Groundwater Resources Association of California

HYDROVISIONS

VOLUME 22, NO. 1 SPRING 2013

Investigation and Remediation of Dry Cleaner Release Sites

By Richard Makdisi

On November 7, 2012, the day after the elections, GRA held its third symposium on Dry Cleaners. The previous Dry Cleaner symposia were held in 2003 and 2004, in northern and southern California, respectively; given the advances in the technology of discovery and remediation, along with changes in the regulatory framework with the use of risk assessment guidance, a new symposium was due.

The symposium featured 12 speakers in four sessions followed by a panel session. In addition there were 18 posters presented and 13 exhibitors, with a post-symposium reception for perusal of the posters and exhibits. ACS Tech Services was a co-sponsor of the symposium. The turnout was above expectations, at over 170 attendees. The GRA Organizing Committee for the symposium consisted of Brian Aubry of Geologica, Inc., Kevin Brown of SF Bay Regional Water Quality Control Board, Bruce Marvin of Geosyntec Consultants, John Gregory of Farella Braun + Martel, LLP, Steve Miller of Erler & Kalinowski, Inc., Tom Mohr of Mohr HydroGeoScience, Paul Parmentier of The Source Group, and Mike Vivas, formally with DTSC. Emily Vavricka of Environmental Engineering & Contracting, Inc., and Richard Makdisi of Stellar Environmental Solutions, Inc., were also on the committee and were the symposium co-chairs.

Symposium Co-Chair Richard Makdisi of Stellar Environmental providing the opening remarks

The sessions presented: (1) source characterization, (2) remedial strategies, (3) regulatory and risk, and (4) the legal and insurance perspectives. These were followed by a panel discussion on the technical, regulatory and legal challenges facing dry cleaner cleanups. These sessions and panel discussion provided the framework and tools critical to understanding the dominant challenges at dry cleaner sites and moving toward achieving the goal of regulatory site closure.

Since the previous symposia, issues associated with dry cleaner contamination and resolution have seen some significant changes—as well as added concerns—in the areas of vapor intrusion assessment and mitigation. There has also been significant progress in site characterization techniques and more viable in-situ technologies, along with the tools to better evaluate their efficacy. The development and use of CHHSL and ESLs as regulatory tools has come into its own over the last decade. These emergent issues were addressed in the symposium. Other issues, such as the movement towards a State Fund for Dry Cleaner-contaminated sites, have unfortunately remained static.

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

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Our Indefatigable Groundwater Leader

By Sarah Raker

If you know Vicki Kretsinger Grabert, you might wonder how this modest woman can possibly accomplish so much. Where does she find so many more hours in the day than us mere mortals? How can she be so prolific? And where does she get her seemingly inexhaustible energy? Those of us who have had the pleasure of working with Vicki know that in addition to her enormous contributions to technical and policy issues facing our precious groundwater resources, she is also incredibly gracious.

Vicki joined Luhdorff and Scalmanini Consulting Engineers in 1983 and serves as its current president. Gene Luhdorff, Jr. was a great supporter of Vicki and encouraged her to join the California Groundwater Association (CGA), a non-profit organization founded in 1948 for drillers, contractors, suppliers, manufacturers, geologists, engineers, hydrologists, and government employees. CGA is the same vintage as the National Ground Water Association (NGWA), formerly the National Water Well Association. Gene knew that Vicki understood the need for a technical organization focused on groundwater issues. Vicki joined CGA in 1989, added a technical component to the organization's newsletter, and encouraged technical participation by its members. Vicki knew that complex groundwater issues were emerging in California, and that groundwater professionals and the public needed education regarding these issues. Yet, CGA was not focused on groundwater science and collaboration. Vicki worked within CGA's organizational structure to try to gain voting rights for CGA's technical members, but to no avail at that time. She resigned as a technical officer of CGA in 1992.

GRA was formed in January 1992, and Vicki became GRA's founding president. During GRA's charter year, nearly 500 members joined. A primary goal throughout GRA's early development was to encourage a balanced participation by groundwater professionals from many industry sectors, including consultants, contractors, academics, and government agencies. Geographic diversity was also encouraged. Active GRA Branches emerged in Sacramento, San Francisco Bay, Central Coast, South San Joaquin Valley, and Southern California. These Branches continue to be active today.

Through Vicki's leadership, GRA members were encouraged to actively address California's groundwater needs at the local and state levels and to participate in educational programs. Vicki marshaled the development of GRA's working committees to facilitate this involvement, including Membership, Seminars (currently the Events Committee), Annual Meeting, Education, Scholarship (currently part of the Education Committee), Legislative, Newsletter (currently the Communications Committee), Technical Guidance, and Liaison (currently the Affiliates Committee).

GRA's first technical seminar rolled out in March 1992 with *Testing and Modeling of Low Yield Aquifers*. This was followed by *Vadose Zone Monitoring and Remediation* (1993), *Applied Environmental Statistics* (1994), and *Overview of California Hydrogeology* (1995).

GRA's Annual Meeting has always been a key forum for California groundwater professionals. The first Annual Meeting was held in San Francisco in November 1992 with the theme "Visions into California's Vital Resource." Marc Reisner, of *Cadillac Desert* fame, was the keynote speaker and spoke of "Bringing Groundwater Management into the 20th Century and Beyond." This has been a continuing theme for GRA.

The first edition of GRA's *HydroVisions* Quarterly Newsletter was hot off the press in the spring of 1992 thanks to its editor David Von Aspern and layout designer Janie McGinn. Over twenty years ago, Vicki sat in my position and wrote the President's Message. In addition to important information about the newly formed GRA, Vicki reminded readers of Dr. Oscar Meinzer's prescient speech in 1937 to the American Association of Water Well Drillers. Dr. Meinzer, head of the USGS's Ground Water Branch, was well known to hydrogeologists. Regarding increased groundwater use, he wrote, "*The water is ours for beneficial purposes; there is no advantage in letting it go to waste if*

Continued on the following page…

Our Indefatigable Groundwater Leader – *Continued*

it can be made to serve human welfare. Only, we must guard against depletion or spoiling of our extremely valuable underground reservoirs. Indeed, the conservation and efficient use of the natural reservoirs is one of our major national problems, and it is immediately urgent." This urgent message presented in Vicki's column reminded GRA's members of our need to educate the public on groundwater issues facing the state. I have repeated that message here because it is still very relevant.

