HYDROVISIONS

Volume 17, No. 4 | Groundwater Resources Association of California | Winter 2008

Summary of the 17th Annual GRA Conference and Meeting *"Groundwater: Challenges to Meeting our Future Needs"*

COMPILED BY VICKI KRETSINGER AND TED JOHNSON, CONFERENCE CO-CHAIRS

The first speaker of the conference, Wendy Martin of the California Department of Water Resources (DWR), set the tone right up front with the catch phrase ***"Plan for the Worst but Hope for the Best"*** to describe our current water situation. This phrase provides a message that California is in dire times with our water supply, and we need to do some serious planning and project implementation now to meet our needs in the future if conditions do not improve. Reservoirs are at depleted levels, the drought continues, infrastructure is aging and fragile, water transfers are expensive and energy intensive, and humans must compete with the environment for the available water supply.

GRA's 17th Annual Conference and Meeting was held in Costa Mesa on September 25 and 26, 2008; optional activities preceded the conference on the 24th. The conference, themed ***"Groundwater: Challenges to Meeting our Future Needs,"*** included many fine presentations by experts throughout the state and country on how groundwater resources can be maintained and enhanced to help meet the water needs of the nation. Although presentations focused generally on California's ground-

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INSIDE

HydroVisions Going Online-Only in 2009

Our member survey indicated that over 60% would prefer an online version of *HydroVisions*. An online version also allows for a full-color, environmentally green product that we think you will enjoy. The first issue of 2009 will be accessible on the web via a link emailed to you, or directly from the GRA website. Downloads for printing will be supported.

To view more results from the member survey, please go to http://www.grac.org/survey.pdf.

Application of Optimization Techniques to Groundwater Projects — Event Summary

BY ROB GAILEY, R.M. GAILEY CONSULTING HYDROGEOLOGIST

GRA offered a pair of events on October 15 and 16 that focused on applying mathematical optimization, or operations research, techniques to groundwater projects. The half-day short course and full-day symposium were held in Sacramento and drew approximately 60 speakers and attendees. While mostly from California, some participants travelled from other western states and the East Coast in order to discuss this technical specialty that many agree will provide significant value to groundwater projects in the future. The group was enthusiastic and the discussions lively!

The short course, taught by Rob Gailey (R.M. Gailey Consulting Hydrogeologist), Chin Man Mok (AMEC Geomatrix), Tracy Nishikawa (USGS), and Eric Reichard (USGS), addressed both the motivations for using optimization techniques on groundwater projects and the details of how the technical work is performed. The

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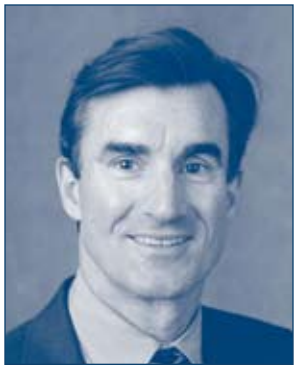

President's Message

BY JAMES STRANDBERG

Recognizing Contributors to GRA's Success in 2008

At GRA's Annual Meeting and Conference, the subject of the lead article in this issue of *HydroVisions*, the Awards Luncheon focused primarily on the two distinguished awards given by the Association: the Kevin J. Neese Award, and the Lifetime Achievement Award (please see articles in this issue for more on the Orange County Water District and Dr. Perry McCarty, the well-deserving award winners). I also had the pleasure of bestowing 2008 President's Awards to a number of individuals who provided a significant contribution to the organization during 2008. Four of the individuals contributed at the organizational level; the other four led highly successful events. The award recipients and their contributions are featured below.

Ted Johnson, Water Replenishment District of Southern California, is in his first term as a Director, serves as the Membership Committee Chair and led the development of the recent member satisfaction survey (see http://www.grac.org/survey.pdf for a summary and analysis of the results). He is also the Events Committee Co-chair and served as Co-chair of this year's Annual Meeting and Conference.

Steve Phillips, US Geological Survey, took over the important role of *HydroVisions* editor. This is a demanding role that he has taken full responsibility of and has worked tirelessly (and patiently) with the many contributors to enhance the high quality of GRA's quarterly publication. He serves on the Communications Committee and is involved in an initiative to redesign *HydroVisions*.

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GUEST EDITORIAL

California's Water Storage Problem, the Underworld and the Body

BY GRAHAM E. FOGG

While the scientific community has reached broad consensus on effects of climate change at the global scale, effects at the local scale or even subcontinental scales (e.g., California) is very much a research topic among climate and hydrologic scientists. Whether California becomes wetter or drier, however, we should anticipate less snow in the Sierra Nevada in the coming decades. Climate model projections suggest the

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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.

UNIVERSITY OF CALIFORNIA WATER RESOURCES CENTER ARCHIVES

California Colloquium on Water

CO-SPONSORED ANNUALLY BY THE GROUNDWATER RESOURCES ASSOCIATION AND OTHERS

According to the UC Water Resources Center Archives, "water is the lifeblood of California. Without it, the landscape we know today would not exist. Throughout California's history, water has been a source of food, commerce, energy, and recreation. It makes possible the bountiful Central Valley farms and the vibrant coastal cities. It has inspired countless poets and painters. Californians have simultaneously fought over water, marveled at its beauty, and – through impressive feats of engineering – moved it hundreds of miles."

"The popular lecture series, the California Colloquium on Water, continues. Scholars of distinction in the fields of natural sciences, engineering, social sciences, humanities, law and environmental design will offer monthly lectures. These lectures are designed to increase the understanding and appreciation among students, faculty and the general public of water resources and to contribute to informed decisions about water in California."

James Strandberg, GRA president, and Vicki Kretsinger Grabert, GRA director, attended the November 18, 2008 Colloquium lecture by Dr. Marious Sophocleous, Senior Scientist from the Kansas Geological Survey. Following the presentation, "*Groundwater Sustainability and its Application in Kansas*," Strandberg presented Dr. Sophocleous with GRA's book, California Groundwater Management (2005).

Upcoming Events

DTSC's Symposium on Global Perspectives on Green Remediation — Making Clean 'Green'

FEBRUARY 4, 2009
BYRON SHER AUDITORIUM, SACRAMENTO

SPONSORED BY CAL/EPA'S DEPARTMENT OF TOXIC SUBSTANCES CONTROL, IN COOPERATION WITH THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY AND GROUNDWATER RESOURCES ASSOCIATION

DTSC is hosting a free, one-day symposium, ***"Global Perspectives on Green Remediation--Making Clean 'Green'."*** The symposium will bring together both national and international environmental clean-up consultants, private and public entities restoring contaminated sites, Brownfields developers, academicians, and regulators. The purpose–bring "green" considerations into remediation decisions.

Speakers from England and Canada will contribute the international perspective. Other experts from both the private and public sectors will share case studies and tools for assessing the carbon footprint, health and safety risks and other environmental impacts from application of different treatment alternatives. The symposium will showcase DTSC's forthcoming Green Remediation Guidance and present breaking information on revisions to the guidelines for compliance with California Environmental Quality Act (CEQA), which will require consideration of the Greenhouse Gas emissions generated by new clean-up projects. Other presentations will cover U.S. EPA's Green Remediation Primer, prospects for a Green Remediation certification program, and their Climate Change & Contaminated Lands Initiative, as well as a technical white paper under development by the U.S. Sustainable Remediation Forum (SuRF).

The Symposium will be webcast live from Sacramento and videotaped. Links to the final program schedule, speaker biographies and presentation slides, as well as post-symposium video clips will be available at www.dtsc.ca.gov/OMF/Grn_Remediation.cfm. Registration is required for on-site attendance, and space is limited to 280 persons: Go to http://www.dtsc.ca.gov/OMF/green_remediation_registration.cfm. Webcast attendees are also encouraged to register to receive link-up information, information updates and notification of future symposia. For questions, assistance or special accommodations, please contact DTSC at least 30 days in advance at GreenRemSym@dtsc.ca.gov.

Upcoming Events

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

FEBRUARY 23-24, 2009
ORANGE, CA

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

Course Description

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

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

Experienced instructors with a broad in-depth knowledge of California groundwater and watershed hydrology will teach the course. Topics include:

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

Course Instructors

Randy A. Dahlgren, Ph.D., is a professor of Soil Science and Biogeochemistry in the Department of Land, Air and Water Resources at the University of California, Davis. His research program in biogeochemistry examines the interaction of hydrological, geochemical, and biological processes in regulating surface and ground water chemistry.

Thomas Harter, Ph.D., joined the faculty at the University of California, Davis, in 1995, where he is in charge of the Groundwater Hydrology Cooperative Extension program. His research focuses on characterizing and assessing nonpoint-source pollution of groundwater, on the statistical and hydrodynamic evaluation of groundwater resources where data are limited, on groundwater modeling, and on a better understanding of contaminant transport processes at a wide range of spatial and temporal scales.

Registration and Additional Information

Online registration and a printable registration form is available at grac.org. Discounts are available for participants who also register for GRA's Conference "Groundwater Monitoring: Design, Analysis, Communication & Integration with Decision Making," which follows the short course at the same location, February 25-26, 2008. For more information, contact Mary Megarry at GRA, mmegarry@nossaman.com or (916) 446-3626.

Upcoming Events

SAVE THE DATE

Joint 2010 Annual Meeting

Cordilleran Section of GSA – Pacific Section of AAPG

MAY 27-29, 2010

The 2010 Joint Annual Meeting of the Cordilleran Section of the Geological Society of America (GSA) and the Pacific Section of the American Association of Petroleum Geologists (AAPG) is scheduled for May 27-29, 2010 at Anaheim, California. The Cordilleran Section host is California State University Fullerton. A call for technical session proposals will be forthcoming in Summer 2009 with an expectation of a number of technical sessions on various aspects of hydrogeology.

Suggestions for session topics are welcomed! Please contact Jeffrey Knott (Technical Program Chair), Associate Professor at the Dept. of Geological Sciences, California State University Fullerton at jknott@fullerton.edu; or Phil Armstrong (Joint Meeting Chair), Associate Professor of Geology, Department of Geological Sciences, California State University Fullerton, parmstrong@exchange.fullerton.edu; or Vicki Kretsinger Grabert (GSA Hydrogeology Division Representative for the Cordilleran Section), Principal Hydrologist, Luhdorff & Scalmanini, Consulting Engineers, vkretsinger@lsce.com.

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

FEBRUARY 25-26, 2009
ORANGE, CA

Groundwater is a major component of the Nation's water supply, and groundwater monitoring is an essential tool for characterizing and managing this vital resource. The goal of this conference is to showcase recent developments in all phases of groundwater monitoring, including the design of monitoring networks, the analysis and interpretation of monitoring data, the communication of monitoring findings, and the role of monitoring in groundwater management and groundwater policy. The Conference will address such topics as:

- Design of groundwater quality monitoring networks on multiple scales, from detailed monitoring of contaminant sites to water-quality assessment on a statewide or national scale;
- Monitoring for assessing groundwater supplies and forecasting changes in basin storage;
- Role of monitoring in protecting and managing groundwater resources;
- Integration of monitoring with groundwater policy development;
- Statistical techniques for analyzing and interpreting monitoring data;
- Role of monitoring in groundwater modeling and model calibration;
- California's Groundwater Ambient Monitoring and Assessment (GAMA) program and the USGS's National Water Quality Assessment (NAWQA) program;
- Monitoring approaches for non-point source pollutants;
- Strategies for monitoring hydrologic processes in the vadose zone;
- Methods for collecting and managing groundwater data; and
- Communication of groundwater monitoring findings to the public and to policy makers.

