts of climate change on water resources remains an evolving but ever-improving science, especially in decreasing the uncertainty of estimates.

Pro-Active Steps for Water Professionals to Consider:

Speakers at GRA's symposium emphasized the following important considerations for State guidance and technical predictions:

- California's population continues to grow, and expanded water conservation efforts will help to ameliorate this fundamental supply/demand conundrum, which will be exacerbated by predicted volatility from climate change effects and other pressures such as the Wanger (e.g. Delta Smelt) decision and other allocation reductions. Long-term water resources management plans and models must consider the range of impacts of climate change.
- Given predicted climate change impacts, groundwater is a more attractive and valuable portion of water-supply portfolios compared to surface water, given reliability, energy considerations and synergistic conjunctive use solutions.
- Planning for longer droughts and expanded groundwater monitoring (of water levels and extraction) is necessary to evaluate potential effects of increased reliance and stress on groundwater supplies.
- Groundwater planning documents should carefully consider the results of state-wide climate change studies, but keep in mind their inherent uncertainty with respect to local implications.
- Water supply operations are inherently energy intensive, and state-wide emissions reduction and energy optimization initiatives will roll down to end-users, such as water purveyors; this creates opportunities for alternative energy projects.
- Evaluating carbon/greenhouse gas implications in planning and infrastructure decisions may present opportunities for long-term cost savings.
- Expanded conjunctive use efforts may provide one of the best opportunities in the water resources field for adapting to earlier and more intense runoff.
- Water demand, especially in the agricultural community, may shift due to temperature and/or carbon dioxide-related impacts on crops.
- Groundwater may prove valuable in mitigating emissions impacts through carbon sequestration.
- Although the labyrinth of water rights law and water transfer mechanisms in California is often looked at as either too complex or as the third-rail of water policy, the magnitude and severity of predicted impacts of climate change on water resources necessitates reconsidering some long-held beliefs, laws and/or policies to encourage or even allow meaningful adaptation.
- Much water supply planning is done at the water supplier level, but climate change, which clearly reaches beyond water agency boundaries, may galvanize efforts already underway for Integrated Regional Water Management, funded by DWR grants.
- California agencies are responding to directives from the Governor and legislature to study and implement policies associated with climate change. Additional legislation/policies/regulations on this issue are in the works, especially for water. As always, active participation in legislative and/or agency decision-making can only improve the resultant laws or policies.

Water Planning:

For hydrologists, water managers and groundwater scientists at the local level, there is an inherent disconnect between technical developments and California's environmental and water planning requirements. Although more precise predictions of the effects of climate change on surface water resources are being made (e.g. the State Water Project in particular, with extensive climate change evaluations upcoming in the 2009 State Water Plan and Delivery Reports, and DWR's 2008 draft Climate Change White Paper), limited guidance is available on incorporating climate change in the next round of 2009 Urban Water Management Plans or in environmental planning documents. Legal challenges to water-related environmental planning documents have already been made, based in part on a lack of quantification of climate-change impacts to water resources (Santa Clarita Oak Conservancy Case). Summarizing the Santa Clarita Oak Conservancy case decision, local agencies could rely on DWR's assessment that direct quantitative impact of climate change on water supplies was not yet possible. The 2009 water analysis updates from DWR, however, may have direct implications associated with this decision. Aside from including the potential impacts of climate change on water resources management as part of long-term planning, there are potential legal considerations given these challenges of not considering what is known in planning documents. However, there is the standard guidance in CEQA planning to only include what is "reasonably foreseeable" in analysis.

Water and Energy:

In addition to the hydrologic implications of climate change for water resources, there is a strong connection between supplying water and energy use. Groundwater supplies are generally one of the least intensive energy uses related to water sup-

ply. Water resource managers may need to go beyond cataloging emissions as part of water system operations, and may need to start considering the carbon dioxide/greenhouse gas-emissions implications of energy sources. Because many water systems include open space, there may be opportunities for co-generation and/or alternative energy supplies (solar/wind).

Conjunctive Use/Transfers:

As detailed in several other GRA symposia, expanded conjunctive use may present one of the best adaptations to earlier and more intense runoff from snowmelt. However, state and local water rights laws and the adjudication process often present challenges for implementing large-scale transfers and groundwater storage/enhancement projects. A number of successes have recently occurred, and the predicted climate change impacts on water resources may fuel the desire and/or need for evaluation of fair and equitable solutions and consideration of innovative approaches as potential adaptations to water resource challenges posed by climate change.

Other Groundwater-Related Implications:

Studies are continuing on the potential effects of sea-level rise on sea-water intrusion into freshwater aquifers. Although sea-level rise may affect salt-water intrusion, anthropogenic stresses on aquifers generally pose a much greater challenge for sea-water intrusion issues. Agricultural demands on groundwater may change as a result of shifts in irrigation requirements associated with the impacts of climate change (temperature and carbon dioxide levels) on plants and/or changes in crops. Predicted air temperature changes and decrease in snowpack may result in significant changes in water temperatures that may have ecological implications. The USEPA is developing groundwater carbon sequestration guidance; when finalized, this may present an opportunity for the groundwater industry to assist in reaching carbon dioxide goals.

What to Watch For:

As noted earlier, the technical science of climate-change-related predictions is continually improving and key researchers at California universities and laboratories are leading much of this research, as is the USGS.

DWR will publish its "White Paper" on climate change in fall 2008. In 2009, DWR will update the State Water Plan and the State Water Project delivery reliability reports. The SWRCB and CEC are performing their own studies and may issue guidance or rules related to the energy-water nexus and conservation. The Water-Energy (WET-CAT) subgroup within the state Climate Action Team is working on its own recommendations across multiple agencies.

At the regional/local level, grants are available through DWR and SWRCB for Integrated Regional Water Management planning. CEQA issues are always evolving; watch for important new developments in the water supply sections of EIRs or related legal challenges. Even without explicit guidance for inclusion of climate change impacts in 2009 UWMP updates, it may be prudent to touch on the widely accepted projections regarding climate change impacts to water supply, especially for those sensitive to surface water deliveries.

Summary:

GRA always strives to facilitate discussion of developing issues in the groundwater field. Although there remains some debate over the predicted magnitude of climate change impacts on water resources, California agencies and legislators are aggressively studying and enacting policies and laws related to climate change. Based on the presentations at this Symposium, water professionals should be aware that this issue transcends traditional divisions associated with water supply. Symposium speakers made it clear that one overarching component of evaluating specific responses to potential regulatory, legal or technical challenges associated with climate change should include a holistic view across the water planning, groundwater, surface water, energy, carbon footprint, ecological, public planning, and water rights fields.

Jon Rohrer chaired GRA's Climate Change Symposium. He is a hydrogeologist with Aqui-Ver in low-lying Long Beach. Special thanks and credit are due to the Symposium planning committee, GRA staff and the GRA Board for calling attention to this important, developing issue.

Michael Kavanaugh and Jennifer Nyman of Malcolm Pirnie, Inc., Murray Einarson of AMEC Geomatrix, and John Sankey of True Blue Technologies, Inc.

The first two days of symposium presentations were held at the California Environmental Protection Agency Headquarters Building in Sacramento. An impressive lineup of speakers from industry and academia presented overviews and recent updates for site characterization and remediation technologies and linked the use of those technologies to successful remedial design. The final day of the symposium, May 16, was held outdoors at California State University, Sacramento, and provided vendors an opportunity to demonstrate the latest equipment and technologies for drilling, site characterization and remediation.