Vicki became an Advisory Council member for the University of California Water Resources Center in 1994 and contributed to its Biennial Groundwater Conference that had been showcasing technical water issues to the California public since 1957. In 1997, Vicki helped GRA collaborate with the Water Resources Center to create the joint *Biennial Groundwater Conference and GRA Annual Meeting*. This joint meeting continues to be one of GRA's most successful events. When the Water Resources Center closed in 2009 due to loss of funding, Vicki rescued the vast experience and technical expertise gained from the joint Biennial Conference collaboration. In 2010, GRA's Board approved an initiative prepared by Vicki for GRA to become the new administrator of the Biennial Conference. GRA is proud to extend the life of this important groundwater event.

Also in 2010, in conjunction with reinvigorating the Biennial Groundwater Conference, Vicki and GRA directors Thomas Harter and Tim Parker leveraged their relationships with technical, policy and legal experts and created the Contemporary Groundwater Issues Council. The vision of the Council, as outlined by Vicki in previous *HydroVisions* articles, is to help GRA identify the state's most pressing information, education, and networking needs which pertain to groundwater, thereby allowing GRA and other key stakeholder organizations to effectively address integrated water resources and environmental stewardship issues. Council members include a select group of executives and leaders from a range of disciplines and backgrounds representing regulatory agencies, research and educational institutions, non-government organizations, water users, consultants, and the public at large. The Council provides a congenial forum to share experiences with, and potential solutions to, the state's most pressing groundwater issues. Results of the annual Council meetings held in 2011 and 2012 have provided GRA with key issues to focus its workshops, symposia, and legislative efforts and the opportunity to expand GRA's influence, outreach, information dissemination, and membership.

In 2011, Vicki, along with other dedicated members of GRA's Education Committee, helped create the David Keith Todd Distinguished Lecture Series to honor Dr. David Keith Todd for his enormous contributions to groundwater science and technology, and to foster interest and excellence in applied groundwater science and technology. The lecture program has been very successful.

Vicki continues to contribute news articles and collaborate with several other leading groundwater organizations on behalf of GRA. Not surprisingly, Vicki heads GRA's Affiliate Committee, the goals of which are to develop strategic alliances, coordinate activities with allied organizations, and initiate formal Affiliate status of other organizations with GRA. GRA is an active affiliate with the following organizations:

- International Association of Hydrogeologists (IAH): GRA submits announcements for upcoming GRA events in IAH's newsletters
- Geological Society of America (GSA): GRA is an Associated Society of GSA and contributes to its newsletters
- National Ground Water Association (NGWA): GRA participated as a cooperating organization for the 2012 NGWA Ground Water Summit
- Association of California Water Agencies (ACWA): GRA is continuing coordination with ACWA through participation on subcommittees on water quality, data, groundwater management, and recharge for development of ACWA initiatives to implement their Groundwater Sustainability Framework; additionally, preliminary planning has begun on a series of groundwater management symposiums in 2013 in collaboration with ACWA
- Department of Water Resources Groundwater Caucus: Vicki is co-chair with Tim Parker and coordinates with DWR for regular updates on the California Water Plan Update 2013
- California Groundwater Association (CGA): Dialogue continues on topics of mutual interest; a workshop, co-sponsored by CGA and DTSC, on "Managing Wells in California" was held in 2012.

Apparently, GRA and California were not enough for our tireless groundwater leader. Vicki has also made tremendous strides advancing groundwater science and education with other groundwater organizations, including NGWA, IAH (she's the current US National Chapter Treasurer), and GSA (as the IAH Liaison). From 1998 to 2007, Vicki was a director of the Association of Ground Water Scientists and Engineers Division (AGWSE, division of NGWA and now called the Science and Engineering Division); she was a Vice President of NGWA and the AGWSE Division Chair from 2004 to 2005. In 2004, she and Dawn Kaback (with AMEC's office in Denver, CO) launched a periodic newsletter, *Ground Water News & Views*, for the AGWSE Division which has since become a

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Our Indefatigable Groundwater Leader – *Continued*

themed column in the *Ground Water* Journal; she and Dawn are still co-editors of the column.

In 2004, under Vicki's leadership, Dave Rudolph (Professor, University of Waterloo) and Bill Woessner (Professor, University of Montana) crafted an initiative for the NGWA Ground Water Summit. Vicki helped shepherd the initiative through approvals by NGWA's Board of Directors and various committees. The Summit, launched in 2005, was created to provide a complement to NGWA's annual Ground Water Expo; the Summit facilitates scientific and policy discussions by groundwater professionals. The Summit initiative included the "Darcy Forum," a new venue comprising renowned experts assembled to discuss their perspectives on scientific advancements and the relevance of groundwater science to society.

In 2003, Vicki was instrumental in facilitating an agreement between NGWA and GSA to have NGWA's Darcy Lecturer become a standing part of the GSA's Annual Conference. Similarly, this arrangement later led to GSA's Birdsall-Dreiss lecturer becoming a standing element of NGWA's Ground Water Summit.

With Vicki's effort beginning in 2000 and finally coming to fruition in 2003, NGWA approved a new Associated State Society category such that science-focused organizations could be recognized as affiliates of NGWA. Previously, NGWA had only the category of Affiliated State organizations, which applies to contractor-focused organizations. The new Associated State Society designation was developed to foster mutual benefit and information sharing between national and state organizations. GRA became the first NGWA Associated State Society, demonstrating GRA's gravitas among groundwater professionals.