Registration forms are available at grac.org. GRA is pleased to invite participants to sponsor Conference functions or to exhibit at the Conference. Please contact Mary Megarry at mmegarry@nossaman.com or 916-446-3626 for more information.

Upcoming Events

Groundwater Salinity: A Groundwater Dilemma

MARCH 24-25, 2009
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 elsewhere globally from increasing chloride concentrations in groundwater used for municipal supplies, to 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.

"Groundwater Salinity: A Groundwater Dilemma" is the 22nd 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
- impacts of increasing salinity on agriculture, urban water users, natural resources, industry, water providers, regulators, policy makers
- impacts from food processing, the dairy industry, agriculture, land application of wastewater, ponds and lagoons, and natural processes

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 and in aquifers
- 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;" mass balance approaches
- 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

Sponsors and Exhibitors

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.

Upcoming Events

Micropol & Ecohazard 2009

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

CONFERENCE CO-CHAIRS
PROF. DAVID SEDLAK, UNIVERSITY OF CALIFORNIA AT BERKELEY (SEDLAK@CE.BERKELEY.EDU)
DR. RULA DEEB, MALCOLM PIRNIE, INC. (RDEEB@PIRNIE.COM)

CONFIRMED PLENARY SPEAKERS
PROF. DAMIA BARCELO, CHEMICAL & ENVIR. RESEARCH INST. OF BARCELONA (IIQAB-CSIC), SPAIN
PROF. MARTIN JEKEL, TECHNICAL UNIVERSITY OF BERLIN, GERMANY
PROF. MICHAEL PLEWA, UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN, USA
DR. SHANE SNYDER, SOUTHERN NEVADA WATER AUTHORITY, USA

Conference Topics

- Environmental chemistry
- Advances in analytical methods
- Occurrence, fate, transport, process studies
- Modeling approaches
- Toxicity and risk assessment
- Biological effects in the environment
- Mixture toxicity
- Ecological risk evaluation and assessment criteria for effluents
- Approaches to determine the toxicological relevance in drinking water
- Wastewater treatment and water reuse
- New concepts and methods to reduce and/or remove micropollutants 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 during soil aquifer treatment, groundwater recharge and surface water replenishment efforts
- Stormwater overflow and sewer exfiltration
- Biosolids
- Fate, transport and removal in soil and groundwater
- Site investigation and remediation
- Modeling
- Case studies
- Regulations and management
- Wastewater, recycled water, groundwater, surface water, drinking water
- Urban water management
- River basin management
- Source control
- Drinking water treatment
- Fate and removal 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

Collaborating Organizations

- Dechema, Germany
- Department of Toxic Substances Control, California
- Federal Institute of Hydrology, Germany
- Global Water Research Coalition (GWRC)
- International Association of Hydrogeologists (IAH)
- Malcolm Pirnie, Inc., Independent Environmental Engineers, Scientists and Consultants
- Microseeps
- National Water Research Institute (NWRI)
- United States Environmental Protection Agency
- University of California at Berkeley
- Water Environment Research Foundation (WERF)

Student Presentation Awards

Students are encouraged to attend Micropol and Ecohazard 2009. Student participation in the conference should be valuable to career development. The platform and poster presentations and the exhibits will provide useful information about the work of a wide range of organizations. To help make it possible for more students to attend, the student registration fee is less than half the standard rate.

As an added feature of the conference, a student presentation competition will be conducted. The primary student author of each winning presentation (oral and posters) will be recognized during the conference's closing session. Significant financial awards will also be presented to the student winners.

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Micropol & Ecohazard 2009 –

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Eligibility. The primary author must be a full-time student when the abstract is submitted. Abstracts may list faculty advisors as co-authors, but the conference presentation (oral or poster) must be made by the student.

Criteria. Review criteria will be originality of the research, technical approach, data interpretation and presentation, and general relevance to the scope of the conference.

Inquiries. Questions about the student presentation awards may be directed to Rula Deeb (rdeeb@pirnie.com).

Sponsors and Exhibitors

IWA and GRA are pleased to invite participants to become conference Co-Sponsors or Exhibitors. Exhibits should demonstrate recent and cutting-edge technologies related to environmental chemistry, wastewater treatment, drinking water treatment, potable reuse, ecotoxicology, environmental risk assessment and human toxicology related to micropollutants. For additional information about Sponsor and Exhibitor opportunities, please go to http://www.grac.org/micropolsponexhib.doc.

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, E-Mail: mmegarry@nossaman.com, Website: http://www.grac.org/micropol.asp

Upcoming Events

NGWA Groundwater for the Americas Conference: Call for Abstracts

DUE JANUARY 9, 2009

SUBMITTED BY CLIFF TREYENS, NGWA PUBLIC AWARENESS DIRECTOR

The National Ground Water Association (NGWA) seeks abstracts by January 9, 2009 for presentations at the Groundwater for the Americas conference to be held June 8-10, 2009, in Panama City, Panama. The conference is co-sponsored by the International Association of Hydrogeologists (IAH) and the La Asociación Venezolana de la Industria de las Aguas Subterráneas (or AVIAS, Aguas Subterraneas).

This three-day event provides an opportunity for all who work in the groundwater community to address a broad spectrum of issues that inhibit efficient and effective groundwater management strategies. The conference is intended to foster dialogue among peoples of the Latin American region about how they can best manage water resources in the context of socioeconomic and cultural realities.

At first 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. Efforts to protect groundwater from further degradation and extend its period of use traditionally have focused on improved water management. As enunciated in the United Nations International Hydrology Programme IHP-VII themes and the proposed actions of the Alicante Declaration, effective groundwater management must take into consideration the broader socioeconomic and cultural conditions that affect societal well-being.

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

- Environmental and ecological impacts on groundwater sustainability
- Groundwater, rain forests, and watersheds
- Salt water 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
- Community-based water resources management planning
- Managed aquifer recharge and conservation as components of sustainable water resources management.

Wells and Words

Technical Corner

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

Well screen aperture size selection for an artificial filter packed well, 90% (D_{90}) or 10% passing rule

This article is the second of two parts. Part 1 described selection of well screen aperture size for a naturally developed well: that is applied aptly to cable tool drilling methods. This article describes the selection of an artificial filter pack and complementary well screen aperture size that can be applied to cable tool and rotary drilling methods. Choosing the correct filter pack, screen design, and matching aperture size are vital to successful operation of production wells and to collection of reliable water quality samples from monitoring wells.

The well screen serves the same purpose as described for a naturally developed well, except that it will retain the surrounding filter pack instead of aquifer materials. The filter pack is placed in the annulus between the well screen and borehole; this envelope increases the effective hydraulic diameter of the well.

Filter pack designs are used to offset uncertainty of formation textures and sample locations, to increase well yields in fine-grained or highly-stratified aquifers, or to stabilize the annulus in consolidated formations. The filter pack is more permeable than most aquifer materials and will mechanically retain the aquifer's finer-grained fractions. However, the filter pack is also a secondary filtering barrier consisting of non-native materials placed between the screen and the aquifer, which can decrease the well's specific capacity, especially as the well ages. Filter pack material should be well-sorted, well-rounded particles, clean, siliceous, and free of silt, clay, shale, organic matter, gypsum, and carbonate materials. Selection of a filter pack gradation is based on the aquifer's particle-size distribution. See Part 1 where I discussed the procedures for particle-size distribution analysis.

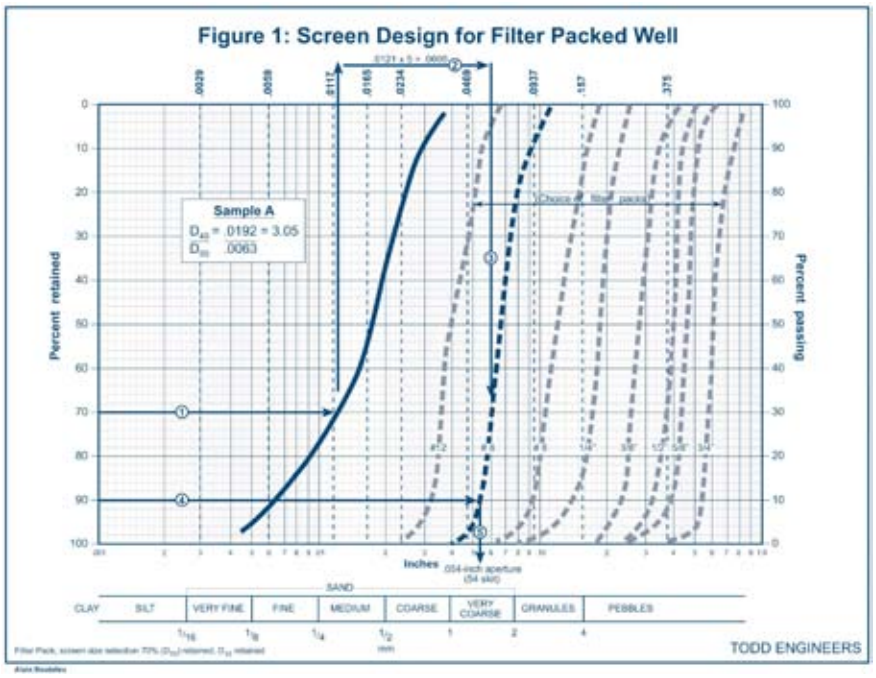

Figure 1 shows an example of procedures used to select proper filter pack and matching screen aperture size. Sample A is a fine- to coarse-grained sand with a uniformity coefficient of about 3.05. Particle distribution curves for eight commercial filter pack materials from the same supplier are shown on the right side of the graph (dashed particle distribution curves). The supplier provides product labels for each filter pack (No. 2 to ¾-inch). Beware that these labels are not standardized and different suppliers may have different labels for similar filter pack gradations. Procedures to select the well design criteria for Sample A are shown on Figure 1.

Step 1: determine the 70% retained (D_{70}) or 30% passing grain size for Sample A (0.0121-inches). Step 2: multiply D_{70} by a scaling factor ranging between 4 and 10 (5 is used routinely; 0.0605-inches). Step 3: determine which filter pack has a D_{70} of 0.0605-inch (No. 8). Step 4: use the 90% retained (D_{90}) on the Y-axis projected to the selected filter pack from Step 3 to determine the complementary screen aperture size. Step 5: select the aperture size on the X-axis (0.054-inch or 54 slot). Sample A would require a No. 8 (very coarse sand) from this supplier and a 54 slot screen. If multiple formation samples are analyzed, the filter pack should be selected for the aquifer's finest-grained material.

The scaling factor can range between 4 and 10. If the formation is uniform or the D_{40} of the formation material is less than 0.010-inch, then a finer-grained filter pack would be recommended, corresponding to a scaling factor of 4 to 6. For example, using a scaling factor of 4, the D_{70} of the filter pack selection is 0.0484-inch or halfway between a No. 8 and No. 12. A smooth filter pack distribution curve can be drawn parallel to adjacent curves intersecting the

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The Federal Corner

BY JOHN UNGVARSKY,
U.S. ENVIRONMENTAL
PROTECTION AGENCY

Federal Legislative/Regulatory Corner

US Geological Survey Investigations of Ground-Water Quality

The September/October issue of Journal of Environmental Quality features in-depth USGS investigations of national and regional trends in ground-water quality in the US. The investigations, primarily focusing on nitrate, pesticides, and pesticide degradates, highlight national trends over the last 10-15 years, including increasing concentrations of nitrate in ground water in selected aquifers underlying agricultural areas associated with oxygenated conditions and well-drained soils. National analyses also show decreasing trends, overall, in selected agricultural pesticides, such as atrazine. To access the papers, go to: http://jeq.scijournals.org/content/vol37/5_Supplement/.