DTSC and its co-sponsors and cooperators appreciate the participation of the following industry representatives who shared the latest in remediation technology during the symposium through their displays and discussions with attendees during symposium breaks and receptions: Thermal Remediation Services, CETCO Liquid Boot Company, Regenesis, EOS Remediation, Boart Longyear, Blaine Tech Services, Inc., RSI Drilling, AMEC Geomatrix, and Brown and Caldwell.

Information on the symposium, including slide presentations, videos of presentations, photos, speaker biographies and links to websites for participating vendors, is available at www.dtsc.ca.gov/HazardousWaste/Remediation.cfm.

Symposium Summary

Watson Gin, DTSC's Chief Engineer, opened the symposium the first day by describing the overwhelming interest in the event. He discussed the recent reorganization of cleanup programs within DTSC into a single Cleanup Program, which brings together all the resources needed for cleanup, incorporates the priorities of the former programs and provides opportunities for improvements and enhanced efficiencies. Mr. Gin then spoke about the transformation of remedial technologies over time, and emphasized the current availability of green technologies for remediation, such as *in situ* approaches, to be covered during this symposium and in a subsequent public DTSC symposium.

The first technical session of the symposium addressed characterization methods for successful remedial design. **Murray Einarson** of AMEC Geomatrix presented advances made in site characterization and monitoring over the past 30 years from high-resolution field research. Key advances in knowledge included the spatial and temporal variability in dissolved contaminants, the presence of non-aqueous phase liquids (NAPLs), limitations of hydrodynamic

Vironex displays the CPT/MIP technology during the field demonstration day.

mixing transverse to flow, consideration of aquifer contamination versus groundwater contamination and the importance of biochemical reactions. Mr. Einarson emphasized the need for high-resolution site characterization and the depiction of plumes using cross-sections transverse to flow (in transects). The Triad approach, a second-generation investigation/cleanup strategy developed under the leadership of U.S. EPA, was then discussed by **Brad Call** of the Army Corps of Engineers, Sacramento. Mr. Call is a member of the U.S EPA-led Triad Community of Practice. He explained the procedures and benefits of three major Triad components: systematic planning (including development and continual refinement of the conceptual site model), dynamic work strategies and real-time measurements.

The final two talks of the session focused on specific site characterization methods. **Eliot Cooper** of Vironex discussed the Membrane Interface Probe (MIP). He outlined its advantages of providing high-resolution, real-time data on both soil lithology and a variety of volatile organic compounds with depth, and then presented case studies in which MIP was used in conjunction with *in situ* remediation to optimize amendment delivery to the subsurface and obtain effective amendment/contaminant contact. **Randy St. Germain** of Dakota Technologies, Inc. presented a new generation of optical sensors for characterizing NAPL source zones. Optical screening tools now have the capability to detect most fuels and oils, including creosotes and tars, at concentrations above 10 to 100 parts per million.

Michael Kavanaugh of Malcolm Pirnie, Inc., transitioned between site characterization and remediation by discussing decision-making for closure of contaminated groundwater sites. Dr. Kavanaugh reviewed technical obstacles to restoration of contaminated groundwater, including the presence of NAPLs, physical heterogeneity, contaminants in inaccessible regions, sorption and difficulties characterizing the subsurface, and he discussed regulatory initiatives recognizing these technical limitations and alternative end-points to groundwater restoration. Dr. Kavanaugh then outlined and discussed the following strategies to accelerate closure: aggressive source depletion technologies, the Triad approach, molecular biological and other diagnostic tools to accelerate the transition to monitored natural attenuation (MNA), risk assessment to identify low-risk sites and the use of land-use controls. Matrices to assist in decision-making for remedy selection are publicly available in U.S. EPA and National Research Council (NRC) documents.

The final session of the day, on *in situ* aeration-based remedial approaches, was delivered by **Paul Johnson** of Arizona State University. Dr. Johnson reviewed the

principles of *in situ* soil vapor extraction, bioventing, air sparging, and oxygen delivery for aerobic biodegradation; the settings in which each should be used; factors affecting performance of each technology; and how to apply the technologies cost-effectively. His work on *in situ* air sparging concluded that air distribution is highly sensitive to subtle changes in soil structure, making predictions of air distributions and long-term performance of air sparging difficult.

The second day included an extended session on *in situ* remediation technologies and an expert panel discussion with questions from the audience. As the first speaker, **Doug Mackay** of the University of California, Davis provided an overview of natural and enhanced bioremediation of groundwater contamination from fuels. Dr. Mackay described why many benzene, toluene, ethylbenzene and xylene (BTEX) plumes have enough distance along their flowpaths to naturally degrade below levels of concern, and how vertical mixing can enhance the natural attenuation by contacting the fuel contaminants with electron acceptors required for microbial degradation. He also discussed the most effective ways to amend oxygen to aid in the degradation of gasoline oxygenates, which are very mobile in groundwater and often extend beyond the BTEX plumes. **Ryan Wymore** of CDM next presented recent progress in the bioremediation of chlorinated solvent dense NAPL (DNAPL) source areas. He reviewed experimental and field studies supporting potential advantages of bioremediation for partial depletion of DNAPL sources, such as destruction of contaminants *in situ* and enhanced mass transfer of chlorinated solvents from the NAPL phase to the aqueous phase. **Lisa Alvarez-Cohen** of the University of California, Berkeley, continued the topic of bioremediation with her talk on the application of molecular tools to optimize bioremediation. Dr. Cohen discussed the key role of *Dehalococcoides* organisms in the bioremediation of chlorinated solvents and the use of molecular tools to identify these organisms, confirm the function of dechlorination and characterize microbial communities. She concluded molecular tools can aid in determining when biostimulation will work, when bioaugmentation is necessary and how to optimize the growth of *Dehalococcoides* at chlorinated solvent sites.

After the discussion of the bioremediation of fuels and chlorinated solvents, **Evan Cox** of Geosyntec Consultants, Inc. addressed the remediation of perchlorate. He first reviewed treatment techniques for perchlorate in groundwater, including the *ex situ* techniques of ion exchange, bioreactors and granular activated carbon, and the *in situ* treatment techniques of metal-catalyzed reduction and bioremediation. He then presented a case study of successful treatment of a perchlorate plume with biobarriers. The second half of Mr. Cox's presentation addressed treatment techniques for perchlorate in soil, including *ex situ* composting and *in situ* bioremediation.

Brian Lewis, Program Chair and GRA Director, and DTSC Director Maureen Gorsen make closing remarks at the DTSC Remediation Symposium.

Wilson Clayton of Aquifer Solutions, Inc. spoke on the basics, theory, design and application of *in situ* chemical oxidation. He reviewed advantages and disadvantages of the approach and summarized the major oxidants used in groundwater remediation. Dr. Clayton emphasized the importance of effectively delivering and transporting the oxidant in the subsurface to react with the contaminant of interest. An iterative design process is required to obtain successful contact between the oxidant and contaminant.

The final speaker of the symposium was **Michael Basel** of Haley & Aldrich, Inc., who presented the evolution of thermal technologies for remediation, the details of three thermal technologies, and recent advances in thermal remediation. Thermal technologies treat a wide variety of contaminants under many conditions via *in situ* destruction, enhanced mass removal and/or acceleration of *in situ* reactions. Dr. Basel emphasized that thermal technologies are efficient and cost-effective if applied under the appropriate conditions; each type of thermal treatment works optimally under specific conditions, and each has its own challenges.