NGWA also recognizes Vicki's diligence and hard work on groundwater issues. In 2008, Vicki received NGWA's Keith E. Anderson Award (formerly known as the AGWSE Special Recognition Award) that acknowledges outstanding contributions made to NGWA. In 2010, Vicki was awarded NGWA's Robert Storm Interdivisional Cooperation Award, which is presented to "*a person or team who, through their activities or written works, contributes to promoting collaboration, enhancing cooperation, and fostering community among all groundwater professionals, and to advancing the mutual interests of all those interested in communicating the importance of the Earth's water resources.*"

Vicki's contributions to the groundwater industry summarized here are more than plenty for one lifetime. But Vicki is young and has years of work ahead of her. I look forward to trying to keep up with her. Thank you Vicki!

Cheers – Sarah Raker,
GRA President

Investigation and Remediation of Dry Cleaner Release Sites

– Continued from page 1

Density of Dry Cleaner Sites

There is a high density of Dry Cleaners (DCs) in urban areas. They are second only to UFSTs in their density and geographical representation as contaminated sites in most towns and cities. Approximately 35,000 retail DCs operate in the United States according to the Fabricare Institute. On average about 75% of known DC sites have some record of contamination associated with them. There are close to 4,000 DC sites in California known to be in need of remediation. Tom Mohr, who authored the SCVWD's 2004 study of DC sites, reported 750 unique locations within the district with dry cleaning machinery using PCE or similar solvents from 1946–2001. Applying the 75% contamination average to that translates to about 560 contaminated sites. Mohr's detailed study, which included former DC sites, suggests that there are likely in excess of 4,000 contaminated DC sites in California.

The proximity to other commercial establishments, particularly in the typical strip mall setting, can result in vapor intrusion issues in neighboring tenants. The persistence of PCE, the main COC; preferential pathways offered by sewer lines; common presence of DNAPL; and PCE being a sinker all make for some plumes of significant length and impact. PCE tends to be a greater threat to deeper groundwater than the more ubiquitous fuel-related sites.

Cost Concerns and Lack of Financing

On the question of cost to bring a contaminated DC to regulatory closure, the range is highly variable, mainly depending on whether only soil or soil and groundwater are impacted. Insurers estimate about $500,000 per average DC cleanup. If one uses the California State Fund estimate of up to $1,000,000 to bring a contaminated UFST to regulatory closure, that translates into a $4 billion California environmental problem, in aggregate. Certainly the risk to groundwater and indoor air is greater at DC sites than at UFST sites.

Symposium Exhibitor Hall

But unlike UFSTs, for which the UFST state fund program is in place to finance cleanups, there is no such relief currently for the California dry cleaners. This is a legacy problem exacerbated by a lack of funds to complete cleanup, because the usual mom and pop operations are not economically viable to complete cleanup actions. Most cleanups that are not driven by regulatory order due to public health or definitive environmental concerns are funded through cleanup actions associated with property redevelopment or sale. The number of former and abandoned DC sites remains to be quantified; many contaminated sites are no longer in use as DCs, and are effectively off the radar screen. Unfortunately, environmental contamination from PCE is unlikely to naturally attenuate on its own.

Remediation and Regulatory Closure

Soil, groundwater and indoor locations can all be affected from DC contamination. If only soil is affected, one is lucky; relatively straightforward soil removal (if possible) or soil vapor extraction can be very effective and economical solutions. But when groundwater contamination occurs, costs can exceed those for a soil-only corrective action by a factor of 10.

Although cleanup of groundwater contaminated by DC operations has in recent years become more viable, faster and less expensive, it still can take years to achieve regulatory closure. More than 900 production wells, or upward of 5% of supply wells in California, have detectable concentrations of PCE. Many of these may be below the drinking water MCL of 5 µg/L, but above the Public Health Goal (PHG) for PCE in drinking water of 0.06 µg/L.

In order to achieve some form of low-treat site closure at PCE-contaminated groundwater sites, flexibility in evaluating pathways of exposure and in institutional constraints is needed, because most of these sites are unlikely to achieve PCE reduction to the MCL, let alone the PHG, due to matrix diffusion. In-situ bioremediation has evolved during the last 10 years both in terms of a better array of products to target PCE and means to evaluate the long-term efficacy of the remediation. With matrix diffusion often limiting achievement of the MCL for PCE at most DC sites, the regulatory community has come to recognize the logic of low-threat closure at sites with a solid conceptual model, no pathways of exposure and potential institutional constraints that can be put in place. The symposium provided an excellent format for discussing the many challenges still out there to bringing known

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Investigation and Remediation of Dry Cleaner Release Sites – *Continued*

and unknown DC-contaminated sites to regulatory closure.

The first session, covering *Source Characterization*, was moderated by **Tom Mohr** of Mohr HydroGeoScience; he also presented a paper on "The Age-duration Surrogate for Solvent Mileage and other Forensic Tools for Prioritizing Dry Cleaner Investigations and Cost Apportionment." **Joe Niland** of Geosyntec Consultants presented an interesting case study entitled "Long Term Effectiveness of the Lincoln Center Remediation Program," followed by **Murray Einarson** of Haley and Aldrich, who presented "A New Directpush Optimal Screening Tool for High Resolution, Real-Time Mapping of Chlorinated Solvent DNAPL in the Subsurface."

The second session, moderated by **Richard Makdisi** of Stellar Environmental Solutions, Inc., covered *Remedial Strategies at Dry Cleaner Sites*. "Direct Injection of ZYI and Organic Carbon Slurry for Treatment of PCE in Clayey Lithology" was presented by **Stacey Telesz** of FMC Environmental Solutions, followed by **Elizabeth Schwartz** of TRC on "Evaluation of In-Situ Treatment Alternatives using Microbial Analytical Methods at a Dry Cleaner Site in Millbrae, California." **Stephen Koenignsberg** of Brown and Caldwell finished the session with "A Review of Conventional and Alternative Processes and Protocols for Accelerating Site Resolution."