EPA Releases Final Climate Change Strategy

EPA's National Water Program Strategy: Response to Climate Change provides an overview of the likely effects of climate change on water resources and the Nation's clean water and safe drinking water programs. This final strategy also describes 40 specific actions the National Water Program intends to take to adapt program implementation in light of climate change. For more information, go to: http://www.epa.gov/water/climatechange/.

EPA Preliminary Decision Regarding Perchlorate

EPA conducted extensive reviews of scientific data and found that in more than 99% of public drinking water systems, perchlorate was not at levels of public health concern. Based on the Safe Water Drinking Act criteria, EPA has made a preliminary determination that there is not a "meaningful opportunity for health risk reduction" through a national drinking water regulation. EPA plans to issue a final regulatory determination for perchlorate by December 2008.

EPA Determines Regulations Not Needed for 11 Potential Contaminants

EPA has made a final determination not to regulate 11 contaminants on the second drinking water contaminant candidate list. The agency's final regulatory determination is based on extensive review of health effects, occurrence data and public comments. EPA will update health advisories for boron; dacthal mono- and di-acid degradates; 1,3-dichloropropene (Telone); 2,4-dinitrotoluene, 2,6-dinitrotoluene; and 1,1,2,2-tetrachloroethane. EPA has determined that updated or new health advisories are not needed for 1-dichloro-2,2-bis(p-chlorophenyl) ethylene (DDE); s-ethyl propyl thiocarbamate (EPTC); Fonofos; and Terbacil, because the national monitoring data showed almost no occurrence at levels of public health concern. For more information, go to: http://epa.gov/safewater/ccl/index.html.

USGS Research Helps Address Arsenic Standards

The Antelope Valley of northern Los Angeles County has high levels of naturally occurring arsenic. To meet the new arsenic standard, Los Angeles County Waterworks District No. 40 initiated a well-modification project based on findings of a USGS investigation. The District sealed off permanently the deep portions of five wells, while preserving the ability to pump high-quality water from the upper sections. Average arsenic concentrations are 84 percent lower, and yields decreased by only 24 percent. For more information, go to: http://pubs.usgs.gov/fs/2008/3043/.

Remediation of Drycleaners

The State Coalition for Remediation of Drycleaners (SCRD) has developed a report summarizing its accomplishments since 1998 to improve and ensure the effectiveness of the cleanup at drycleaner sites. The effort was supported from EPA's Technology Innovation and Field Services Division and the National Ground Water Association. For more information, go to: http://www.drycleancoalition.org/download/scrd_10_year_report.pdf.

Nanotechnology for Site Remediation

Nanotechnology holds promise in cost effective site remediation and addressing challenging site conditions, such as the presence of dense nonaqueous phase liquids. EPA has created a fact sheet to help site project managers understand the potential applications of this group of technologies. For more information, go to https://www.clu-in.org/download/remed/542-f-08-009.pdf.

Following Items are from AGI Government Affairs Monthly Review, October 2008

DOE Releases Methodology for Estimating Storage Potential of Carbon Dioxide

The U.S. Department of Energy (DOE) released its Methodology for Development of Geologic Storage Estimates for Carbon Dioxide on October 1, 2008. This document describes the methodology used to estimate carbon dioxide storage potential. The document will be included as an appendix in the second edition of the Carbon Sequestration Atlas of the United States and Canada. The full report is available at: http://

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Chemist's Corner

Paper or Plastic? Life Cycle Analysis and Groundwater Protection

BY BART SIMMONS

The choice of paper or plastic bags for groceries symbolizes the complexity of making decisions which minimize environmental impact. Life Cycle Impact Analysis (LCA) has emerged as a critical tool for estimating the environmental effects of products and services from cradle to grave. An international standard for LCA has been adopted as ISO 14040.

LCA is only as good as the databases used for input. For example, when I took a life cycle assessment class a few years ago at U.C. Berkeley, we were unable to compare the impacts of organic farming with conventional farming, because the data collected by the U.S. government did not differentiate the two. LCA typically uses generalized data, and may not be useful for specific local conditions.

LCA may yield ambiguous results. An article in the journal Science illustrated this problem where LCA was applied to the choice of a paper or Styrofoam coffee cup. The analysis proved to be very complex, and the winner not obvious.

Transparency is important. A recent article (Evniron Sci Technol, 2008, 42, 7032-7037) stressed the importance of transparency and consistency in the development of USEtox, a consensus model recognizing the joint efforts of the United Nations Environment Program (UNEP) and the Society of Environmental Toxicology and Chemistry (SETAC). One task of the effort was to identify the important metrics of impact. Not surprisingly, the soil and water concentrations were selected as the metric of ecosystem exposure. Two issues related to the fate of chemicals in soil were 1) the choice of a homogeneous versus vertically layered soil compartment, and 2) a generic soil versus division among agricultural, industrial, and natural soils. The work group recognized the difficulty in estimating the impact of inorganic pollutants, and therefore started with organics.

Batch extraction tests, like the Toxicity Characteristic Leaching Procedure (TCLP), Waste Extraction Test (WET), and Synthetic Precipitation Leaching Procedure (SPLP), were all developed with some intent to simulate leaching of inorganics over the lifetime of disposed wastes or soil contaminants left in situ, but are crude predictors when compared with LCA. Limitations of the batch extraction tests have been documented; however, because some, particularly the TCLP and WET, are incorporated into regulations, interpretation of the results is limited. How can the established protocols of the TCLP, SPLP, or WET be reconciled with a life cycle analysis?

Two problems identified by the UNEP-SETAC work group were 1) the lack of characterization factors for some chemicals, and 2) the variability of characterization factors among the existing models.

The lessons at this time seem to be that LCA plays a critical role in sustainability programs, but the details of LCA applied to groundwater protection will require transparent models and improvements in the available models, particularly for inorganics.

Bart can be reached at bartonps@aol.com.

Alliance Corner

International Association of Hydrogeologists

Interested in articles on both theoretical and applied aspects of hydrogeological science, including worldwide progress in techniques and innovations?

The International Association of Hydrogeologists (IAH) publishes the *Hydrogeology Journal* (8 issues/year); this is one of the major cited international journals dealing with peer-reviewed papers on groundwater issues and related topics.

The first issue of the year focuses on a theme or topic;

- 2009 is Ecology of Groundwater Systems,
- 2010 is Coastal Aquifers & Seawater Intrusion,
- 2011 is Natural Tracers in Hydrogeology.

IAH membership, which includes the Hydrogeology Journal, is $102 to receive hard copies of the Journal and $88 for an online subscription. Students enjoy a discounted price of just $51 ($37 for online only). For more information about IAH, its programs, and membership benefits, visit the IAH web site at http://www.iah.org/. Or, contact Mike Wireman, Chair of the IAH US National Chapter, at Wireman.Mike@epamail.epa.gov.

Educational Initiatives

Two key educational initiatives are under way that GRA would like you to be aware of, and consider participating in.

The EARTH Science Literacy Initiative, funded by NSF, aims to gather and summarize the underlying principles of Earth Sciences in a wide variety of research fields to succinctly present what all citizens should know about Earth Sciences. See http://www.grac.org/esli.pdf.

Fortune 1000 executives have expressed concern about Science Technology Engineering and Mathematics (STEM) education. More than half (55%) reported their companies are already experiencing a shortage of American-trained STEM talent, and 95% say that the US is in danger of losing its global leadership position in science and technology because of this shortage. See http://www.grac.org/stem.pdf.

GRA Extends Sincere Appreciation to its Co-Chairs and Sponsors for its September 2008 *17th Annual Conference and Meeting*

Co-Chairs
Ted Johnson, Water Replenishment District of Southern California
Vicki Kretsinger, Luhdorff & Scalmanini, Consulting Engineers

Co-Sponsors
Kennedy/Jenks Consultants
Roscoe Moss Company

Luncheon
Environmental Resolutions, Inc.

Reception
Malcolm Pirnie, Inc.

GRA Extends Sincere Appreciation to its Co-Chairs and Sponsors for its October 2008 *Applications of Optimization Techniques to Groundwater* Symposium

Co-Chairs
Rob Gailey, R.M. Gailey Consulting Hydrogeologist
Chin Man Mok, AMEC Geomatrix

Co-Sponsor
AMEC Geomatrix

GRA Extends Sincere Appreciation to its Co-Chairs and Sponsors for its November 2008 *Emerging Contaminants* Symposium

Co-Chairs
Thomas Mohr, Santa Clara Valley Water District
Jennifer Nyman, Malcolm Pirnie, Inc.

Co-Sponsors
AMEC Geomatrix
Malcolm Pirnie, Inc.

Luncheon
Environmental Resolutions, Inc.

Refreshment
ProHydro/Snap Sampler

Organizational Corner

State Mining and Geology Board Member Seena Hoose Passes Away

SACRAMENTO -- State Mining and Geology Board (SMGB) board member and world-renowned expert on groundwater geology Seena Hoose passed away September 16, 2008 after a brief illness.

"Mrs. Hoose was a dedicated public servant and an outstanding scientist who we will miss personally and professionally," California Department of Conservation Director Bridgett Luther said.

Mrs. Hoose, 67, of Cupertino, served on the SMGB's Geohazards, Minerals & Geologic Resources, and Policy & Legislation committees.

"Having worked with Mrs. Hoose for the last three years, I am deeply saddened by her death," SMGB Executive Officer Stephen Testa said. "This is a tremendous loss for the Board. Mrs. Hoose brought a great deal of experience and perspective to us, worked tirelessly on behalf of the residents of California, and had the respect of all of those with whom she worked, served and regulated. When the Board was considering matters, she was always the first to remind us that the Board serves the public's interest."

Mrs. Hoose was an engineering geologist for the Santa Clara Valley Water District when appointed to the SMGB by Governor Schwarzenegger in March 2005. From 1993-2001, she served on the Board for Geologists and Geophysicists at the appointment of Governor Wilson. Mrs. Hoose served as associate geologist for the San Francisco Bay Regional Water Quality Control Board and research geologist for the United States Geological Survey. She was a registered geologist, certified engineering geologist, and certified hydrogeologist. In the early 1970s, she authored one of the leading papers about the phenomenon of earthquake-caused liquefaction while with the United States Geological Survey.

Mrs. Hoose was the second woman in the University of California system to receive a Bachelor of Science degree in Geology. She earned her undergraduate degree at the University of California-Santa Barbara and her master's in geology from San Jose State University.

Mrs. Hoose was a member of the Geological Society of America, Association for Women Geoscientists, Association of Engineering Geologists and Groundwater Resources Association.

Mrs. Hoose is survived by her husband Robert, sons Shawn and Rowan, and Shawn's wife, Dori.

The above obituary is from a news release from the State Mining and Geology Board (SMGB).

Renew Your Membership Online – It's Quick and Easy

It's time to renew your GRA membership for 2009. You can renew online via GRA's Web site, www.grac.org, or you can request a hard copy dues renewal invoice from Kevin Blatt at kblatt@ihappi.com. To save time and effort, GRA recommends that you renew online as the process is secure and seamless. It will also help GRA to keep related expenses to a minimum.

As GRA approaches 2009 with nearly 1,400 members, the goal of having 1,500 members by the end of 2009 is attainable. To make this happen, please renew your membership and recruit one new member to GRA. Recruiting a new member is a way to introduce your colleagues to a credible, innovative organization that provides many benefits for only $100 (the same rate as in 2008).

Thank you for your interest and continued participation in protecting and improving California's groundwater resources.

GRA 2009 Officers Elected

The GRA Board of Directors elected the following officers for 2009: James F. Strandberg, President; William Pipes, Vice President; Roy Herndon, Secretary; and David Von Aspern, Treasurer. Congratulations to all of you for being elected.