During the presentations, audience members were invited to submit questions, which were presented for discussion to an **expert panel** composed of Watson Gin, Ryan Wymore, Steve Figgins, Evan Cox, Doug Mackay and Randy St. Germain. Many questions regarded the limitations or applicability of specific remedial technologies. The panelists recognized limitations to most of the *in situ* technologies in fractured rock environments and technical challenges to achieving drinking water standards in NAPL source areas. They also concurred that inappropriate application of some technologies, such as air sparging, can mobilize contaminants.

Maureen Gorsen, DTSC Director, concluded the indoor presentations by acknowledging the superior contributions of the speakers, the work of the organizing committee and the attentiveness of the audience. She supported the symposium as an investment in DTSC's personnel and all those involved in site remediation.

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DTSC Remediation Symposium – Highlights – Continued from Page 19

The third and last day of the symposium, held outdoors at California State University, Sacramento consisted of remediation technology field demonstrations by vendors. Technology demonstrations from seven vendors were 30-minute formal presentations with equipment demonstrations to groups of about 20 participants, with interactive question and answer sessions following the demonstrations. Participants rotated through the circuit of seven presentations. Shade canopies, chairs and refreshments helped mitigate the unseasonably hot weather. Field presentations were followed by a group lunch, allowing scientists and vendors to continue the lively information exchange.

Vendor presentations included EOS Remediation bioaugmentation and biostimulation products; Blaine Tech groundwater sampling technical services with demonstration of low-flow sampling using their custom-built sampling truck; Environmental Bio-Systems molecular oxygen diffusion systems for enhanced bioremediation; CETCO Liquid Boot soil vapor barrier system installation demonstration; Boart Longyear drilling and soil core recovery using a 300-series sonic drill rig; RSI Drilling compact sonic drill rig demonstration showcasing the latest generation of small-footprint sonic drill rigs; and Vironex remediation services including a direct-push cone penetrometer test (CPT)/Membrane Interface Probe (MIP) data acquisition demonstration and a detailed review of their custom-built chemical oxidation/biostimulation chemical mixing and injection service truck.

Dr. Jennifer Nyman is an environmental engineer in the Emeryville office of Malcolm Pirnie, Inc. specializing in the characterization and remediation of groundwater and sediment. She is an expert on the geochemistry and microbial transformations of metals in the subsurface.

Photographs are by Dr. John Karachewski of DTSC.

President's Message – Continued from Page 2

topics with a strong groundwater theme, how best to reach our target audiences to enhance attendance, and taking full advantage of the feedback received from attendees on the evaluation forms. This feedback and other information will help event chairs to continuously improve upon our recognized track record of offering high-quality events.

As noted in this column in the last *HydroVisions*, GRA has an active and effective Legislative Committee. One important area of discussion was GRA's role in the California Groundwater Coalition. This organization, formed in 2007 as a lobbying coalition under state law, was conceived by GRA's Legislative Committee and included two other founding organizations (the American Ground Water Trust and the Association of Ground Water Agencies). A principle objective of the CGC has been to advocate for increased funding for groundwater programs under state bond measures. Steps are now being taken to form a new nonprofit mutual benefit corporation, and to establish Bylaws and a Board of Directors. GRA will continue to be an active member of the CGC. Our Legislative Committee will continue to work independently on behalf of GRA, including organizing and convening the highly visible Legislative Symposium and Lobby Day in Sacramento each spring (mark your calendars for April 15, 2009).

Both the Communications and Education Committees identified new activities for 2009. Our challenge continues to be matching our sincere desire to offer as many member benefits as possible with a matching level of volunteer support in light of our financial resources. One key area where members can support GRA in achieving its mission and giving back to the groundwater community at the same time is to solicit scholarship funds. Our Sacramento Branch has been most successful to date in soliciting corporate scholarship donations that GRA has matched. These scholarship donations, typically less than $500 each, are given to selected professors at local universities or colleges to support student research. If you are able to contribute to the scholarship program, please contact your local branch officers or Jean Moran, the Director chairing the Education Committee.

Overall, the planning meeting met its objective of challenging GRA's leadership to look ahead and identify ways of continuously improving the association. GRA is healthy and growing, and in a prime position to be a strong voice in leading efforts to better manage California's groundwater resources. As always, please contact me with any comments or suggestions to improve the association.

Call for Abstracts: Micropol & Ecohazard 2009

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will have the possibility to feature case studies, products and manufacturing equipment (size appropriate for exhibit hall).

Conference Contact Information

Groundwater Resources Association of California Attention: Mary Megarry, 915 L Street, Suite 1000, Sacramento, CA 95814, Phone: +001 / 916-446-3626, Fax: +001 / 916-442-0382 and E-Mail: mmegarry@nossaman.com.

Wells and Words — Continued from Page 8

A more conservative slot based on the 50% retained (D_{50}) particle size would be recommended if groundwater was corrosive, poor quality samples were collected, the sample distribution approaches a uniformity coefficient of one, or the overlying formation contains fine-grained sediments. For example, using the D_{50} criteria, Sample A would require an aperture size of 12 slot while Sample B would have 115 slot. For coarse sand and gravel aquifers, a larger aperture size may be beneficial; the D_{30} slot size would increase the open area of the well screen and increase the developed near-well permeability, resulting in a longer lived and more productive well, especially in encrusting groundwater environments. In summary, the well screen aperture size is selected from the D_{30} to D_{50} range where D_{40} is routinely the chosen size for a naturally developed well.

Legislative Update — Continued from Page 9

remediation, or other management options as part of the planned supply. *GRA is neutral on AB 2046 (Jones).*

AB 2175 (Laird) sets numeric water conservation targets for urban and agricultural water use and conditions water management grant funding on local agency implementation of conservation measures. This bill is part of the legislative package proposed by Senate President pro Tem Perata and Assembly Speaker Bass. AB 2175 has passed out of policy and appropriations committees and is awaiting a floor vote in the Senate. *GRA is neutral on AB 2175 (Laird).*

AB 2270 (Laird) would require increased reporting requirements regarding recycled water by the DWR and allow any local agency that operates a sewer system to control residential salinity inputs after a finding by the SWRCB that residential salinity control would help meet water quality standards. Residential salinity discharges to sewer systems are one of the most significant impediments to expanding recycled water. Current law allows local agencies to regulate water softeners; however, it requires an extensive, costly process. *GRA is in support of AB 2270 (Laird).*

Federal Interest and Involvement in Aquifer Storage Policy and Permitting

BY CAT SHRIER, PH.D., P.G., AQUIFER STORAGE ISSUES LLC

California has long been a national leader in the use of aquifer storage. The first western U.S. aquifer storage systems were developed in conjunction with the California State Water Project in the 1970s, with pioneering systems by the cities of Goleta, Camarillo, and Oxnard. These systems were made possible through the delivery of water from northern to southern California. U.S. Geological Survey studies at Antelope Valley in Lancaster, California have provided important information on the understanding of aquifer storage systems, including questions related to the formation and fate of disinfection byproducts.

Permitting of aquifer storage systems can be complex, involving agencies and boards at many levels. Permitting and other regulatory considerations include not only groundwater quality protection (particularly under the U.S. Environmental Protection Agency (EPA) underground injection control or "UIC" requirements), but also regulation of water rights or other actions impacting the availability of water to be stored in aquifer storage systems; regulation of management of groundwater resources; regulation of drinking water and public water supplies; and regulation of land use.

California's intricate approaches to institutional oversight of aquifer storage system development and operation provide a prime example of the level of institutional complexity that can be involved with these systems, as cited by the National Academy of Sciences (NAS) Study Committee Report on Prospects for Managed Underground Storage of Recoverable Water (January 2008; see *HydroVisions*, Spring 2008). These approaches range from groundwater management districts to Groundwater Management "AB 3030" plans, local ordinances, and court adjudications of groundwater pumping rights. In addition, California has been one of the leading states in the nation in developing regulations specific to aquifer storage systems that use treated effluent as their source waters; these regulations are currently under revision and review (California Department of Public Health, 2008).