The third session covered *Regulatory Risk and Vapor Intrusion Issues* and was moderated by **Kevin Brown** of the San Francisco Bay Regional Water Quality Control Board. **Blayne Hartman** of Hartman Environmental Geoscience presented "Simplifying Vapor Intrusion Assessments at Dry Cleaner Sites: On-Site TO-14 & Method TO-17." The risk perspective was addressed by **Kimberly Day** of the Department of Toxic Substance Control who presented "Changes in Risk and Hazard Criteria and how they Impact Risk due to Vapor Intrusion, and California CHHSLs." Down from Oregon to discuss the successful DC fund program in that state was **Dick DeZeeuw** of Oregon Department of Environmental Quality, who presented "Oregon's Dry Cleaner Program – What We've Learned and how California can Benefit."

Kimberly Day of the Department of Toxic Substances Control presenting on Risk and Hazard Criteria and how they Impact Risk Due to Vapor Intrusion

The fourth session covered *Legal and Insurance Perspectives*, and was moderated by **Emily Vavricka** of Environmental Engineering & Contracting, Inc. Presentations were given by **Stephen Hanshaw** of PolicyFund, speaking to the use of "Historical Insurance to Fund Environmental Investigations and Cleanup." This was followed by a legal perspective given by **Edward Firestone**, Attorney at Law, on "Sanitary Sewers as a Source of OPCE in Soil and Groundwater: Potential Liabilities for Sanitary Districts." **Robert Schultz** of AMEC Environment & Infrastructure, Inc., finished the session with "Litigation, Alternative Cleanup Levels, More Litigation, Another Cleanup Level Proposal,... Where Did the Cycle Start, and Where Could it Stop? Water Resource Impacts to the Livermore Basin in Livermore, Alameda County, California."

The fifth and final session was a panel discussion on the *Technical, Regulatory and Legal Challenges Facing Dry Cleaner Cleanups*, which was moderated by **John Gregory** of Farrella Braun + Martel, LLP, with the following panelists: **Jim Arnold** of The Arnold Law Practice; **Blayne Hartman** of Hartman Environmental Geoscience, who brought the consulting practice perspective to the panel; and the regulatory perspective on the panel was represented by **Stephen Hill** of San Francisco Bay Regional Water Quality Control Board and **Barbara Cook** of the Department of Toxic Substance Control. A hypothetical case was presented in which the legal, regulatory and environmental consulting practice perspectives were presented. The panel discussion engendered much audience participation and crystalized some of the gray areas regarding points of compliance and regulatory closure relative to DC cleanup actions.

If you have questions regarding the symposium, please contact the author at rmakdisi@stellar-environmental.com.

Panel discussion members and moderator, from left to right: Moderator John Gregory, Farella Braun + Martel, LLP; Stephen Hill, San Francisco Bay Regional Water Quality Control Board; Barbara Cook, Department of Toxic Substances Control; Jim Arnold, The Arnold Law Practice; and Blayne Hartman, Hartman Environmental Geoscience

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1-DAY COURSE

2 Opportunities

June 4th—Sacramento, CA
June 6th—San Jose, CA

COURSE DESCRIPTION

Learn about the high resolution site assessment process utilizing Geoprobe's Hydraulic Profile Tool (HPT), Membrane Interface Probe (MIP), and Electrical Conductivity (EC) logging systems. Learn about data interpretation methods and powerful computer software used to review logs and create high-resolution two-dimensional cross-sections of the subsurface that show lithology and the distribution of volatile contaminants.

- Learn how to obtain subsurface information within budget quickly
- Evaluate VOC contamination and assess type based on detector responses
- Learn to use the HPT logs and dissipation tests to understand hydrogeology
- Watch field demo of the HPT & MIP system log as the probe advances
- Use DI Viewer software to interpret the logs obtained during demo
- Construct cross sections of lithology/hydrostratigraphy using logs
- Earn Continuing Education Units (CEUs)

SPACE IS LIMITED!

MORE INFO: www.asc-technologies.com/events/high-resolution2013

This is a not-for-profit Continuing Education Course. A portion of the proceeds from this event will be for the benefit of the AEG Student Scholarship fund.

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Dates & Details

GRA EVENTS & KEY DATES

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

Contemporary Groundwater Issues Council Workshop
Apr. 16, 2013 | Davis, CA

GRA Annual Legislative Symposium
Apr. 24, 2013 | Sacramento, CA

GRA Symposium
Managed Aquifer Recharge in the Urban Environment: Technical & Policy Changes
May 22-23, 2013 | Burlingame, CA

GRA Board and Planning Meetings
Jun. 1-2, 2013 | Petaluma, CA

GRA Symposium
High Resolution Tools and Techniques for Optimizing Groundwater Extraction for Water Supply: Symposium and Field Demonstrations
Jun. 19, 2013 | Garden Grove, CA
Jun. 20, 2013 | Anaheim, CA

29th Biennial Groundwater Conference and GRA 22nd Annual Meeting
Oct. 8-9, 2013 | Sacramento, CA

PLAN TO ATTEND

GRA Annual Legislative Symposium & Lobby Day

APRIL 24, 2013
SACRAMENTO CA

9th Symposium in GRA's *Series on Water Resources*

"Managed Aquifer Recharge and Recovery in the Urban Environment: Technical and Policy Challenges"

MAY 22-23, 2013 | BURLINGAME, CA

CO-SPONSOR: AMEC

Symposium Focus

GRA will be offering a 1.5-day technical and policy symposium focusing on managed aquifer recharge and recovery in the urban environment. The Symposium will be co-presented by ReNUWIt (Re-inventing the Nation's Urban Water Infrastructure), an interdisciplinary, multi-institution, National Science Foundation engineering research center with the goal to change, update and improve the ways in which urban water is managed (http://urbanwatererc.org). Symposium collaborators include Stanford's Water in the West program (http://www.stanford.edu/group/waterinthewest) and the Berkeley Water Center (http://bwc.berkeley.edu).