Organizational Corner

Groundwater Resources Association Kevin J. Neese Award Presented to the Orange County Water District

BY JAMES STRANDBERG, GRA PRESIDENT

The Kevin J. Neese Award recognizes a significant accomplishment by a person or entity within the most recent 12-month period that fosters the understanding, development, protection or management of groundwater.

James Strandberg, GRA president, presented the Kevin J. Neese Award to the Orange County Water District (OCWD). Stephen Sheldon, OCWD Board president, accepted the award on behalf of the District.

GRA president James Strandberg (l) presents the Kevin J. Neese Award to Orange County Water District board of directors president Stephen Sheldon (r).

OCWD, a special district formed by the State of California in 1933 to manage and protect the Orange County groundwater basin, was honored for its Groundwater Replenishment System (GRS), a new water purification plant that became operational last January. The new facility replaces the world famous Water Factory 21 and produces 70 MGD of near-distilled-quality water each day. The GRS takes already treated sewage that is normally discharged into the ocean, purifies it through a three step process, and then conveys the water to mix with groundwater supplies. The three treatment processes used are: microfiltration, reverse osmosis, and ultraviolet light with hydrogen peroxide. The facility provides enough water for 500,000 residents annually at 265,000 cubic meters per day and has the ability to expand to accommodate future growth and demand. OCWD provides approximately two-thirds of Orange County's water supply. This varies year to year depending on groundwater supply availability.

OCWD remains an international leader in groundwater management and water reuse, has won multiple awards, including the distinguished Stockholm Industry Water Award, and is helping local communities, including Los Angeles, to create their own version of the GRS. A number of conference attendees thoroughly enjoyed a field trip of the massive plant and groundwater recharge facilities as part of GRA's Annual Meeting. In his acceptance speech, Mr. Sheldon praised the work of OCWD technical and managerial staff, and credited his fellow Directors in making the GRS a reality.

Organizational Corner

GRA Welcomes the Following New Members

AUGUST 22, 2008 – NOVEMBER 14, 2008

Abadie, Megan	San Jose State University
Ackerman, Corine	PRIMA Environmental, Inc.
Beach, James	LBG-Guyton Associates
Beran, John	ENSR – AECOM
Birk, Gary	EOS Remediation
Blute, Nicole	Malcolm Pirnie, Inc.
Cameron, Stephen	Environmental Guidance, LLC
Carlton, Stephen	Geotrans Inc.
Carreno, Orlando	Basin Water
Chong, Bennett	Water Replenishment District
Conner, Kenn	Brown and Caldwell
Dunphy, Jill	
Durkin, James	ERS
Fitzwater, Phillip	Iris Environmental
Foglia, Laura	Larry Walker Associates
Fourie, Jaco	Dunn Environmental
Glick, Cathrene	Geosphere Consultants
Gorey, Tim	Central Arizona Project
Haney, Robert	Basin Water
Houston, Kelly	ARCADIS
Jordon, David	INTERA
Karz, Allen	Allen E. Karz, MD
Kovacs, Robert	Geosyntec Consultants
Lee, Cathy	City of Roseville
Lockwood, Brian	Pajaro Valley Water Management Agency
Lundberg, KAte	Larry Walker Associates
MacLeod, John	Chevron EMC
Maurath, Garry	URS Corporation
Menna, Greg	Brown and Caldwell
Molla, Natasha	Chevron Environmental Management Company
Munster, Jennie	Balance Hydrologics
Newman, James	Napa County Department of Environmental Management
Noren, David	EBA Engineering
O'Keefe, John	Calcon Systems, Inc.
Polenghi-Gross, Isabella	AMEC Geomatrix, Inc.
Pollack, Kelly	Geosyntec
Preece, Jason	ENGEO
Radyk, John	Weiss Associates
Reyes, Yvonne	
Rogers, Mark	Basin Water
Ross, Christopher	Hargis + Associates, Inc.
Schratz, Pete	Calcon Systems, Inc.
Shepard, Andrew	Earth Tech AECOM
Smith, Ryan	Calcon Systems, inc.
Tesfamichael, Aklilu	Geosyntec Consultants
VanerMarck, Monique	San Jose Water Company
Villaroman, Cathy	Geosyntec Consultants
Wallace, Glen	Pacific Groundwater Group
Wilson, Craig	Stoel Rives LLP

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water picture, many were applicable to any groundwater basin. A summary of the conference topics follows.

Pre-Conference Activities

Three optional pre-conference activities were offered by GRA. Dr. Dennis Helsel conducted a short course titled "Introduction to Practical Statistics" that provided students with valuable tools to analyze the diverse, large data sets often collected during site investigations. The course offered some of the newer nonparametric and permutation tests for scientific applications and showed some of the common pitfalls of traditional statistical methods. Also offered was a field trip hosted by Roy Herndon of the Orange County Water District (OCWD) to visit OCWD's facilities, including their surface water spreading grounds, one of their seawater intrusion barrier injection wells, and the recently completed state-of-the-art 70 mgd advanced wastewater treatment facility known as the Groundwater Replenishment (GWR) System. The GWR System uses microfiltration, reverse osmosis, advanced oxidation, and other methods to purify water prior to groundwater recharge at the seawater barrier and spreading basins. Concluding the day's events was the Annual Conference Dinner Meeting held in conjunction with GRA's Southern California Branch. Attorneys Bill Kruse and Russ McGlothlin presented two very good talks on the groundwater storage framework being developed in the Central and West Coast basins. They described the challenges that have been faced during nearly 8 years of negotiations among multiple parties on ways to manage up to 450,000 acre-feet of potential storage in these basins.

Conference Opening and Plenary Session

(James Strandberg (Welcome) and Ted Johnson and Vicki Kretsinger, Moderators)

The conference opened on September 25 with welcoming comments by GRA President Jim Strandberg and a thank-you to the sponsors, cooperating agencies, conference committee, and exhibitors by conference co-chair Ted Johnson. Vicki Kretsinger, conference co-chair, opened the Plenary session by emphasizing that the 2008 Annual Conference involves presentations describing the challenges we face to meet future water needs and the important role groundwater plays. As indicated in DWR's 2005 California Water Plan, we are on the cusp of a fundamental transition in how we view water management in California. Three invited Plenary session speakers, Wendy Martin, Executive Program Manager and Statewide Drought Coordinator of DWR; Jeffery Kightlinger, General Manager and Chief Executive Officer of Metropolitan Water District (MWD); and William Alley, Chief of the Office of Ground Water of the U.S. Geological Survey (USGS) provided presentations aligned with the conference theme.

Wendy Martin reported that California is facing a significant water crisis. Two drought years and record dry spring conditions have depleted the reservoirs, and water deliveries from the Delta have been reduced by 20 to 30 percent. Looking ahead, conditions appear grim. The resiliency of the state's water system is severely diminished, and impacts to agricultural operations are severe. The Delta is the nexus of a delicate balance between maintaining ecosystem health and water quality, and avoiding flood risk and subsidence. She emphasized that there is no one strategy to fix all problems in the Delta. The Delta Vision process, and subsequent implementation, is critical to developing an integrated regional approach for protecting the Delta ecosystem and improving reliability of the state's water supply. The solution will require additional surface water and groundwater storage.

Jeff Kightlinger described MWD's groundwater production and use of surface water storage reserves during the past two years. MWD's main sources of supply include imported water from the Colorado River and the Delta, which face unprecedented challenges because of dry conditions and restrictions imposed on Delta pumping. The Colorado River experienced the driest year ever in 2003; since that time, MWD's river water supplies have diminished by as much as 50%. MWD considers water conservation a vital water management tool and has heightened its request to consumers and businesses to reduce water use and waste. Beginning in 1990, MWD increased the groundwater stored in its basins. Jeff emphasized that if 2009 becomes another drought year, MWD will be withdrawing groundwater from what it terms "emergency storage supply," and they will simply be "running out of cards to play." MWD supports partnerships in the Delta and urgently encourages development of ways to balance ecosystem needs with the need for a functional water system. Jeff stressed that, currently, the Delta is a "broken delivery system," and MWD "can't access the water they have." MWD has joined with agencies in Arizona and Nevada to fund construction of a new reservoir to increase operational flexibility along the Colorado River.

William Alley began his presentation with some basic questions about our national groundwater supplies. Do we know how much we have? Are we running out? Where are groundwater resources most stressed? Where are resources most available for future supplies? He provided a retrospective on historical studies relating to these questions, including the epic works of O.E. Meinzer, *The Occurrence of Ground Water in the United States, with a Discussion of Principles* (1923), and other studies through the decades. Studies to date have provided important information, but new information developed using new methods and technologies needs to be incorporated with the historical data. He emphasized the need to maintain long-term monitoring programs, periodically repeat resource evaluations, and integrate the information to better understand the response of groundwater systems to changed conditions. He described the increasing complexity of water resource utilization and augmentation, including enhanced groundwater storage through artificial recharge. The increasing importance of optimal management of our water resources is driving a number of data and information needs. These include consistent water-use databases; annual and seasonal

GRA Annual Conference attendees tour the Groundwater Replenishment System.

data; site-specific data on withdrawals and return flows; better tracking of the human-influenced redistribution of water; and improved remote sensing applications. Across the U.S., groundwater level declines in excess of 40 feet have occurred since predevelopment; and, on a national scale, these groundwater depletions are increasing over time (see the recently released USGS Circular 1323, *Ground-Water Availability in the United States* at http://pubs.usgs.gov/circ/1323/).

William Alley then described a national program to ultimately assess 30 to 40 regional aquifer systems, or about 94 percent of the Nation's groundwater use. These assessments will emphasize the integrated use of monitoring data, groundwater modeling, and other information to evaluate the status of groundwater resources in the context of the complete water budget for each aquifer system. Key products that provide benefits at the state or local level include the regional modeling studies, which evaluate available data and existing monitoring networks and identify data gaps, and also the completed models that can be used as a tool to evaluate water resources management strategies. Identification and testing of new approaches to regional assessments will be an important part of the studies, and the results of these efforts will provide useful information to other programs and agencies involved in monitoring. He reported on the work of the federal Advisory Committee on Water Information (ACWI) and the Subcommittee on Ground Water (SOGW). The SOGW's overall goal is to develop and encourage implementation of a nationwide, long-term groundwater quantity and quality monitoring framework that would provide information for the planning, management, and development of groundwater supplies to meet water needs and ecosystem requirements. This national framework for groundwater monitoring would be developed to assist in providing data and information needed to assess the quantity of U.S. groundwater reserves, as constrained by quality. A report from the ACWI Subcommittee is anticipated later this year that includes recommendations on data collection, storage, and retrieval to facilitate data sharing and maximize the investments in, and benefits of, groundwater monitoring.

Surface Water/Groundwater Interactions

(Eric Reichard, Moderator)

Jay Jasperse (Sonoma County Water Agency [SCWA]) described the unique Riverbank Filtration System and the complex surface water/groundwater interactions along the Russian River in Sonoma County. The Filtration System, one of the largest in the world, consists of collector wells, vertical wells, infiltration ponds, and an inflatable dam. SCWA is applying a variety of methods to better understand the system dynamics. Temperature-based analyses help quantify seasonal trends in recharge and provide estimates of hydraulic conductivity and stream conductance. Geophysical methods, including tomographic radar, resistivity, and spontaneous potential, provide information on water content and movement. Potential pathogen removal is being assessed using both in-situ and column studies.

Michael Donovan (Psomas) presented a framework for incorporating ecohydrology into the assessment of development impacts. Three key aspects of ecohydrology identified by UNESCO are regulation, integration, and harmonization. Subareas of ecohydrology are construction, resources management, species management, and sustainability. Resources management includes assessment of the impact that groundwater development has on hydrologically dependent habitat.