Aquifer storage issues in California and around the country were further explored at a one-day forum on Managed Underground Storage Policy, Planning and Permitting Issues, sponsored by NAS and cosponsored by several organizations, including GRA. Similar aquifer storage issues in California and other southwestern states were explored in the May/June 2008 issue of *Southwest Hydrology* (Vol. 7, No.3); this issue was wholly dedicated to articles on aquifer recharge, storage, and recovery, including information on the city of Roseville aquifer storage permitting process. This publication and the forum (captured as a webcast) are available for free download at www.aquifer-storage.com.

Aquifer storage systems do not occur in isolation, but they are one component in the integrated and conjunctive management of groundwater and surface water resources. Aquifer storage systems have been an integral part of water supply storage in many parts of the country and help meet aquatic and riparian habitat, agricultural, municipal, industrial, and other economic and environmental demands. All aquifer storage systems require source water from somewhere – and, typically, that source is a surface water body. Groundwater-to-groundwater aquifer storage systems occur almost exclusively in cases where water rights can be more easily acquired from groundwater sources, such as in Texas.

As mentioned previously, many of the earliest aquifer storage projects in California were developed because surface water supplies became available through State Water Project deliveries, and additional storage was required. Similar needs for additional storage in combination with a need to manage groundwater have been seen in the Colorado River basin, where systems in Arizona and Nevada were developed, in part, to address the need for storage of Colorado River Compact allocations within those states.

The issue with the Bay Delta and the curtailment of State Water Project deliveries in California is an example of how federal initiatives can impact the water supplies available for aquifer storage. Federal actions connected to endangered species and habitat restoration led to curtailment of State Water Project deliveries to central and southern California. The reduction in State Water Project water deliveries to groundwater replenishment districts in southern California has resulted in decreased planned recharge to groundwater basins. The lack of availability of source water impacts the integration of these projects into water supply planning for the region, as well as the ability of the districts reliant on groundwater for much of their water supplies to maintain groundwater levels without reductions in groundwater use. Efforts towards prevention of saltwater intrusion may also be impacted by State Water Project delivery curtailments – which, again, are tied to federal regulations.

While site-specific questions certainly arise on any aquifer storage project, just as they do on any surface storage project, there are common concerns that can benefit from greater availability of data and knowledge bases. Project proponents have expressed a need for better guidance and availability of information on ways to approach permitting of aquifer storage systems. Some states and project proponents have been reluctant to seek federal guidance or other involvement in permitting, policy, and planning, other than the provision of funds through grants for studies or through bonds for projects. And yet, as already illustrated, aquifer storage projects already face a host of existing state and federal regulations which may affect the projects' viability, availability of water supply, the length of time required for permitting, and expense associated with the development and operation of aquifer storage systems, particularly with respect to monitoring costs. There are state and federal research agencies, as well as state and national associations and academic institutions, which could help to provide a

better basic understanding of aquifer storage issues and integration of these systems into regional water planning.

Equally valuable are the development of guidance documents and examples of planning metrics, monitoring approaches, decision matrices, and other supporting materials for project development and operation. However, there has been very little collective information made available on aquifer storage systems on a national basis. The U.S. Army Corps of Engineers' (COE's) "Principles and Guidelines," which are often used as the standard for integrated water resources planning and management, do not typically consider aquifer storage as part of regional storage evaluations. Planning metrics for conjunctive water management that includes both surface and aquifer storage are not yet part of the Principles and Guidelines – even though individual COE districts have led development of aquifer storage initiatives including the Comprehensive Everglades Restoration Project and the Farmington Recharge Program, a 10-year, $35 million program to restore groundwater levels and prevent saltwater intrusion in the Eastern San Joaquin Groundwater Basin (Peterson, 2006). Information is not readily available on aquifer storage systems, where they are, how they work, who uses them and what population within the U.S. is served by water storage in aquifers, and how they compare or can be combined with surface water storage and treatment systems through the development of approach planning metrics.

A summary of current federal agency regulation and other federal and state initiatives that could impact or support a better understanding of aquifer storage, including UIC and associated groundwater protection measures, drinking water protection, water planning, high water use agencies, "landed" agencies and research agencies, is provided in Box A.

A lack of national clarity and consistency in the approaches to protection of

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Box A: Current Federal Roles in Aquifer Storage and Conjunctive Water Management

Although groundwater management issues are typically handled at the local and state level, federal agencies have long been involved in aquifer storage. Past federal studies have included the U.S. Geological Survey's (USGS) post-World War II groundwater recharge studies and the U.S. Bureau of Reclamation's Ground Water Recharge Demonstration Projects in the 1980s, which were a major catalyst for western aquifer storage system development.

1) Underground Injection Control. The biggest direct federal involvement in aquifer storage systems that use wells comes from the U.S. Environmental Protection Agency's Underground Injection Control (UIC) program. Promulgated under the Safe Drinking Water Act in 1981, the UIC program was developed to protect all potential underground sources of drinking water (USDW) and to prevent degradation of the quality of aquifers that could constitute a potential USDW. This program was developed to address concerns regarding disposal of waste through underground injection, mainly focusing on hazardous materials, rather than to consider aquifers as a location for drinking water storage. Aquifer storage wells are designated as "Class V" wells, a catch-all category that includes wells permitted for waste disposal. UIC programs are often implemented at the state level through primacy (primary enforcement responsibility) granted by the EPA, or by EPA regional offices in "direct implementation" states and on tribal lands. As a result, approaches to aquifer storage permitting are inconsistent (AWWA, 2002; NRC, 2008). Additional focus of EPA resources on reviewing and updating, as necessary, permitting practices would be a positive step. There have been requests by state programs and EPA regional offices for greater clarity by EPA on the application of UIC to aquifer storage, and EPA recently completed an internal review of aquifer storage issues. EPA's newly drafted rules for carbon sequestration include several considerations that have been suggested for aquifer storage by state agencies and project proponents, such as development of monitoring protocols and creation of a classification separate from the other Class V wells.

2) Other Drinking Water Protection. In many states, public water supply agencies have traditionally had little direct involvement in aquifer storage permitting, asserting that their role begins when water enters a public water supply system. In many cases, however, UIC permits are written to require that the water placed in storage meet drinking water standards. Drinking water standards can change over time, as has occurred with the recent change in the arsenic standard, and could occur with the potential addition of various emerging contaminants. Project proponents may find themselves caught between a drinking water agency's requirement to chlorinate and a groundwater protection agency's requirement to ensure that no disinfection byproducts (such as trihalomethanes or "THMs") are formed. Around the country, permitting agencies and project proponents have struggled with questions of how to take into consideration the changes in water quality that can occur due to differences in chemical composition of the stored water, the native water in the aquifer, and the aquifer material. Changes can occur quickly or over longer storage periods, and may occur within some distance from the wellhead. Agencies have questioned whether drinking water standards must be met at all times and all locations if impacts to other public water supply wells are prevented and if post-recovery treatment can be used before the stored water is introduced into a public water supply system. Use of pH adjustments before and after storage is already a common

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Box A: Current Federal Roles in Aquifer Storage and Conjunctive Water Management — Continued from Page 21

practice for aquifer storage wells in systems rich in iron and manganese, where precipitation of metals could impact well performance. The Florida Department of Environmental Protection (FLDEP, which has Class V UIC primacy) has sought formal approval from EPA on a proposal to allow a point of compliance (possibly other than the wellhead) that assures non-endangerment of human health. Pending a response from EPA, FLDEP has worked with current aquifer storage users to develop creative and adaptive solutions to address issues with arsenic mobilization. Approaches under consideration, such as degassification facilities, would make aquifer storage cost-prohibitive for communities throughout Florida, including those that have depended upon aquifer storage for their water supplies (some systems have operated over 20 years).