The Symposium will emphasize the growing range of approaches to the capture and recharge of urban stormwater, recharge of aquifers with reclaimed water, reduction of the footprint and energy needs for recharge, and water quality issues associated with managed aquifer recharge. Additionally, the Symposium will examine technical and policy challenges related to current and planned small- and large-scale projects, as well as strategies for increasing managed aquifer recharge to help address goals for conjunctive use and groundwater banking.

Preliminary Session Topics

- Where does the water go?
- Site investigation: Geophysical methods and techniques
- Developing and testing sensors that can provide real-time physical and chemical data to maximize storage and recovery
- Developing decision support systems based on real-time data to inform recharge operation
- Designing and operating MAR systems to maximize storage capacity and water recovery
- Advancing the engineering of distributed stormwater infiltration systems
- Water quality issues related to aquifer recharge and recovery
- Developing models to predict water flow, quantity, and quality through MAR systems to aid in decision making
- Managed aquifer recharge policy challenges and barriers.

Student Participation

Students are encouraged to attend the Symposium and to present their research results. All students will be entered in a "Student Presentation Competition" with free registration prizes for up to five winners and cash prizes for up to three winners. In addition, GRA will recognize student winners by presenting a summary of their presentation in a future issue of *HydroVisions*.

For questions, please feel free to contact the Symposium co-chairs Professor Dick Luthy (luthy@stanford.edu), Dr. Rula Deeb (rula.deeb@arcadis-us.com; 510-596-9596) and Mr. Tim Parker (tim@pg-tim.com; 916-596-9163).

7th Symposium in GRA's
Series on Tools and Technologies

"High Resolution Tools and Techniques for Optimizing Groundwater Extraction for Water Supply: Symposium and Field Demonstrations"

PRESENTED IN COOPERATION WITH THE...
CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL
CALIFORNIA DEPARTMENT OF WATER RESOURCES
UNITED STATES GEOLOGICAL SURVEY

CO-SPONSOR
AMEC

JUNE 19, 2013
SYMPOSIUM: HYATT REGENCY HOTEL – GARDEN GROVE, CA

JUNE 20, 2013
FIELD DEMONSTRATIONS: ORANGE COUNTY WATER DISTRICT TRANSFER WELL SITE – ANAHEIM, CA

Groundwater research, developments in drinking water regulations and experience operating water supply wells have resulted in a growing awareness of and appreciation for the importance of variations in geology, geochemistry and well condition in the vertical dimension. High costs for, among other factors, replacing wells, pipeline relocation, various forms of treatment, and operations and maintenance in perpetuity, have led to new applications of existing technologies as well as development of new technologies for well diagnosis. Much has been learned in recent years, and there have been marked increases in efficiency and cost effectiveness. The goal of this symposium and field demonstration is to present information regarding recent advances in collecting and using high resolution data with respect to groundwater wells (municipal, remediation, agricultural, industrial and monitor).

Symposium Focus

The Symposium on June 19 will feature invited speakers from consulting, contracting, industry, government, and academia. Topics addressed will include:

- Tools and techniques to identify the scale of geologic and water quality variability and well screen condition under pumping and non-pumping conditions
- Differences in water quality between test holes and constructed wells
- Contaminant delineation in pumping wells
- Modifying wells to improve water quality relative to undesirable constituents
- Effects of nearby pumping on idle wells
- Screen rehabilitation
- Vertical conduit evaluation and management
- Modeling well modification results
- Age dating and vulnerability assessment
- Optimizing groundwater production wells to reduce cost and maximize benefit

In addition to the oral presentations, a poster session will be held at the conclusion of the Symposium. The poster session will provide an excellent forum for the authors to present their work in an informal and interactive setting.

The field demonstrations on June 20 will feature vendors for data collection services for pumping and non-pumping wells. The vendors will demonstrate well inspection and diagnostic methods and tools such as:

- Video logging
- Straddle packers and test-hole sampling
- Spinner logs
- Depth discrete water sampling
- Electromagnetic flow meters
- Dynamic dye tracer and sampling method
- Heat pulse flow meter
- Ambient dye tracer ambient flow profiling

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7th Symposium in GRA's *Series on Tools and Technologies* – Continued

- Nuclear magnetic resonance
- Colloidal Boroscope logs
- Westbay-MOSDAX System for multi zone pressure profiling
- Low flow purge pumps
- Other temperature and pressure measurement tools

Who Should Attend: groundwater supply managers and engineers, hydrogeologists, regulators and students.

Agenda for Field Demonstrations will be available mid-March.

Posters are being solicited for the June 19 symposium in areas related to the above-listed topics. Guidelines for submitting an abstract for a poster presentation are as follows:

- Word 9.0 documents are preferred.
- Indicate the topic of the abstract.
- Abstracts and bios must be one page in length or less, and should be titled and include all contributing authors' names and affiliations. Please identify the name of the person who will be presenting the poster. Bios should be 50 words or less in paragraph form, and full mailing and e-mail addresses and phone and fax numbers must be included.
- Margins should be 1-inch top, bottom, and 1¼-inch right and left margins. The text should be single-spaced, 12-point size, Arial font, with no pagination, footers and headers. Paragraphs should be justified.
- Major headings should be 16-point bold; minor headings should be 12-point italicized not bolded. There should be one blank line above and below all headings, except above major headings, which should have two blank lines.
- Graphics should not be used in abstracts.

By virtue of submitting an abstract, the submitter(s) grants GRA the right to publish any accepted abstract or the right to decline any abstract. The Symposium Committee will review abstracts and make final selections. If your abstract is accepted for poster presentation and you agree to present, you will be expected to register and pay for the event using GRA's online registration.