Joe Hevesi (USGS) presented an overview of the new Integrated Ground-Water Surface-Water Flow Model (GSFLOW). GSFLOW couples the Precipitation-Runoff model, PRMS, with MODFLOW. Precipitation is partitioned between evapotranspiration, runoff, infiltration, and storage by balancing daily energy and mass budgets of the snowpack, soil zone, and unsaturated zone. Coupling PRMS with MODFLOW allows recharge, evapotranspiration, and runoff to be explicitly simulated, rather than specified as boundary conditions. GSFLOW can be applied to address issues such as groundwater development, conjunctive use, ecohydrology, and climate change.

Watershed Water Quality Management

(Richard Laton, Moderator)

This session included presentations on regulatory challenges, regulatory successes and new geophysical techniques for urban groundwater studies.

Pamela Creedon, Executive Officer, Central Valley Water Regional Water Quality Control Board (RWQCB), presented the various challenges and successes her board has had in dealing with watershed management. She talked about the importance of getting all stakeholders in the same room, educating them on the issues, and then proceeding with buy-in from all parties.

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Jerry Thibeault, Executive Officer, Santa Ana RWQCB, talked about success of the Santa Ana Watershed Groundwater Management Plan. He brought to light the importance of stakeholder buy-in, and further provided insight to how others might learn from Santa Ana's success.

John Jansen, Ruekert & Mielke, Inc. presented the delineation of saltwater intrusion in the West Coast Basin utilizing geophysical tools including resistivity and Time Domain Electromagnetic Induction.

First Day Luncheon Keynote Speaker — Robert Glennon

The September 25 luncheon guest speaker was Robert Glennon, author and attorney, who gave a very entertaining and thought-provoking talk on water problems and water mismanagement across the country from his book *Water Follies: Groundwater Pumping and the Fate of America's Fresh Waters* (Island Press, 2002). The examples of various over-pumping instances and their resulting negative impacts should provide lessons to us all on the delicate relationship between groundwater, surface water, land stability, and water supply. In his upcoming book, *Unquenchable: America's Water Crisis and What We can Do About It* (due February 2009, Island Press), he will further explore the problems we have created for our water supply; it also provides some solutions to ensure future availability.

Groundwater Storage

(Tom McCarthy, Moderator)

This session covered groundwater storage from applied study results to National Research Council (NRC) policy and regional projects in-between. David Pyne, ASR Systems, presented aquifer storage and recovery (ASR) as a means for meeting water quality goals for arsenic, disinfection byproducts and nutrients. David illustrated relationships between constituents and recovery of stored water. Recent Florida projects suggest that achievement of arsenic goals can be achieved at low cost through formation and maintenance of an adequate buffer zone around an ASR well. Based on these results, an ASR Arsenic Surrogate Model has been developed and is adaptable to simulate response of other constituents besides arsenic, such as nutrients.

Kathy Kunysz, MWD, presented an MWD evaluation of the groundwater storage space available in southern California groundwater basins. The study considered physical characteristics of each basin, management, facilities and operations. Kathy stated that they identified more than 4,300 active production wells, 36 ASR wells, 5,000 acres of spreading basins, 7 seawater intrusion barriers, 16 desalters, and 400 acres of water quality wetlands within the study area. As of 2005, active recharge utilized 60% of the reported available storage capacity and 3.2 million acre-feet of basin capacity remains available for storage.

Taking the session to the big-picture level, Will Logan of the National Research Council (NRC) presented the results of the NRC Policy Forum on managed underground storage of recoverable water. The NRC committee assessed geological, geochemical, biological, engineering, and institutional factors that affect the performance of sustainable underground storage technology. The NRC recently published its findings in *Prospects in Managed Underground Storage of Recoverable Water,* NRC, 2008. Will provided an overview of the study, research needs, and priorities for the implementation of managed storage projects.

Demonstrating Groundwater Supply Sufficiency/Reliability

(Sarah Raker, Moderator)

This session focused on two methods to evaluate long-term reliability of groundwater supply in arid environments where there is increased demand for water supply.

Average, single and multiple dry water years, and groundwater sufficiency must be demonstrated by project proponents per Senate Bills 610 and 221 to assess whether a project will have an adequate supply of water for 20 years. However, the criteria for estimating these parameters are not expressly defined in the Water Code. Chris Heppner, Erler & Kalinowski, Inc. (EKI), presented the challenges with developing criteria in semi-arid basins. Dr. Heppner presented a case study that compared traditional safe yield estimates using limited groundwater level and precipitation data to those developed using a "dynamic water balance" model. Results of the analysis showed that traditional analytical methods overestimate the basin yield and that significantly longer data records are needed to conduct the analysis.

The second presentation in this session focused on the application of a decision support system used to evaluate the optimum location for water supply wells in Santa Fe County, New Mexico. David Jordan, INTERA, presented a geographic information system (GIS) approach that was used to integrate key parameters needed for optimization, including minimizing impacts to existing water supply wells, streams and springs, and maximizing proximity to existing infrastructure, population centers, and areas of favorable hydrogeology and land ownership. David presented the numerous data used for model input and the favorable response from the decision-makers and the public.

Collegiate Groundwater Colloquium

(Jean Moran, Moderator)

This annual meeting of the GRA featured the debut of the Collegiate Groundwater Colloquium, which is intended to carry on as an annual tradition. Five graduate students whose thesis or dissertation projects address research topics in groundwater transport, occurrence, or contamination participated in the Colloquium. The students came from graduate programs around the state, and their presentations covered a wide range of current topics in hydrogeology. The Collegiate Groundwater Colloquium offered an opportunity for practicing groundwater professionals to hear about students' recent research, and gave students an opportunity to present their work at a meaningful venue and to network with practitioners.

Laura Roll, a master's student at University of California at Davis, started

the session off with a presentation on an evaluation of monitoring methods for natural attenuation. Three monitoring approaches were critically reviewed in highly-resolved flow and transport simulations at the well-characterized Lawrence Livermore National Laboratory site. The goal of her work is to develop models that will accurately predict whether a monitoring scheme will capture the phenomena involved in the natural attenuation.

Adam Saide, a PhD student at University of California at Los Angeles, presented his work on examining stratigraphic controls on seawater intrusion in the Dominquez Gap area of Los Angeles. His efforts were aimed at assessing the implications of different groundwater management scenarios for mitigating seawater intrusion, including the possibility of a rise in sea level due to climate change.

Peggy Barthel presented a description of her field work and modeling efforts that were aimed at developing a water budget and flow model for a spring at the Zzyzx Desert Studies Center. A recent graduate from the master's program at California State University Fullerton, Peggy was the recipient of a GRA scholarship, which was used to fund the field-work portion of the study.

Colleen Garcia, of California State University Northridge, described a survey and assessment for groundwater recharge and storage in canyon areas of the western San Fernando Valley where contamination and overdraft threaten the groundwater supply. She integrated data from water quality reports, well logs and geotechnical reports to assess the western portion of the watershed for potential areas suitable for recharge.

Finally, Illenia Battiato, of University California San Diego, presented her doctoral research on mathematical homogenization techniques for reactive transport. She showed that hybrid models, which combine aspects of pore scale and continuum scale models can be adapted to provide more realistic representations of reactive transport in porous media. She showed examples of mixing induced precipitation, in which two contaminants react to form a third species that may precipitate on solid grains.

Delta Issues

(Chris Petersen, Moderator)

The Delta Issues sessions included presentations on innovative technologies and management constructs employed to preserve water supply and protect the fragile Delta ecosystem. Robert Niblack from DWR began the session with an "Overview of the Sacramento Valley Water Management Program and Related Conjunctive Use Projects." He provided an overview of water fluxes into and out of the Delta, identified the water uses both upstream and downstream of the Delta, and explained the causes of salinity intrusion into the Delta and associated impacts to water supply and the environment. Under the Sacramento Valley Water Management Agreement, upstream water users are required to implement water projects that contribute water to meet Delta water quality standards. To date, up to 174,400 acre-feet of groundwater may be pumped annually to replace surface water diversions, resulting in improved Delta water quality.

Claudia Faunt from the USGS presented "Role of Delta in Central Valley Groundwater System – Results from Central Valley Groundwater Model." The study updates the USGS Central Valley Regional Aquifer System and Analysis (CV-RASA) model that was originally calibrated to 1961-1977 conditions. The updated model, the Central Valley Hydrologic Model (CVHM), was calibrated to 1961-2003 observed conditions and incorporates a dynamically integrated water supply-and-demand accounting to simulate groundwater and surface water flow across the entire Central Valley aquifer system, including the Delta.

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Kim Taylor closed the session by describing "Subsidence Reversal Through Wetland Restoration and Carbon Sequestration in the Delta." Ms. Taylor explained that long-standing farming practices in the Delta expose fragile peat soils to wind, rain and cultivation, emit carbon dioxide (CO2) and cause land subsidence. To capture or contain the carbon, farmers could instead "grow" wetlands. In doing so, they would begin to rebuild the Delta's unique peat soils, take CO2 out of the atmosphere, ease pressure on the Delta's aging levees and infuse the region with new economic potential. This concept is being demonstrated by the USGS and DWR project underway on Twitchell Island in the western portion of the Delta.

Exhibits and Poster Session

An evening reception on September 25th provided networking opportunities with exhibitors and poster presentations. Lively networking occurred as attendees mingled between posters, exhibits, and hors d'oeuvres stations.

SECOND DAY OF CONFERENCE

Groundwater Protection and Remediation — Part 1

(Roy Herndon, Moderator)

The session on Groundwater Protection and Remediation (Part 1) was kicked of by Paul Jehn, technical director of the Ground Water Protection Council, who provided a national perspective on groundwater supply and protection issues. Paul discussed the GWPC's document, "Groundwater Report to the Nation -- A Call to Action," noting that groundwater characterization and monitoring are critical to understanding and addressing the nation's groundwater availability. Surprisingly, 16 states were reported to have either inactive or no groundwater quality monitoring network. Groundwater quality protection through education and government oversight are key in areas such as source water protection, underground tank regulation, stormwater and abandoned mine management, and underground injection of hazardous materials. Paul also highlighted the growing interest in CO2 sequestration and the development of associated regulations within the USEPA.

Chris Ross, principal hydrogeologist with Hargis + Associates, presented "Realizing Groundwater Remediation Goals," which included some lessons learned on two case studies in California. Chris explained that site remediation goals are driven by the maximum contaminant levels of the constituent(s) of concern and several other factors, including beneficial uses of the aquifer, exposure pathways, cost, timeliness, and site-specific conditions. Site characterization is scale dependant; large sites typically are characterized to a lesser degree of detail than small sites due to cost and other considerations. Traditional pump-and-treat and in-situ chemical or biological enhancement methods have proven to be effective in achieving remedial goals. An understanding of contaminant source and transport pathways is essential, and the remedial outcome is largely influenced by subsurface hydrogeologic conditions.

Dave Mark, principal hydrogeologist with OCWD, concluded the session with an overview of an OCWD VOC remediation project known as the North Basin Groundwater Protection Project (NBGPP). Dave explained that OCWD is undertaking the NBGPP to contain VOC plumes that have impacted potable supply wells and will further degrade the aquifer if unabated. The NBGPP will consist of 5 to 7 extraction wells, producing approximately 600 gpm each, to hydraulically contain the contamination. The extracted water will be conveyed to a centralized treatment system from which the treated water will be returned to the aquifer via a series of injection wells.