3) Water Planning Agencies. Agencies such as the U.S. Bureau of Reclamation and U.S. Army Corps of Engineers (COE) are involved with large-scale river basin planning activities. These agencies, along with the U.S. Fish and Wildlife Service and other U.S. Department of Interior agencies, also are involved with initiatives to restore ecosystems and other natural resources that are of national interest, such as the Bay-Delta, Everglades, Platte River, and Chesapeake Bay. When larger-scale water resource planning efforts are undertaken, multiple benefits are considered. Multiple alternative water management scenarios may also be considered, such as development and operation of water storage. These storage considerations can include both surface water reservoirs and aquifers, and even natural storage, such as snowpack. The COE "Principles and Guidelines" have not historically included consideration of aquifer storage. Planning activities are most effective when locally directed, but larger state or federal entities can provide support for planning processes through facilitation of meetings; compilation and distribution of data and statistics; studies and development of planning metrics; and provision of funding support for projects that have been identified through collaborative planning processes. When performing basinwide or regional planning to meet national priorities, such as for habitat restoration, optimal water management approaches include incorporation of all types of water storage and consideration of conjunctive use approaches to preserve aquatic habitats and otherwise meet water demands. Individual water entities such as South Metro (Colorado) Water Authority and the cities of Phoenix, Arizona and Beaverton, Oregon have developed methods for comparing benefits and costs of surface storage, underground storage, and conjunctive use. These integrated planning approaches can be further developed and made more widely available for better decision support and resource management.

4) High Water Use Agencies. Agencies involved with high water use activities, such as the U.S. Department of Energy (DOE) and U.S. Department of Agriculture also have a strong interest in aquifer storage and may have initiatives that support greater use. DOE is currently exploring increased use of treated effluent and water produced during energy-related extraction activities, and it is also interested in the potential storage of that water underground. Pilot studies in Wyoming have already been completed on the use of produced water in ASR wells.

5) "Landed" Agencies. Agencies that own large areas of land such as National Parks Service, U.S. Forest Service, U.S. Bureau of Land Management, and U.S. Fish and Wildlife Service (USFWS), may own sites that provide ideal aquifer storage locations, or have their own water storage needs to support on their lands. There are several Colorado State Wildlife Areas in the Lower South Platte River, close to the Colorado-Nebraska state line, which provide ideal locations for recharge ponds used to re-time streamflows, supporting ecosystem restoration efforts for bird-nesting habitat in the "Big Bend" region under the "Three States Agreement." Projects constructed on these public lands must provide habitat benefits, according to lease requirements for the state wildlife areas. Consequently, the recharge ponds have been constructed to support duck habitat and feed a "live stream" to breed state-listed minnow species. The Natural Resources Conservation Service's Environmental Quality Incentives Program (EQIP) and Wildlife Habitat Incentives Program (WHIP) and the USFWS Partners for Fish and Wildlife program also support development of recharge ponds that provide habitat benefits on private lands.

6) Other Technical, Planning, and Funding Support. While the USGS is not a policy agency per se, USGS studies are often developed to answer questions important to policy-makers, and the findings of these studies are frequently used to guide the development of science-based policy. USGS is working on a national water availability inventory, which considers, among other things, potential surface water storage and aquifers as groundwater resources, but doesn't explicitly consider aquifers as storage locations. USGS also provides funding to the Water Resources Research Institutes, housed at a university in each state. Other agencies, such as the EPA and DOE, also earmark funding to support studies and pilot projects for permitting support through the Ground Water Protection Council. Through these federally-supported efforts, data, and knowledge on aquifer storage can be made more widely accessible and accepted.

Federal Interest and Involvement in Aquifer Storage Policy and Permitting – Continued from Page 23

human health and the environment and management of water and other aquatic resources has resulted in prolonged permitting processes for some projects. At the same time, there has been a call by many federal, state, and local officials for the increased use of groundwater banking and conjunctive water management, and for the development of integrated regional water plans. "Groundwater banking" has been cited by the new Congressional Water Caucus as one of the 12 principles of U.S. water policy. California has some funding available to support groundwater recharge projects, with additional bonding issues under consideration; although, bonds for projects provide little benefit if the project cannot obtain a permit. With the need for climate change adaptation, more creative tools and approaches to water supply and water resource management (including aquifer storage) have also been called for, as discussed in Box B.

Aquifer storage is governed by federal and state permitting, or by other federal and state initiatives impacting water supply and resource management. Therefore, it is critical for groundwater professionals, water managers, and others knowledgeable of the operations, issues, and opportunities associated with aquifer storage facilities to become actively involved to ensure policy decisions and regulations are based on sound information and commonly available data and knowledge sources are created. Better data and statistics, and an informed dialog will help to ensure the development of risk- and science-based permitting processes, policies, and planning approaches for further integration of aquifer storage systems as part of conjunctive water use planning and management.

Citations

American Water Works Association, 2002, Survey and Analysis of Aquifer Storage and Recovery (ASR) Systems and Associated Regulatory Programs: American Water Works Association, Denver, CO.

California Department of Public Health, 2008, Groundwater Recharge Reuse: Draft Regulation, August 5, 2008: California Department of Public Health, Division of Drinking Water and Environmental Management, Sacramento, California.

National Research Council, 2008, Prospects for Managed Underground Storage of Recoverable Water: National Academies Press, www.nap.edu.

Petersen, C.E., 2006, Recharging Groundwater: The Military Engineer, July-August 2006.

Cat Shrier served on the National Academy of Sciences Study Committee on Managed Underground Storage of Recoverable Water. With degrees in government, geology, environmental management, and civil engineering, and more than 20 years experience with agencies, legislative staff, consulting firms, and water institutes, she provides a balanced understanding of the interplay between water management, planning and policy. Cat founded Aquifer Storage Issues LLC (www.aquifer-storage.com) to support the development of educational programs and materials on aquifer storage and conjunctive water management.

BOX B: A Few Links between Aquifer Storage, Conjunctive Water Management, and Climate Change Adaptation

1) ***Temperature Rise and Increasing Evaporation Rates.*** The earliest understanding of climate change likely came from recognition of rising temperatures and associated increases in evaporation rates. Most water is currently stored in surface reservoirs, which are likely experiencing higher levels of evaporative losses. Aquifer storage methods mitigate evaporative losses.

2) ***Rising Ocean Levels and Seawater Intrusion.*** One projected consequence of climate change is sea-level rise. According to NOAA, in 2003, approximately 153 million people (53 percent of the nation's population) lived in the 673 U.S. coastal counties. Many coastal communities are dependent upon groundwater resources. Aquifer storage facilities – such as those in southern California, Florida, South Carolina, and New Jersey – are operated, in part, to prevent seawater intrusion. If federal regulatory changes result in loss of permits for existing systems, as well as the prevention of new permits, and these de facto saltwater intrusion barriers are no longer available, important groundwater sources of water supply for coastal populations could be further impacted by saltwater intrusion.

3) ***Changes in Seasonal Hydrology and Surface Water Storage Operations.*** Surface water storage infrastructure is designed and operated based upon historical records of seasonal and extreme hydrology. As streamflow patterns are changing due to changes in rainfall or timing of snowmelt, greater resilience in the operations of water infrastructure is needed to ensure water supply needs are met. Aquifer storage projects can be used as part of conjunctive water management approaches to provide back-up water storage when surface water supplies are diminished. As streamflows become less predictable, this flexibility becomes increasingly important.