Please submit your abstract by email to: Mary Megarry, Groundwater Resources Association of California, mmegarry@grac.org no later than May 1, 2013.

Additional information: Contact Rob Gailey, rmgailey@thesourcegroup.net or 415-407-8407, or Noah Heller, nheller@besstinc.com or 866-298-8701.

GRA will award CEUs for attendance at the Symposium and Field Demonstrations. The Symposium provides up to 7 contact hours, and the Field Demonstrations provides up to 4.8 contact hours. GRA is an official provider of CEUs for the California Operator Certification Program (OpCert), California Registered Environmental Health Specialists (REHS) and California Minimum Continuing Legal Education (MCLE).

MARK YOUR CALENDAR

GRA Presents

The 28th Symposium in its *Series on Groundwater Contaminants*

"Trace Elements of Environmental Consequence in Groundwater"

SEPTEMBER 10-11, 2013
SACRAMENTO, CA

CO-SPONSOR: AMEC

Calendar September 10-11, 2013 for GRA's 2-day symposium on "Trace Elements of Environmental Consequence in Groundwater." GRA members and professionals from the regulatory, environmental and engineering consulting, municipalities, environmental law practices and academic communities will want to attend this symposium. The primary focus is to provide a thorough overview of past, current and emergent concerns about trace elements in the environment in terms of the natural occurrence and associated geochemistry, and the anthropogenic cases, such as the well-known and persistent chromium plumes associated with electro-plating operations or arsenic in treated lumber, agricultural or plant nursery operations. Fate and transport mechanics will be addressed. The natural occurrences of As, Cr, V, etc., are important regional concerns in California basins that rely on groundwater as a source of supply. Regional and regulatory issues will be discussed along with human health risk issues. The changing regulatory landscape regarding some emerging trace elements with no previous drinking water standards also will be addressed. Watch for GRA's Call for Abstracts in early June 2013.

29th Biennial Groundwater Conference & GRA 22nd Annual Meeting

"California's Groundwater Future in the Balance: Integrating Quantity & Quality in a Changing Climate"

OCTOBER 8-9, 2013 | SACRAMENTO, CA

CO-SPONSOR: AMEC

Technical Presentations by Industry Leaders
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Wells and Words

By David W. Abbott P.G., C.Hg., Senior Hydrogeologist, Daniel B. Stephens & Associates, Inc.

Auger Drilling—The workhorse for shallow boring depths, monitoring well installations, and geotechnical investigations

There are several different types of construction augers[1] used to drill borings in soft unconsolidated sediments for the installation of large diameter pier foundations for buildings and infrastructure[2], fence posts and utility poles, surface (upper annular) well seals for water supply wells, construction dewatering wells, monitoring or production wells, piezometers, and lysimeters. The range of auger drilling methods include hand- and power-operated augers for small diameter (ϕ) borings, bucket augers for large ϕ borings, and solid and hollow stem continuous-flight augers for reconnaissance-level and detailed geotechnical investigations to evaluate local soil conditions. All of these methods, except for the bucket auger, operate on the same basic mechanical principle of a rotating Archimedes' screw, which lifts cuttings from the bottom of the boring to the ground surface.

The Archimedes' screw is a device made of a tube (or flighting) bent spirally around a solid or hollow straight piece of pipe, or of a broad-threaded screw encased by a cylinder used to lift water[3]. The Archimedes' screw has been modified to lift and convey a variety of materials, including soil cuttings from a boring along the outside of the drill string, grains to storage elevators and silos, removal of grit and solid materials from primary sewage treatment facilities[4], and many other applications including boat propulsion. This remarkable invention was created by Archimedes of Syracuse in the 3rd century BC[2], and is based on the basic principle of the lever.

Figure 1: Track-mounted Hollow Stem Auger drilling rig installing a 15-foot deep by 4-inch ϕ flowing artesian dewatering well in a residential subdivision of Pleasanton, CA, circa 1998. The track-mounted rig allows for access in rugged and small areas that larger truck-mounted rigs could not negotiate and reduces the post-construction footprint. The right forefront of the picture shows three 10-inch ϕ flight augers with drill cuttings still wrapped around the flightings. The well was constructed within the hollow stem of the flights prior to removal of the drill string. (Photo courtesy of E.D. Hendrix, P.G., C.Hg., Daniel B. Stephens & Associates, Inc.)

Solid stem augers (SSA) can drill borings of up to 60-inch ϕ and hollow stem augers (HSA) can drill holes up to 18.5-inch ϕ (bit size) with an axial inside ϕ of 2.25–12.25 inches for construction of 2- to 10-inch ϕ monitoring wells; the outside ϕ of the flightings range from 5.625–17.25 inches[5]. The auger flights (or drill pipe joints) are usually 5 feet long. The augers are rotated by the drill string, allowing the Archimedes' screw to carry the soil cuttings to the surface during drilling. The cuttings are conveyed outside and along the continuous flighting, resulting in smearing of clays and silts along the borehole walls, which can be difficult to remove during well development, and thus may decrease well efficiency.

As the name implies, the bucket auger uses a rotating cylindrical bucket-like device (10–60-inch ϕ) attached to the bottom of the drill string to hold and remove cuttings[6]; a toothed cutting edge mounted on the bottom of the bucket breaks up and skims-off the formation. The cuttings are removed by repeatedly retrieving the bucket from the hole every 5 feet of vertical advancement. Unstable and caving conditions in the upper part of the boring can occur unless casing is installed.

The attainable depth using auger drilling methods is dependent on the character of the subsurface sediments; several tens of feet are generally feasible, and depths are typically less than 50 feet. Small-ϕ augers in favorable soil textures can reach depths of 150 feet. Auger drilling can be difficult and nearly impossible in bedrock, coarse-grained gravel and cobble, and loose saturated sands. Heaving sands, caused

Continued on the following page…

Wells and Words – *Continued*

by the difference in hydrostatic pressure inside and outside the HSA flight, pose additional constraints to drilling below the water table.