Groundwater Protection and Remediation — Part 2

(John Ungvarsky, Moderator)

The second session on Groundwater Protection and Remediation provided three case studies on the treatment of contamination plumes using pump-and-treat and in-situ chemical treatment. Duncan Austin with the Central Valley RWQCB discussed the benefits of pump-and-treat involving a PCE plume in Lodi, California. The presentation showcased an effective visual tool that creates time-lapsed, three-dimensional views of the plume with and without treatment. Duncan also discussed a new interactive Water Quality Environmental Screening Tool.

Dr. Weixing Tong, with the Los Angeles RWQCB, discussed the effectiveness of in-situ treatment options available under the RWQCB's General Waste Discharge Requirements for remediation of leaking underground storage tank sites. The analysis demonstrated that, in general, in-situ treatment is usually effective, but pilot testing is recommended before full implementation of an in-situ treatment option.

Gary Cronk, with JAG Consulting Group, discussed cleanup of benzene and TCE plumes at an industrial site. After the effectiveness of pump-and-treat plateaued, in-situ chemical oxidation treatment provided additional cleanup and a savings of a half-million dollars. Site closure is now anticipated in 2009.

Recycled Water for Recharge — Part 1

(Ted Johnson, Moderator)

Part 1 of the Recycled Water for Recharge session focused on the regulations and risk associated with using recycled municipal wastewater for groundwater recharge. Brian Bernados, California Department of Public Health (CDPH), presented "California's Draft Criteria for Groundwater Recharge with Reclaimed Water." Brian focused on the roles of CDPH versus the State Water Resources Control Board (SWRCB) for permitting a recharge project, and showed highlights from the new draft regulations, including source control, monitoring wells, the use of tracers or other methods for determining travel times of recycled water to potable wells, and using Total Organic Carbon as a means for unregulated contaminant control and to dictate maximum recycled water contributions. See: http://www.cdph.ca.gov/HealthInfo/environhealth/water/Pages/Waterrecycling.aspx.

Gordon Innes, SWRCB, presented "Recycled Water Recharge Regulations and the SWRCB." He provided an overview of the various groundwater recharge projects using recycled water in the state, the permitting process, and an overview of the status of the SWRCB policy being developed for recycled water reuse, along with an alternative policy proposed by industry stakeholders.

Jeff Soller, Soller Environmental, presented "Risk Assessment for the Montebello Forebay Groundwater Recharge Program," a WateReuse foundation supported program involving a recycled water groundwater recharge project that has been in operation in Los Angeles County since 1962. Secondary-treated effluent was used in spreading grounds until 1977, when it was replaced with tertiary-treated effluent. Water quality data from two nearby drinking water wells, which contained over 30% recycled water, were compared to wells farther away that did not contain recycled water. It was deemed unlikely that the recycled water contributes substantially to any human health risk associated with water from the two wells near the spreading grounds.

Recycled Water for Recharge — Part 2

(Martin Steinpress, Moderator)

The second part of the Recycled Water for Recharge session featured presentations on a range of California recharge projects from the design stage, through pilot testing, to the optimization of a large operating reclaimed water system. Leslie Dumas, RMC, presented "Meeting Future Needs: Looking for Storage in Unusual Places" on an innovative design for seasonal storage of recycled water in a shallow unconfined aquifer to mitigate salinity intrusion in the Salinas Valley. Andy Campbell, Inland Empire Utility Agency, discussed how "Soil-Aquifer Treatment Demonstrations Enhance Recharge in the Chino Groundwater Basin, Southern California," where pilot testing with recycled water has shown effective removal of total organic carbon and total nitrogen. Shivaji Deshmukh, OCWD, gave an update on "The Groundwater Replenishment System: 70 mgd of New, Local Supply for the Orange County Groundwater Basin," detailing the challenges of this year's treatment plant start-up and efforts to optimize operations. The session highlighted the technical challenges for this small but critical and expanding water supply source for California.

Day 2 Luncheon and Awards Program

On September 26, awards were presented during the lunch program to recognize the significant contributions of Senator Michael Machado, Dr. Perry McCarty, and the OCWD. Senator Michael Machado was presented with a Special Recognition award for a distinguished career in the legislature highlighted by a commitment to California's water policy and funding. Senator Machado was first elected to the State Assembly in 1994 and served as the Chairman of the Assembly Water, Parks and Wildlife Committee. In 2000, Machado was elected to the Senate and held the position of Chairman of the Senate Natural Resources and Wildlife Committee during his first term. He is one of only a select few legislators to hold the Chairmanship in both houses of the legislature. Senator Machado co-authored Proposition 13, the Safe Drinking Water, Clean Water, Watershed Protection, and Flood Protection Bond Act and assisted in the passage of Proposition 50, the Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002. Senator Machado understood and appreciated the role of groundwater in meeting our state's water supply needs, and placed a high value on GRA's input when considering groundwater legislation. The Senator often solicited GRA's input when important groundwater matters were pending in the legislature, and was a frequent participant and featured speaker in GRA events. Chris Frahm, Brownstein Hyatt Farber Schreck, GRA Legislative Advocate, accepted the award on behalf of Senator Machado, who was unable to attend but expressed his deep thanks for the recognition accorded to him by the GRA Board. Senator Machado will remain a strong voice in California water policy and will certainly cross paths with GRA in the years ahead.

Stephen Sheldon, President of the Board of Directors of the OCWD, received the Kevin J. Neese Award on behalf of the District for the start-up of the new OCWD and Orange County Sanitation District Groundwater Replenishment System on January 10, 2008. (See also Award Citation on page 14.) Dr. Perry McCarty received GRA's Lifetime Achievement Award

Continued on page 22

— Continued from Page 21

for his lifetime of exemplary contributions to groundwater science and the industry. The luncheon program also included a brief overview of GRA's annual activities and an update of California's legislative activities relating to groundwater by Chris Frahm, GRA Legislative Advocate with Brownstein, Hyatt, Farber, Schreck.

Closing Session

(Murray Einarson, Moderator)

Bob Wilkinson, UC Santa Barbara, presented "Groundwater as a Climate Solution: The Energy Intensity of Water Supply Options." Key indicators show that climate change is occurring, and we already have a water supply system that is energy intensive and over-allocated. Bob emphasized the need for flexibility, and offered this quote: "Governments at all levels should reevaluate legal, technical, and economic procedures for managing water resources in the light of climate changes that are highly likely" (Roger Revelle and Paul Waggoner; *Climate Change and U.S. Water Resources*, 1990). Consequently, Wilkinson said we need strategies. "We need to develop and implement integrated, whole-system approaches to water and energy management. Policy strategies should be designed to tap multiple benefits, and they should be flexible in the face of changing circumstances."

Sally Benson, Stanford University, presented "Geological Storage of CO_2 and Potential Groundwater Impacts," which included the motivation for CO_2 capture and sequestration, the fundamentals of sequestration security, environmental risks, and risk management and mitigation. She summarized the motivation for using CO_2 capture and storage with a quote from the Intergovernmental Panel on Climate Change (IPCC) Special Report on CO_2 Capture and Storage (2005): "…the fraction retained in appropriately selected and managed geological reservoirs is likely to exceed 99% over 1,000 years." There are, however, potential release pathways that may occur, including well leakage (injection and abandoned wells), poor site characterization (undetected faults or gaps in the seal), and excessive pressure buildup that damages the seal. As a result, potential groundwater impacts may include CO_2 migration into shallow aquifers, displacement and migration of saline brines into shallow aquifers, hydrocarbon migration into shallow aquifers, migration of gases co-injected with CO_2, and water-table rise. Risk management measures can mitigate these impacts; importantly, careful site selection and monitoring are needed to avoid groundwater or other environmental impacts.

David Sedlak, UC Berkeley, presented "Anticipating Threats to Groundwater Posed by Chemical Contaminants in Recharge Water." We have experienced a number of emerging contaminants over the past decade or more, including MtBE; 1,4 –dioxane; NDMA; and perchlorate. What have we learned from these contaminants? David described a number of key characteristics, one or more of which are common to these constituents, including their mobility, degradability, toxicity, and/or treatability. He investigated some of his colleagues' latest research to explore what might be the new genre of emerging contaminants. Such constituents as perfluorinated organics, NDMA precursors, emerging disinfection byproducts (haloacetonitriles, haloketones, and halomethanes) may be among the "new" emerging contaminants. He expressed that there needs to be more funding to better assess the quality of our water sources. He summarized his talk with these final comments:

- "We have made progress in identifying and addressing issues related to industrial and effluent-derived contaminants.
- Water quality issues (contaminants) need to be considered as alternative sources (e.g., conjunctive use, desalination, wastewater reclamation) are being evaluated.
- Research is needed to anticipate problems."

Application of Optimization Techniques to Groundwater Projects – Continued from Page 1

material was divided into three parts that covered introductory linear programming, advanced linear programming and additional information related to topics other than linear programming.

During the first part, introductory information was offered to explain both the basic structure of linear optimization analysis and the motivation for applying this technique (thoroughness of analysis and time-efficiency) through presentation of a brief case study from the mining industry. A range of potential groundwater applications was also discussed. Then, a more detailed case study demonstrated the finer points of applying linear programming analysis within a project-specific context involving steady-state flow at a remediation site. A seven-step process for formulating, solving and interpreting the results of linear programming analysis was presented with examples.

The second part of the course addressed more complex project needs such as incorporating transient flow, identifying and addressing non-linearities, and the role of sensitivity analysis. These concepts were also explained within the context of a brief case study (seawater intrusion management) and then reinforced through presentation of a longer case study (water supply management). While the course emphasized linear programming, the third and final part of the course covered non-linear programming and uncertainty analysis. The conditions under which non-linearities arise and the challenges in solving non-linear programming problems were explained. A brief remediation case study was presented and the range of potential solution techniques was summarized. Finally, approaches for addressing uncertainty were touched upon. The course was followed by a reception that included poster presentations and exhibitor booths.

The symposium included two morning sessions, a lunch speaker and two afternoon sessions. Groundwater remediation was the topic of the first morning session with presentations addressing plume capture and concentration reduction. Rob Greenwald (GeoTrans, Inc.) presented results from a comparison of optimization codes applied to Department of Defense contamination sites. Alaa Aly described the optimal design of a pumpage and treat system for TCE. Alan Laase (Hydrologic Consulting) presented a particle tracking optimization scheme for plume containment. These talks demonstrated that optimization techniques are quite valuable with respect to 1) automating much of the laborious aspects of model-based design, and 2) identifying better solutions than might otherwise result from the design process.

The second morning session was the first of two focusing on water resources management planning. After a review of the increasingly complex regulatory approval process for water projects by Jim Brezack (RBF Consulting), presentations were made by Rob Gailey and Tracy Nishikawa that demonstrated how optimization could be used to develop results-oriented insights related to management of conjunctive use projects.

The lunch speaker, Professor Jay Lund from UC Davis, spoke about the importance of integrating groundwater management into California's water supply system operations planning.

The topic of water resources management planning was continued during the first afternoon session with talks by Steve Phillips (USGS), Chin Man Mok, and Wes Danskin (USGS) that addressed aquifer storage and recovery, groundwater-surface water interaction, operations uncertainty, and litigation-based negotiation of third-party effects. Paul Barlow (USGS) provided an overview of the groundwater management capability recently added to the MODFLOW suite (GWM).

California applications were considered during the final session. Tariq Kadir (California Department of Water Resources) described how groundwater is incorporated into the California Department of Water Resources water allocation model (CalSim). Larry Dale (Lawrence Berkeley National Laboratory) presented an analysis of the relation of groundwater levels and cropping patterns under climate change scenarios. Randy Hanson concluded the symposium with an overview of the new Farm Process for MODFLOW, which uses optimization procedures to estimate water demand and supply options. The question-and-answer sessions during the symposium were spirited, reflecting the enthusiasm attendees had for potentially applying the concepts discussed during the short course and symposium to future groundwater projects.