4) ***Changes in Seasonal Hydrology and Aquatic/Riparian Habitat.*** A critical concern regarding the changes in seasonal hydrology is the impact on streamflows needed to support aquatic and riparian habitat, especially in areas inhabited by endangered species. Aquifer storage projects have been developed to reduce demands on streams for water withdrawals during low-flow periods. Aquifer storage projects are being piloted or operated to store water that can be returned directly to streams during low-flow periods to restore aquatic and riparian habitat ranging from bird nesting habitat in the Platte River, to salmon

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GRA Welcomes the Following New Members

FEBRUARY 6 – AUGUST 21, 2008

Aguiar, Gary	Hydro Analysis, Inc.
Amy, DeBarruel	CSUS
Barry, Tom	Shaw Environmental
Barton, Tracy	Thermal Remediation Services, Inc.
Bauters, Tim	Golder Associates
Benito, Pascual	U.C. Berkeley
Bergen, Brianna	Earth Tech
Berman, Benjamin	E2C Inc.
Boushaki, Farid Ishak	Wildermuth Environmental, Inc.
Brown, James L.	Clear Water Compliance Services
Brown, Jason	Confluence Environmental, Inc.
Brown, Steve	RMC Water and Environment
Carmi, Angela	
Clark, John	URS Corporation
Cleary, Jenny	CRA
Culkin, Sean	MACTEC E&C
Curry, Debra	CaWSC, USGS
Deen, Sandy Willard	Glenn Colusa Irrigation District
Discar-Espe, Debra	San Diego County Water Authority
Dodson, Michael	Thermal Remediation Services
Duey, Kirsten	The Source Group, Inc.

Dugan, Bill	GeoRestoration, Inc.
Dumas, Leslie	RMC Water & Environment
ElHassan, Ali	Robertson-Bryan, Inc.
Endo,Takahiro	University of California, Davis
England, Jacquelyn	Conestoga Rovers & Associates
Erdelyi, Nasrin	Cal State Los Angeles
Fernandez,Bill	CDM
Field, Tom	Riverside Public Utilities
Fisher, Kari	California Farm Bureau Federation
Fitzwater, Phillip	Iris Environmental
Fleming, David	Thermal Remediation Services, Inc.
Fox, Nicole	SCS Engineers
Gadley, Kyle	Geosyntec Consultants
Gaines, Preston	Santa Clara Development
Gala, Satya	Robertson-Bryan, Inc.
Gillis, Ian	Schlumberger Water Services USA Inc.
Glantz-Murphy, Laurie	Accutest-Northern California
Glikman, Amilia	DOWNEY | BRAND
Gotberg, Nicole	Geosyntec Consultants
Hakakian, Mack	Riverside Public Utilities
Hanson, Erik	
Hey, Neil	Shaw Environmental
Higgins, Geniece	Orange County Health Care Agency
Hoelzel, Richard	Kings River Conservation District
Hopmans, Jan	University of California, Davis
Houghton, Barbara	Kern County EHSD
Hutson, Matt	BSK Associates
Ian, Jones	
James, Abaidu Daniel	JamesAD Business Ventures
Jones, Gail	ERAS Environmental, Inc.
Kalve, Erica	Environmental Science Associates
Kavanaugh, Michael	Malcolm Pirnie, Inc.
Kenline, George	San Bernardino County
Kenoyer, Galen	Kleinfelder
Kerns, Josh	Confluence Environmental
Kile, Mary Beth	ETIC Engineering Inc.
Kirby, Randy	Weiss Associates
Klamecki, Joseph	
Koster, Amber	URS Corporation
Lepine, Monique	
Langridge, Ruth	University of California, Santa Cruz
Lin, Edwin	Todd Engineers
Lind, Carl	Shaw Environmental
Maguire, Sean	Kennedy/Jenks Consultants
Manning, Ken	Chino Basin Watermaster
Manzano, Anthony	Riverside Public Utilities
McDonald, Elizabeth	Hewlett-Packard Company
McDonald, Jason	Sky Plus Investment
McFarlan, Renee	URS Corporation
Mettler, Charles	TRC

Meyer, Susan	San Jose State University
Mills, Suzanne	MWH Americas, Inc.
Moore, Cyndi	E.S. Babcock & Sons, Inc.
Morrison, Carl	Morrison & Associates, Inc.
Muehleck, Joe	ETIC Engineering
Munster, Jennie	
Nelson, Andrew	PW Environmental
Oaxaca, Jacob	MWH Americas, Inc.
O'Hagan, Joseph	California Energy Commission
Osmer, Dennis	Pajaro Valley Water Management Agency
Osornio, Daniel	Andreini & Company
Parkinson, David	Geosyntec Consultants
Parulekar, Nishant	RMC Water and Environment
Peterson, Alex	Kennedy/Jenks Consultants
Rathbun, Hugh	Dellavalle Laboratory, Inc.
Reed, Morgan	TEC Accutite
Rhoades, Matthew	MWH Americas, Inc.
Rodriguez, Larry	Robertson-Bryan, Inc.
Rosecrance, Ann	Conestoga-Rovers & Associates
Rossitto, Chris	Holdrege & Kull Consultants
Rowley, Paul	Golden State Water Company
Sakai, Danielle	Best Best & Krieger LLP
Scheuring, Chris	California Farm Bureau Federation
Schriener, Jr., Alexander	Earth Systems Southwest
Sharma, Rohit	California State University Fresno
Shulters, Jacqueline	URS Corporation
Smith, Cody	University of Nevada
Squyres, Drew	Pacific Gas and Electric Company
Stern, Michele	HDR Engineering
Su, Joy	
Terpolilli, Christopher	Shaw Environmental
Van Velden, Chris	Student
Vergara, Jose	Self
Wagner, Brian	U.S. Geological Survey
Ward, Walter	Modesto Irrigation District
Williams, John	Kleinfelder
Williamson, Richard	Borrego Water District
Xu, Xiuyuan	MACTEC
Zilles, Joe	BSK Associates
Zorba, Peter	City of Lancaster

BOX B: A Few Links between Aquifer Storage, Conjunctive Water Management, and Climate Change Adaptation — Continued from Page 25

streams in Washington, to the Everglades in Florida. This application of returning water stored in the aquifer back into streams can be particularly valuable when the water stored below the surface is at a cooler temperature than overheated streams during drought periods.

5) ***Increased Extreme Weather Events and Associated Natural Disasters.*** Several aquifer storage systems have been developed to provide protected storage of treated water for events in which surface water supplies, delivery infrastructure and water treatment capabilities are impacted (e.g. Des Moines, IA for floods; Walla Walla, WA for catastrophic fires; Charleston, SC for hurricanes). Integrating aquifer storage into regional water planning increases water reliability for seasonal variability in water supplies and demands, and emergency water-supply shortages. Water reliability includes availability of supplies as well as access to treated water, since many natural disasters can destroy water treatment and delivery systems, or cause increases in sediment and contaminant loads that would make treatment of water to drinking-water quality temporarily not possible with standard treatment processes.

6) ***Storage that Supports Restoration of Barrier Islands and Deltas through Sediment Delivery.*** Regulation of rivers through surface water storage inhibits sediment delivery to delta systems, including barrier islands. The impacts of river-mouth sediment delivery losses are significant with respect to ecosystems, coastal properties, and buffering of energy from coastal storms (e.g. Katrina). While aquifer storage systems often require diversion of water from surface waters, the aquifer storage zones themselves can provide a means of off-stream storage that does not inhibit sediment delivery to deltas and barrier islands, as well as to sand bar habitats such as the "Big Bend" in Nebraska.