Hand, power, bucket, and solid-stem auger methods provide relatively poor subsurface sediment samples, which are usually collected as the flighting carries (or bucket removes) the cuttings to the ground surface. In contrast, the HSA usually allows for excellent – no, outstanding – undisturbed subsurface specimens when used with several sampling systems that facilitate recovery of discrete or continuous sediment cores from below the pilot bit. These coring devices include thin-walled tube samplers, barrel- or split-spoon samplers with inner sleeves, Shelby tube samplers, California modified samplers, piston samplers, and Denison core barrel samplers[7]. Loose sand and saturated materials may require spring sampling retainers or retrieval baskets to retain the sample in the device. Samples are collected by dropping a 140-pound weight a distance of 30 inches onto the sampling drill string. Periodic groundwater sampling can be conducted during drilling, but is less precise than soil sampling. Thief samplers (narrow ϕ bailers) or hydropunch-type devices lowered down the hollow stem can be used to retrieve groundwater samples.

Bucket auger, SSA, and HSA are usually truck mounted and require a relatively small drilling rig footprint. No drilling fluids are required in the vadose zone, but fluids can be used to facilitate drilling below the water table. Small and portable power-operated units can be used in small areas, in buildings, and on slopes. The basic drill string for SSA and HSA drilling includes (from bottom to top): a removable center rod and drill string with plug and pilot bit for HSA, auger head bit, drill pipe or flights, and Kelly with table- or top head-drive systems. Supporting equipment includes: (1) service vehicles; (2) sand-line to move construction materials and equipment; and (3) cat head hoists and lines to move lighter materials and drive the sampler into undisturbed soils below the pilot bit. The typical drilling crew for an auger rig includes the driller and one helper. Daily drilling rates can exceed 50 feet per day excluding casing installation. Figure 1 shows a track-mounted HSA rig completing a flowing artesian well.

Most wells constructed within hollow-stem augers are designed with filter packs because of the much larger boring ϕ relative to the casing ϕ. SSA and HSA drilling methods are excellent tools for providing geologic subsurface information relatively rapidly, have low equipment and operating costs, provide cores to evaluate shallow subsurface geologic conditions, and allow for construction of the well within the cased hollow stem – the right tool for the right project.

[1] Acker, W.L., III, 1974, *Basic Procedures for Soil Sampling and Core Drilling*, Acker Drill Co., Scranton, PA, 246 pages.

[2] Macaulay, David, 1988, *The Way Things Work*, Houghton Mifflin Company, Boston MA, 384 pages.

[3] Merriam-Webster, 1980, *Webster's New Collegiate Dictionary*, G&C Merriam Company, Springfield, MA, 1532 pages.

[4] Metcalf and Eddy, Inc., 1991, *Wastewater Engineering Treatment, Disposal, and Reuse*, (third edition), G. Tchobanoglous and F.L. Burton (editors), McGraw-Hill, Inc., New York, 1334 pages.

[5] Poehls, D.J. and G.J. Smith, 2009, *Encyclopedic Dictionary of Hydrogeology*, Elsevier Press, Amsterdam, The Netherlands, 517 pages.

[6] NGWA, 2003, *Illustrated Glossary of Groundwater Industry Terms: Hydrogeology, Geophysics, Borehole Construction, and Water Conditioning*, NGWA, Westerville, OH, 69 pages.

[7] Aller, Linda, T.W. Bennett, et al., (date unknown), *Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells*, NGWA, Dublin, OH, 398 pages.

Legislative Update

By Tim Parker, GRA Legislative Chairman,
Chris Frahm and Duncan McFetridge, GRA Legislative Advocates

With the 2012 legislative session in the books, 2013 is quickly shaping up to be another politically dynamic year. It will also be the first time in over a decade that California begins the year without a budget crisis. Thanks to the passage of Proposition 30 and significant reductions in general fund spending during the past two years, Governor Brown has begun to restore fiscal order to California's budget.

New Legislative Member

The California Legislature began its 2013-2014 session with 47 new members, 39 of whom were sworn into office for the first time on December 3rd. It is the largest freshman class since 1966, and Democrats now hold a supermajority in both chambers for the first time since 1883.

The Senate replaced nine of its forty members. Only one of these freshmen, Democrat Richard Roth of Riverside County, is a true newcomer; the other eight are all former Assembly Members. Senate leadership consists of returning President pro Tempore Darrell Steinberg, Majority Leader Ellen Corbett, and GOP leader Bob Huff. Fran Pavley will head up the Senate Committee on Natural Resources and Water.

In the Assembly, 38 of 80 seats were filled this session by freshmen. Nora Campos is Speaker pro Tempore and new Assemblymember Kevin Mullin is Assistant Speaker pro Tempore. Serving as Majority Floor Leader is Toni Atkins; Connie Conway is the Minority Floor Leader. Ben Hueso is the chair of the Assembly Water, Parks & Wildlife Committee.

State Budget Update

This month, Governor Brown released his 2013-14 Budget. The Governor points out that the state will see its first budget surplus in over a decade, in large part due to the passage of Proposition 30. In his budget proposal, Brown focused on education, jobs and healthcare reform as important cornerstones of his budget.

In his State of the State Address, Governor Brown elaborated on his proposal. He hailed the progress made by several state groups, namely those responsible for keeping up on the latest renewable energy sources and increasing efficiency standards. The Energy Resources Conservation and Development Commission will be getting funding this year in the budget to be set aside for the Electricity Program Investment Charge fund, which supports cost-effective energy efficiency and conservation activities.

On the subject of water, Governor Brown reiterated his plan to build two 30-mile long 40-foot wide tunnels in the San Joaquin Delta and restore almost 100 square miles of habitat. The goal, he says, is to improve the ecology of the Delta and avoid a disaster caused by earthquake, storm, or rise in sea level. The financial resources necessary to oversee and implement the Delta Plan will be evaluated during the spring budget process, after the Delta Stewardship Council has held public hearings and formally adopted the Plan.