Wells and Words – Continued from Page 9

coordinates (0.0484-inch, D_{70}). Sample A would require a No. 10 (my designation; coarse sand) and a 38 slot screen. The custom filter pack could be ordered from this supplier to meet the No. 10 distribution criteria or from a different supplier who stocks the No. 10 filter pack.

If the aquifer is semi-consolidated to unconsolidated, highly non-uniform, or includes silts or clay stringers then the scaling factor may range between 6 and 10. For example, using a scaling factor of 9, the D_{70} of the filter pack selection is 0.1089-inch. In this case, Sample A would require a No. 6 (granules) and a 93 slot screen.

In summary, the artificial filter pack is selected from formation material (D_{70}) and screen aperture size is selected from the filter pack (D_{90}). For most applications, artificial filter pack distribution should be five times the D_{70} of the aquifer, and in all applications screen aperture size should be based on the D_{90} of the filter pack.

President's Message – Continued from Page 2

Jean Moran, California State University, East Bay, serves as Education Committee Chair. She re-focused the Committee's mission and led the development of a new database of key hydrogeology/water resources university/college professors, which has served as a valuable and consistent means of connecting and interacting with both professors and students. She has worked closely with the Events Committee to sponsor student poster sessions at events and led the establishment of the Collegiate Colloquium, which successfully premiered at the 2008 Annual Conference.

Stephanie Hastings, Brownstein Hyatt Farber Schreck, led the updating of GRA's Bylaws and an extensive review of the Articles of Incorporation as Bylaws Committee Chair. She serves as GRA's General Counsel and provides pro bono legal services. She also serves as Awards Committee Chair.

Rula Deeb, Malcolm Pirnie, Inc., co-chaired the very successful 2008 Site Closure Strategies Symposium and is serving as GRA's liaison for the 2009 International Water Association (IWA) International Micropol and Ecohazard Conference (June 2009).

Elie Haddad, Locus Technologies, co-chaired the very successful 2008 Site Closure Strategies Symposium. He is also serving as GRA's liaison for a Department of Toxic Substances Control Nanotechnology Conference to be held in February 2009.

Chris Frahm, Brownstein Hyatt Farber Schreck, was instrumental in organizing an outstanding 2008 Legislative Symposium and Lobby Day that featured presentations by key legislators and staff from both sides of the house as well as senior agency directors and regulators. Chris also leads BHFS's very effective lobbying services for GRA.

Paul Bauer, Brownstein Hyatt Farber Schreck, was also instrumental in organizing the outstanding 2008 Legislative Symposium and Lobby Day. He was also very effective in arranging for both Senator Machado and his senior staff to provide luncheon addresses during the 2008 Climate Change Symposium. Paul also provides great value to GRA with his lobbying work in Sacramento.

It has been a pleasure working with all of these fine professionals this year. Please join me in thanking these individuals for their contributions to GRA. There are, of course, a number of other individuals, especially other GRA Directors, who have made substantial contributions to GRA not only in 2008 but for many prior years to help make GRA the leading authority and educator on groundwater resources in California.

The Federal Corner – Continued from Page 10

fossil.energy.gov/programs/ sequestration/publications/Project_Reports/carbonstorage_method08.pdf

EPA – The Environmental Protection Agency announces a meeting of the National

Advisory Council for Environmental Policy and Technology (NACEPT) to discuss the draft findings from NACEPT's 20th anniversary report, sustainable water infrastructure, biofuels, EPA's 2009-2014 Strategic Plan Change Document, and EPA's Draft Information Access Strategy. A draft of the report will be posted at http://epa.gov/ocem/nacept/reports/index.html. For more information or to submit comments, contact Sonia Altieri at altieri.sonia@epa.gov or (202)564-0243.

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.

California's Water Storage Problem, the Underworld and the Body – Continued from Page 2

Sierra Nevada snowpack could dwindle to a mere 20-40% of its historical volume during this century. In fact, historical data show that for the last century, the average April-July flows in the Sacramento River have declined steadily, apparently caused by a roughly 2° F rise in air temperature and the consequently thinner snowpack.

Basically, the total precipitation has not declined, but winter is bringing less snow and more rain. Climate models and the temperature record indicate this trend will continue. Consequently, less water will be available when it is most needed in the summer because surface reservoirs will have to release more water in the winter. So the 7th-ranked economy in the world, that also provides some 50% of the nation's fruits and vegetables, relies on a water system that depends precariously on storage of water in a gradually diminishing snowpack.

Currently, the state has no working storage alternative that would adequately compensate for declines in the snowpack. One approach is to build more dams and raise the heights of existing dams, but there is general consensus that the problem cannot be solved by augmenting surface storage alone.

Subsurface storage is a tantalizing alternative and could be vastly increased if certain technical hurdles and limitations in our knowledge of the underworld could be addressed.

The "tantalizing" part – currently there is space for storage of an additional 10 to 50 million acre-feet of water in the Central Valley, one of the largest aquifer systems in North America. For perspective, consider that the combined capacity of our four largest reservoirs (Shasta, Oroville, Trinity, and New Melones) is 13 million acre-feet. Some subsurface storage and recovery of water has already been done in the Central Valley, but the time has come to adopt a grander vision on how to better use this vast reservoir at a regional scale.

The "technical hurdles" part – water percolates slowly into most aquifer systems. To capture more of the winter runoff and move it underground will either require new reservoirs to hold the water while it is doled out to spreading basins or a way of speeding up or optimizing the recharge. The latter has not been seriously considered, but, I would argue, becomes plausible if we gain greater knowledge of the subsurface 'anatomy.'

The "limited knowledge" part – most aquifer systems are mostly not aquifer. For example, in the systems underlying the Central Valley, only about 20 to 50% of the volume is comprised of aquifer material (sands and gravels), while the remainder is comprised of non-aquifer material (silts and clays). Hydrostratigraphic research and characterization show that these aquifer 'bodies' constitute an extensively connected network that is embedded in the non-aquifer materials. The way that water moves through such a system is not unlike how liquid moves through the human body. Picture a 3D network of 'avenues' that support relatively fast flow of liquids (aquifers; veins and arteries), and the intervening regions consist of materials or tissues that support much slower rates of movement. Liquid in the fast zones moves hundreds to thousands of times faster than in the slow zones and there is a tremendous amount of liquid and chemical exchange occurring between the two.

Unlike the human body, however, the locations of the fast flowing 'avenues' and where they approach the land surface is generally not known in the Central Valley. Fortunately, this knowledge is obtainable, and it would create a new world of possibilities. For example, by knowing the small percentage of the landscape where the aquifers intersect the surface, one could design aquifer recharge enhancement projects to efficiently move large volumes of winter runoff into the subsurface. One possible strategy in less developed parts of the valley is to let the river floodplains flood, thereby maximizing the chances that floodwaters soak into the "sweet spots" in the system. Many other possible strategies could also be envisioned.

Yes, there would be problems, like clogging of recharge basin sands by suspended matter in floodwater and maintaining water quality of both the floodwaters and the deeper groundwater. These problems, however, are resolvable through research and integrated management of surface water, groundwater and land use. An easy retort: "No one's ever done that type of thing before, and the technical and institutional hurdles are just too difficult." The counterargument should go as follows: "Too difficult compared to what? Would it be any more technically outrageous or costly than the construction of Hoover Dam in 1931-1935? Would it be any more difficult than damming every major river that drains the Sierra Nevada and routing the water through the largest network of water canals in the world, including the State Water Project and Central Valley Project?" That is the scope of thinking that we need for the efficient use and prudent management of the Central Valley stream-aquifer system.

The bottom line? The subsurface storage potential in the Central Valley is exciting and the technical hurdles are not insurmountable. The first task is to better define the subsurface anatomy – and then the means and the will to manage our subsurface water as effectively as we manage our surface reservoirs will emerge.

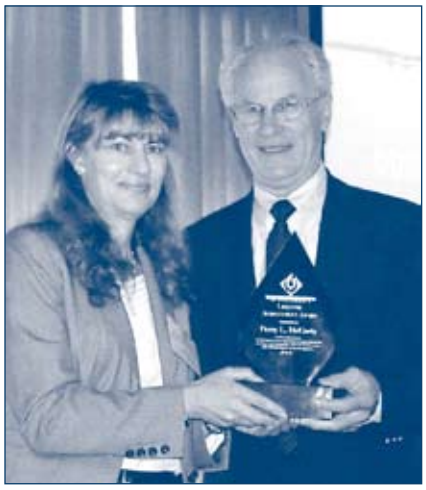
Graham E. Fogg is a Professor of Hydrogeology and Chair of the Hydrologic Sciences Graduate Program at the University of California, Davis.

Groundwater Resources Association 2008 Lifetime Achievement Award Presented to Dr. Perry L. McCarty

BY VICKI KRETSINGER GRABERT

GRA's **Lifetime Achievement Award** is presented to individuals for their exemplary contributions to the groundwater industry and for contributions that have been in the spirit of GRA's mission and organization objectives, including the management, protection and improvement of groundwater. These individuals are pioneers in their fields of expertise.

For more than 40 years, McCarty has devoted his life to extraordinary contributions to groundwater science, research, protection and improvement of water quality, education, and international awareness of the importance of groundwater. He received his M.S. and Sc.D. in sanitary engineering from the Massachusetts Institute of Technology in 1959 and was awarded an Honorary Engineering Doctorate from the Colorado School of Mines in 1992. He joined Stanford in 1962 to develop the Environmental Engineering and Science Program, and Chaired the Department of Civil and Environmental Engineering from 1980 to 1985.



GRA director Vicki Kretsinger Grabert (l) presents the Lifetime Achievement Award to Dr. Perry L. McCarty (r).

Legacy of Innovation and Contributions to Environmental Engineering and Science

His research interests and enthusiasm for problem solving reside at the interface of all aspects of water resources and cover a tremendous breadth of issues with social relevance. From early years to the present, his research includes aerobic and anaerobic biological processes for control of environmental contaminants (including nitrogen removal), advanced wastewater treatment processes, wastewater reuse, contaminant fate and transport, and groundwater remediation (including in-situ biodegradation of chlorinated solvents and other hazardous chemicals).

His combined knowledge of physical, chemical, biological, and microbiological processes and engineering solutions for water treatment laid the groundwork for regulatory confidence in worldwide technological development of surface-water, groundwater, and wastewater treatment technologies. His efforts have been instrumental in building the necessary scientific foundation for water recycling and the use of recycled water in California, the Nation, and the world.

McCarty has enormously influenced research that focuses on the importance and understanding of contaminant fate and transport in soil and groundwater, and groundwater remediation methods.

He was instrumental in developing a focus on groundwater research at Stanford in the early 1970s; this was one of the Nation's first groundwater research programs.

McCarty led early work on the Palo Alto Baylands project to research the creation of a saltwater intrusion barrier to protect the aquifer used to supply drinking water to the City of Palo Alto. The project's goal was to create a saltwater intrusion barrier by injecting clean, recycled water from the Palo Alto Water Quality Control Plant.

McCarty has commented that reverse osmosis technology was considered just a "laboratory curiosity in the early 1960s." In October 1976, his work with the Orange County Water District (OCWD) led to the first program to

inject treated wastewater into a potable supply aquifer from the District's reverse osmosis plant (Water Factory 21), which blended the recycled water with deep well water to create a full-scale saltwater intrusion barrier. The project was a great success, and with OCWD's new Groundwater Replenishment System, the legacy of this groundbreaking plant lives on.