Groundwater Recharge Using Recycled Water?

The California Department of Public Health (CDPH), formerly DHS, has just posted for review its latest draft regulations for Groundwater Recharge Reuse on its Web site. The comment period ends on October 31, 2008. The draft, dated August 5, 2008, reflects CDPH's current thinking on the regulation of recharge of groundwater with recycled municipal wastewater. Also on the Web site is a summary of the differences between the January 2007 version and this latest version. You can check them both out at: http://ww2.cdph.ca.gov/HealthInfo/environhealth/water/Pages/Waterrecycling.aspx.

Sacramento Branch Highlights

BY JOHN W. AYRES,
BRANCH SECRETARY

The Sacramento Branch hosted Karen Burow of the USGS National Water-Quality Assessment Program at the May branch meeting. Ms. Burow presented "Spatial and temporal trends in nitrate c*oncentrations in the eastern San Joaquin Valley.*" Ms. Burow is a hydrologist, and serves as technical groundwater specialist in the National Water Quality Assessment Program. Ms. Burow's presentation indicated that widespread areas with elevated concentrations of nitrate are present in the eastern San Joaquin Valley, ranging from areas with a median concentration of 16 mg/L (as N) to areas with a median of 3.7 mg/L. Historical data indicate that nitrate concentrations have slowly increased over the last several decades in both the shallow and deep parts of the aquifer system, with slower increases at depth. Current concentrations of nitrate in public-supply wells are likely to reflect the fertilizer application rate and land management practices of 40 to 50 years ago. Correspondingly, concentrations of nitrate in the future will reflect the fertilizer and land use management of more recent times, and will likely increase. The presentation indicated that if fertilizer application and land use practices do not change, it is likely that future nitrate levels in deep aquifers in the San Joaquin valley will be above the current MCL. If land-use practices change to reduce fertilizer use, nitrate levels in groundwater would eventually decrease.

In June, the Sacramento Branch hosted a discussion of "*Sacramento Valley Sand Petrographic Studies and Hydrostratigraphic Implications*," presented by Martin G. Steinpress, of Brown and Caldwell. Deep aquifer studies in Davis and the northern Sacramento Valley have included development of conceptual hydrogeologic models through the use of electric logs, well cuttings, water level and quality data, and aquifer testing; however, the delineation of the boundary of the Tehama and Tuscan Formations at depth is not well understood. A new line of evidence was recently developed through two petrographic studies. Composition of the sands in well cuttings was determined by petrographic analysis of thin sections. Composition of the sands is primarily the result of the composition of rocks in the drainage area of the streams or rivers that transported the sand to the depositional site. Thus, knowledge of the composition of the sand provides indications regarding the source of the sand, and aquifer morphology. The City of Davis test study provided conclusive evidence that the sands were from the Coast Ranges. The textural and mineralogical immaturity of the sands indicates a short travel time and distance, and rules out sands from the Cascades or Sierras. The preferential groundwater recharge direction can therefore be inferred to be from the northwest, in the vicinity of Putah and Cache Creeks. A larger regional study of 56 sand samples from the northern Sacramento Valley was used to help identify petrographic trends and petrofacies that were used to help refine identified interfingering of the Tehama and Tuscan Formations along cross-sections developed by the Department of Water Resources.

San Francisco Branch Highlights

BY BILL MOTZER,
BRANCH PRESIDENT

Twenty members and nonmembers and one student attended the June dinner meeting at Spenger's in Berkeley. Our speaker, Dr. John Karachewski, presented: *Western Geoscapes*. This presentation was a continuation and expansion of last year's presentation: *California Geoscapes*. John, an accomplished professional geologist, photographer, and guidebook author (with Doris Sloan: *Geology of the San Francisco Bay Region*, 2006, www.ucpress.edu), took us on an extended geological and hydrogeological tour of the western U.S. In approximately 43 unique and very colorful slides, beginning with the spectacular Oligocene igneous rock pinnacles of the Organ Mountains in New Mexico, we proceeded westward, viewing additional geoscapes such as the springs in the Redwall Limestone of Grand Canyon. In Arches National Park, near Moab Utah, John described the arches as the largest such concentration in the world and examples of differential erosion in sandstone. Other spectacular photos included the Mammoth Hot Springs in Yellowstone National Park, the John Day Oligocene fossil beds in Oregon, and the Channeled Scab Lands of eastern Washington – site of one of the largest known catastrophic floods in recent geologic history, where a Pleistocene ice dam broke releasing the 1,500 foot deep waters of Glacial Lake Missoula. We ended the tour with spectacular views of Alaska, Hawaii and Midway Atoll National Wildlife Refuge. John's extensive geological and hydrogeological knowledge was evident throughout the presentation, making it both educational and enjoyable. John's photography can be viewed at: http://www.geoscapesphotography.com.

Southern California Branch Highlights

BY GENIECE HIGGINS, BRANCH SECRETARY

The Southern California GRA Chapter was very busy during second quarter of 2008, starting with a meeting on April 30th at La Costa Mexican Restaurant in Montebello with an overview of the NASA/JPL plume in Pasadena, California. The presenter, Mr. Steve Slaten, project manager for NASA, has been overseeing sight clean-up for about 5 years. Upon his assignment in 2003, Mr. Slaten was optimistic that this would be a one-year project; however, due to the complexities of a multi-contaminant (perchlorate and VOCs) and media (soil and groundwater) cleanup, the underlying geology and aquifer systems, and local redevelopment plans, the remedial efforts continue. The site remediation includes a soil vapor extraction system for VOC removal, a pump-and-treat system and flushing of the aquifer at the site, and well-head treatment of water supply wells. To learn more about this Superfund site please visit http://jplwater.nasa.gov.

Photo of the event taken by Assistant Professor of Hydrogeology, Richard Laton. The unique vantage point is courtesy of his balloon-mounted camera. Thanks to Professor Laton and his CSUF students for providing this great picture!

The next event was a short two weeks later on May 14th in the southern portion of the So Cal GRA territory at El Adobe de Capistrano in San Juan Capistrano. The meeting featured a presentation by Mr. Richard Bell and Dr. Dennis E. Williams regarding the Dana Point Ocean Desalination Project. With the ever-growing need for groundwater in our region, the Dana Point Ocean Desalination project was initiated by the Municipal Water District of Orange County in order to investigate the feasibility of an ocean water desalination supply source to southern Orange County. Why ocean water desalinization? Ocean water provides a dependent water supply that is reliable and independent of the hydrogeologic cycle. The pilot test included an innovative near-horizontal drilling from the beach to a gravel layer under the ocean floor located near the mouth of a creek. This design will allow extraction of sea water through the gravel "filter" rather than directly from the ocean. The estimated $136 million project is expected to provide 15 million gallons of potable water per day utilizing a slant-well system where Doheny State Beach meets San Juan Creek. For more information on this Desalination Project please visit: http://www.mwdoc.com/documents/ProjectOverviewDanaPointOceanDesalinationProject-ExecutiveSummary.pdf.

Lastly, on June 11, 2008, the second annual So Cal field branch meeting was held at Cal State Fullerton, which attracted 40 GRA participants and six remediation vendors. The focus of this meeting was on remediation tools and methods, and included the following presenters to demonstrate their services and products:

- **EnviroSupply Services:** remediation equipment rental, pumps, thermal oxidizers, etc.
- **Regenesis:** in-situ remediation technologies, enhanced anaerobic and aerobic degradation, chemical oxidation
- **H_20 Engineering:** ozone generation equipment for in-situ groundwater remediation and ex-situ groundwater treatment
- **CalClean:** mobile high-vacuum dual phase extraction systems
- **JAG Consulting:** in-situ chemical oxidation [ISCO] engineering services
- **TestAmerica Drilling:** geoprobe rigs, chemical injection

The vendors provided pizza and soft drinks for the participants, which was very much appreciated. Each vendor spent about 5 minutes describing their services and products to the group. After the official presentations, participants were encouraged to visit each vendor individually to inquire about more specific information.

The So Cal branch also extends its sincere thanks to the following vendors for supporting our scholastic sponsorship program during the second quarter 2008: Aerotek, CalClean, Calscience Environmental Laboratories, EnviroSupply Services, H20 Engineering, JAG Consulting, Regenesis, and TestAmerica Drilling. Contributions are distributed through a fund for local University Geology students who are engaged in groundwater studies.

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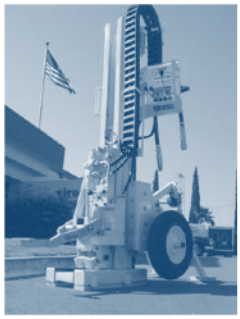

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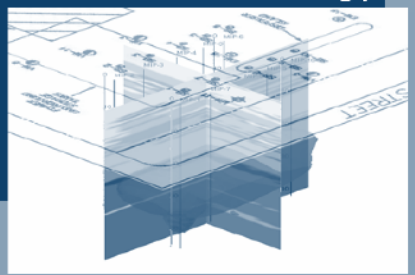

Todd Hanna
Southern California
Santa Ana

800-VIRONEX

John McAssey
Northern California
Pacheco

BRANCH CONTACTS

Central Coast Branch

e-mail: cc.branch@grac.org

President: Brad Herrema
Brownstein Hyatt Farber Schreck
(805) 882-1493
bherrema@bhfs.com

Vice President: Louie Hengehold
Hopkins Groundwater Consultants
(805) 653-5306
lhengehold.hgc@sbcglobal.net

Secretary: VACANT

Treasurer: Sam Schaefer
GEI Consultants, Bookman-Edmonston Division
(805) 729-4677
sschaefer@geiconsultants.com

Sacramento Branch

e-mail: dvajet@aol.com

President: David Von Aspern
Sacramento County EMD
(916) 875-8467
dvajet@aol.com

Vice President: Steve Lofholm
Golder Associates
(916) 786-2424
slofholm@golder.com

Secretary: John Ayres
Brown + Caldwell
(916) 444-1023
jayres@brwncald.com

Treasurer: Rodney Fricke
Aerojet
(916) 355-5161
Rodney.fricke@aerojet.com

Technical Advisory Member, Operations: Pat Dunn
Dunn Environmental
(916) 941-3851
pfdunn@dunnenviro.com

Technical Advisory Member, Scholastic: Julie Friedman
City of Sacramento
(916) 798-5074
jlfriedman1@aol.com

Technical Advisory Member: Kent Parrish
URS
(916) 679-2000
kent_parris@urscorp.com

Technical Advisory Member: Kevin Brown
Geocon
(916) 852-9118
brown@geocininc.com

San Francisco Bay Branch

e-mail: sf.branch@grac.org

President: William E. Motzer
Todd Engineers
(510) 747-6920
bmotzer@toddengineers.com

Vice President: Jennifer Nyman
Malcolm Pirnie, Inc.
(510) 735-3012
jnyman@pirnie.com

Secretary: John Karachewski
Weiss Associates at Lawrence Livermore
National Laboratory
(925) 424-5063
karachewski1@LLNL.gov

Treasurer: David W. Abbott
Todd Engineers
(510) 747-6920
dabbott@toddengineers.com

South Bay Coordinator: Mark Wheeler
Crawford Consulting, Inc.
mark@crawfordconsulting.com

Technical Advisor: James S. Ulrick
Ulrick & Associates
(925) 376-3721
julrick@ulrick.com

Technical Advisor: Carol Kendall
U.S. Geological Survey
(650) 329-4576
ckendall@usgs.gov

Technical Advisor and Scholarship Chair: Brendan P. Dooher
LFR
(510) 652-4500
brenbdan.dooher@lfr.com

Past President: Mary Morkin
Geomatrix Consultants, Inc.
(510) 663-4100
mmorkin@geomatrix.com

San Joaquin Valley Branch

e-mail: lisa.massie@amec.com

President: Bill Pipes
AMEC Geomatrix
(559) 264-2535
bill.pipes@amec.com

Vice President: Tom Haslebacher
Kern County Water Agency
(661) 871-5244
thaslebacher@bak.rr.com

San Joaquin Valley Branch – *Continued*

Secretary: Mary McClanahan
California Water Institute
(559) 278-8468
mmcclana@csufresno.edu

Treasurer: Christopher Campbell
Baker Manock & Jensen
(559) 432-5400
clc@bmj-law.com

Technical Advisory Member: Barbara Houghton
Houghton HydroGeolgic, Inc.
(661) 398-2222
barbara@houghtonhydro.com

Technical Advisory Member: Gres Issinghoff
RWQCB, Central Valley Region
(559) 488-4390
issinghoffg@r5f.swrcb.ca.gov

Technical Advisory Member: Bruce Myers
RWQCB, Central Valley Region
(559) 488-4397
myersb@r5f.swrcb.ca.gov

Southern California Branch

President: Emily Vavricka
emily.vavricka@dpra.com

Vice President: William Sedlak
Kennedy/Jenks Consultants
(949) 261-1577
BillSedlak@kennedyjenks.com

Secretary: Geniece Higgins
Orange County Health Care Agency
(714) 433-6263
ghiggins@ochca.com

Treasurer & Past President: Peter J. Murphy
Kennedy/Jenks Consultants
(949) 261-1577
PeterMurphy@kennedyjenks.com

Technical Advisor: Toby Moore
Golden State Water Company
(714) 535-7711
TobyMoore@gswater.com

Technical Advisor: Sheila Rogan
Tri Hydro
(714) 399-1560
srogan@trihydro.com

Technical Advisor: Paul Parmentier
Locus Technologies
(714) 333-1752
parmentierp@locustec.com

Dates & Details

GRA Meetings and Key Dates

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

GRA Course *Principles of Groundwater Flow & Transport Modeling*	**September 22-24, 2008** Redwood City, CA
GRA Workshop *Introduction to Practical Statistics*	**September 24, 2008** Costa Mesa, CA
GRA 17th Annual Meeting & Conference	**September 24-26, 2008** Costa Mesa, CA
GRA Course & Symposium *Applications of Optimization Techniques to Groundwater Projects*	**October 15-16, 2008** Sacramento, CA
GRA Board of Directors Meeting	**November 8, 2008** Oakland, CA
GRA Symposium *Emerging Contaminants*	**November 19-20, 2008** San Jose, CA
GRA Symposium *Groundwater Monitoring*	**February 25-26, 2009** Orange, CA
GRA/Univ. of CA Center for Water Resources Conference *Groundwater Salinity*	**March 24-25, 2009** Sacramento, CA
GRA Legislative Symposium *& Lobby Day*	**April 15, 2009** Sacramento, CA
GRA/IWA Conference Micropol & Ecohazard 2009 *Assessment & Control of Micropollutants/Hazardous Substances in Water*	**June 8-10, 2009** San Francisco, CA

HYDRO VISIONS

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915 L Street, Suite 1000
Sacramento, California 95814

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