During the early years of groundwater research at Stanford, McCarty and others collaborated with the University of Waterloo (including John Cherry, now Emeritus Professor at Waterloo) to conduct research at the Borden site in Canada. The experience gained through collaborative work at the Borden site brought new insights to the Stanford researchers on field techniques. Subsequent field experimentation led to path-breaking discoveries and new methods, including:

- The identification of organic chemical biological degradation and sorption mechanisms occurring in the subsurface;
- The fate and transport of hazardous and trace chemicals;
- The development of new monitoring and field techniques, and
- Solutions for surface water, groundwater, and soil quality improvement.

Volunteerism

McCarty has served on numerous National Academy of Sciences committees and boards, particularly the National Research Council (NRC). His work on the NRC Committee on Intrinsic Remediation led to water quality improvement in surface and groundwater through in-situ or bioremediation methods; the Committee's work culminated in the NRC report Natural Attenuation for Groundwater Remediation. McCarty has been an invited guest lecturer at universities worldwide. He holds eight patents, has authored or co-authored eight books, including the textbooks Chemistry for Environmental Engineering and Science and Environmental Biotechnology - Principles and Applications, and has over 300 publications.

Lifelong Educator of Students and Others

McCarty has been an educator at Stanford since 1962 and is known for his ability to attract and mentor outstanding doctoral students. He has had more than 40 Doctoral students and also sat on the Committees for about 50 additional Doctoral students.

He became involved in communicating science in China in the 1970s, which led to his appointment as Chair Professor in the Department of Environmental Science and Engineering, Tsinghua University, Beijing, China (2004-2007). About 15 years ago, he led a group of prominent engineers and scientists who traveled for three years to developing nations to communicate the importance of protecting groundwater resources from contamination.

Worldwide Honors and Awards

His previous honors and awards include the John and Alice Tyler Prize for Environmental Achievement in 1992 and the Athalie Richardson Irvine Clarke Prize for Outstanding Achievements in Water Science and Technology in 1997. In 2007, McCarty received the Stockholm Water Prize, a global award presented annually by the Stockholm Water Foundation to an individual, organization or institution for outstanding water-related activities.

Sustaining the Vision

Forty-six years after developing Stanford's multidisciplinary Environmental Science and Engineering Program, he continues, as an Emeritus Professor, to promote contributions at the interface between disciplines. The focus of his research has shifted from solutions having more direct and economic human impact to increased efforts towards the protection of natural systems.

As described by James Leckie, Professor of Environmental and Applied Earth Sciences, Director of Stanford University's Environmental Engineering Laboratory; Co-Director, Singapore Stanford Partnership; and long-time colleague of Perry McCarty, "He is busier than ever!"

Update on DWR's Local Groundwater Management Assistance Act Program

BY HARLEY H. DAVIS, CA DEPARTMENT OF WATER RESOURCES

The Local Groundwater Management Assistance Act of 2000 was enacted to provide grants to public agencies to conduct groundwater studies, groundwater monitoring, and management activities. The enabling legislation (Assembly Bill 303) declared groundwater a valuable natural resource in California that should be managed to ensure its safe production and quality. Over six rounds of the program through 2008, the California Department of Water Resources (DWR) received requests for $102.6 million in grants for 330 projects and awarded nearly $34.4 million in Local Groundwater Assistance (LGA) grants to local agencies to conduct 160 projects. LGA grants are available for award to only local public agencies and are limited to grants for no more than $250,000.

After two years without funding, a total of $6.4 million from Proposition 50, Chapter 8 was made available for issuing grants in 2007. DWR received a record 122 grant applications requesting a total of $27.6 million. The Director of DWR in June 2008 awarded 31 grants totaling $6.4 million; 20 grants were fully funded; six were partially funded; and five were Capacity Building grants, limited to $50,000 each. More information on the Program can be found at http://www.grantsloans.water.ca.gov/grants/assistance.cfm.

Following are examples of projects that recently received funding:

Ojai Basin Groundwater Management Agency in Ventura County, Ojai Basin Groundwater Model for $216,047 ($221,047 total project cost)

Grant funds will be used to develop a groundwater model to support the analysis of alternative basin management scenarios. The model will be used to evaluate hydrogeologic factors including basin storage, effects of pumping, recharge and discharge components of the system, proposed new well construction and development, and conservation measures. Field data will be collected to fill data gaps. The natural, enhanced, and artificial recharge along and near stream beds will be a prime focus of modeling efforts.

Sacramento Central Groundwater Authority in Sacramento County: Comprehensive Update of Data Management System (DMS) for $249,964

This DMS project involves the development of detailed hydrogeologic data and information to assist in the understanding of the groundwater basin and improve groundwater management. Groundwater level, quality, and production data along with lithologic data will be collected, analyzed, and incorporated into a basin-wide DMS to streamline data access, analysis, and reporting. DMS tools will be developed to assist in monitoring and implementation of Basin Management Objectives. The end product will be an up-to-date DMS that allows easy access by all stakeholders and provides the analysis tools for basin management.

Tehama County Flood Control and Water Conservation District: Dedicated Multi-Completion Groundwater Monitoring Wells and Cooperator Outreach for $229,761

This grant will be used to construct two triple-completion dedicated monitoring wells, install data loggers, and conduct public outreach. The District will collect geologic samples at 20-foot intervals, document geologic properties and aquifer zones, run geophysical logs (spontaneous potential, resistivity, and full-spectrum gamma ray), interpret the geologic and geophysical data, interpret borehole lithology, and identify aquifer production zones from test-hole data in the new wells. The objectives of the data loggers are to provide accurate, compatible and reliable groundwater level data from the proposed groundwater monitoring wells, and to provide the District and its cooperators the ability to measure, download and evaluate groundwater level trends.

Tulare County Division of Environmental Health: Groundwater Quality Monitoring Plan for $249,984

The project consists of developing a coordinated groundwater monitoring plan. Tasks will include: 1) collection of groundwater quality data for each aquifer; 2) development of groundwater sampling and testing standards; 3) development of a DMS; 4) aggregating other existing readily available data; 5) data gap identification; 6) one round of sampling and testing from agricultural and domestic wells to fill data gaps; and 7) connecting the DMS to DWR's Integrated Water Resources Information System (IWRIS).

Harley H. Davis is the Local Groundwater Assistance Program Coordinator for the Department of Water Resources, Conjunctive Water Management Branch.

Sacramento Branch Highlights

BY JOHN W. AYRES, BRANCH SECRETARY

August Meeting: The Sacramento Branch hosted an August meeting featuring Steve Macaulay and Ken Loy of West Yost Associates. Steve and Ken gave a joint presentation on climate change and threats to California's water resources. The presentation focused on how climate change is accounted for in integrated regional water resources planning, and discussed the effects of climate change on natural groundwater recharge. As temperatures increase, precipitation will occur as rain instead of snow, creating larger, flashier stream flows. This increased peak flow and reduction in dry-season flow will likely reduce long-term natural groundwater recharge. This presentation complimented the material presented at the GRA Climate Change Symposium held on the following day.

October Meeting: The Sacramento Branch hosted an October meeting featuring ozone-sparging, by Kevin Brown of Geocon Consultants. Kevin presented five case studies in geologically diverse settings, including the Central Valley and Sierra Nevada foothill sites in Newcastle, Courtland, Colfax, Citrus Heights and Oregon House. Depth to water at these sites ranged from about one foot to 38 feet, with contaminant plume lengths ranging from 100 to 650 feet. Each site had 10 to 11 ozone injection wells on a spacing that ranged from 10 to 35 feet. Of the five sites discussed, one has achieved closure status; one project had to be expanded off-site; one project had to have its system expanded to remediate a separate release; and one system continues to operate essentially as originally designed (minor modifications occurred along the way). Kevin concluded that ozone-sparging is highly effective for destroying dissolved petroleum hydrocarbons within the influence of the injection well field, and also provides sustainable dissolved oxygen within the influence of the injection well field once toxicity has been adequately reduced. Ozone-sparging may also provide dissolved petroleum hydrocarbon destruction and sustained dissolved oxygen downgradient of the injection well field in higher velocity aquifers, and was most effective in the lowest velocity aquifers. Ozone-sparging at rates between 0.5 and 2.5 pounds per day did not result in persistent CrVI above background levels within or downgradient of the injection well field.

Southern California Branch Highlights

BY PAUL PARMENTIER, TECHNICAL MEMBER

The Southern California GRA Chapter held two meetings this quarter. On July 26th, in conjunction with UCI Extension, Tim Sovich, Principal Engineer with the Orange County Water District (OCWD), led a half-day field trip of two OCWD facilities. After an overview of OCWD's operations, with emphasis on groundwater issues, Tim led a group of about 30 people through the recently completed "Groundwater Replenishment System" (GRS) plant in Fountain Valley. The effluent from the adjacent Orange County Sanitation District plant is treated by OCWD through a three-step process including microfiltration, reverse osmosis and UV/peroxide. After the treatment plant tour, the participants drove to the groundwater recharge operations in Anaheim, where an inflatable dam controls the amount of Santa Ana River water diverted to the several recharge basins in the northeastern part of Orange County. Tim described the challenges and details of the recharge operations, and their estimates of groundwater flow velocities and recharge rates based on several tracer test studies conducted at the basins and in monitoring wells near the recharge basins and the river.

On September 24th, in conjunction with the Annual GRA conference, a dinner meeting was held in Costa Mesa focused on the topic of groundwater storage in the West Coast and Central Basins in Los Angeles. The discussion, moderated by Toby Moore, Chief Hydrogeologist of Golden State Water Company and a Technical Member with the Southern CA Branch, was energetically presented by Russell McGlothlin with Brownstein, Hyatt, Farber and Schreck, and Bill Kruse with Lagerlof, Senecal, Gosney & Kruse, LLP. The two presenters outlined a framework for potential agreement between all parties involved in the management and storage of water in the two basins.

The two basins were adjudicated at a time when storage issues were not yet a concern, and therefore the associated initial legal agreements regarding groundwater were found not to be applicable to storage operations, forcing intense negotiations between all parties. The State of CA brought in a mediator to open the discussions and determine the points of contention. The issue was further complicated by the differing geographic conditions and estimated storage capacity of the West Coast Basin (about 120,000 ac-ft) and the Central Basin (about 330,000 ac-ft). After several years, a framework for potential agreement between all parties has been worked out and will soon be submitted to all parties for consensus. The agreement calls for several levels of storage accounts to be distributed amongst the parties, and for the storage issues to be administered by the Water Replenishment District and Water Rights and Storage Panels. The CA Department of Water Resources would no longer be the designated watermaster. The agreement will also be flexible and allow the transfer of stored water between basins under certain conditions.

The presentation highlighted that water rights issues are still very contentious despite years of successful basin groundwater extraction and recharge operations.

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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
Department of Toxic Substances Control
(510) 540-4121
Jkarache@dtsc.ca.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)

- **Cal/EPA DTSC Symposium** — **February 4, 2009**, Sacramento, CA
  Global Perspectives on Green Remediation: Making Clean 'Green'
- **GRA Course** — **February 23-24, 2009**, Orange, CA
  Introduction to Groundwater & Watershed Hydrology: Monitoring, Assessment & Protection
- **GRA Conference** — **February 25-26, 2009**, Orange, CA
  Groundwater Monitoring: Design, Analysis, Communication & Integration with Decision Making
- **GRA/Univ. of CA Center for Water Resources Conference** — **March 24-25, 2009**, Sacramento, CA
  Groundwater Salinity: A Groundwater Dilemma
- **GRA Legislative Symposium & Lobby Day** — **April 15, 2009**, Sacramento, CA
- **GRA/IWA Conference Micropol & Ecohazard 2009** — **June 8-10, 2009**, Burlingame, CA
  Assessment & Control of Micropollutants/Hazardous Substances in Water

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Groundwater Resources Association of California
915 L Street, Suite 1000
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