PPIC Water Update

The Public Policy Institute of California recently released a study detailing the growing challenges that California faces in the realm of water management, and some of their recommendations to face those challenges head on. Delta instability, water scarcity, risk of flood, and ecosystem protection were some topics covered by the study; funding is also discussed.

The proposed new tunnels in the Delta have the potential to both safeguard the Delta's delicate ecosystems and maintain a reliable supply of water for the state. But according to the PPIC, there needs to be solid policies on governance, finance and mitigation for Delta landowners and residents, and a well thought out program to adapt management policies to the inherently changing nature of the ecosystem.

Another recommendation from the PPIC includes better pricing policies, such as tiered water rates with higher prices for greater use, which they believe can heighten incentives to conserve while still allowing local water suppliers to balance their budgets. Of particular importance to GRA and its members, the report argues that better basin management is a prerequisite to realizing the significant potential of groundwater banking. Many groundwater basins have effective local management protocols, especially in Southern California and Santa Clara County. As the PPIC points out, progress is needed elsewhere.

Looking Ahead

As the upcoming legislative year begins to take shape, we will continue to keep GRA members apprised of the evolving political and policy landscape in Sacramento. Please mark your calendars for this year's Legislative Symposium and Lobby Day, which will be held on April 24th. We plan to bring together leading water and groundwater experts in California government and provide GRA members with a comprehensive update on the latest in groundwater policy.

HOLD THE DATE
April 24, 2013
Annual Legislative Symposium and Lobby Day

The Federal Corner

By Kelly Manheimer, U.S. EPA

Registration Open for 2013 ITRC Teams

The EPA's 2013 Interstate Technology & Regulatory Council (ITRC) Teams are: Biochemical Reactors for Mining-Influenced Waters, Contaminated Sediments – Remediation, DNAPL Site Characterization, Environmental Molecular Diagnostics, Geophysical Classification for Munitions Response Projects, Groundwater Statistics and Monitoring Compliance, Petroleum Vapor Intrusion, and Risk Assessment. Team descriptions are available at http://www.itrcweb.org/Documents/Team-Resources_OutreachMaterials/2013-Team-Descriptions-revised-Jan-13.pdf. For more information on membership and to register, see http://www.itrcweb.org/Membership/Welcome.

Source Zone Architecture Key to DNAPL Remediation

(Courtesy of SERDP/ESTCP Fall 2012 "Headlines") Groundwater contamination from chlorinated solvents on military installations is a significant environmental liability for the Department of Defense. Many of the dense nonaqueous phase liquid (DNAPL) source zones developed decades ago as a result of historical practices and continue to contaminate groundwater today. In order to successfully treat this contamination, it is essential to understand the physical characteristics of the source zones. An innovative tool has been developed that can provide key information about a source zone's structure and characteristics, also referred to as the architecture. This work, which combines high-end computational techniques and physical models, can help explain why contamination persists, how long it will persist, and what the best options are for treating it. For more information, see http://www.serdp-estcp.org/News-and-Events/In-the-Spotlight/Source-Zone-Architecture-Key-to-DNAPL-Remediation.

Low Impact Development Fact Sheets Available Online

EPA has released a fact sheet series on the benefits of low impact development (LID) and addressing obstacles to wider adoption of LID. Low impact development is an approach to land development (or re-development) that works with nature to manage stormwater as close to its source as possible. It employs principles such as preserving and re-creating natural landscape features, minimizing effective imperviousness, to create functional and appealing site drainage projects that treat stormwater as a resource rather than a waste product. This seven-part series of fact sheets is primarily intended for state and local decision makers who are considering adoption of LID, but have concerns. The fact sheets explain the benefits of LID in clear terms and through examples, and directly address specific concerns that have been raised about adopting LID. The fact sheets are available at http://water.epa.gov/polwaste/green/bbfs.cfm.

EPA Recommends New Recreational Water Quality Criteria

EPA has recommended new recreational water quality criteria for states that will help protect peoples' health during visits to beaches and other recreational waters year round. The science-based criteria provide information to help states improve public health protection by addressing a broader range of illness symptoms, better accounting for pollution after heavy rainfall, providing more protective recommendations for coastal waters, encouraging early alerts to beachgoers and promoting rapid water testing. The criteria released do not impose any new requirements; instead, they are a tool that states can choose to use in setting their own standards. Click here for the news release.

USGS: Understanding and Managing the Effects of Groundwater Pumping on Streamflow

Wells that pump water out of aquifers can reduce the amount of groundwater that flows into rivers and streams, which can have detrimental impacts on aquatic ecosystems and the availability of surface water. Estimation of rates, locations, and timing of streamflow depletion due to groundwater pumping is needed for water-resource managers and users throughout the United States, but the complexity of groundwater and surface-water systems and their interactions presents a major challenge. The understanding of streamflow depletion and evaluation of water-management practices have improved during recent years through the use of computer models that simulate aquifer conditions and the effects of pumping groundwater on streams. For more information: http://pubs.usgs.gov/fs/2013/3001/.

Kelly McCarty Manheimer is Chief of the CA Sites Superfund Section at the U.S. Environmental Protection Agency, Region 9. She works in the Superfund Division and oversees cleanup activities at many Superfund sites in CA. For information on any of the above topics, please contact Kelly at 415-972-3290 or manheimer.kelly@epa.gov.

Copper

By Bart Simmons

Copper is relatively non-toxic to humans and other terrestrial organisms; however, cupric ion (Cu^{+2}) is toxic to microscopic aquatic organisms at the low µg/L (ppb) level. As a result, copper has been identified as a significant contaminant of surface water, and water bodies have been designated as impaired based on copper concentrations. Total Maximum Discharge Limits (TMDLs) for copper have been established to protect bays and inland basins. However, recent research has shown that the toxicity of copper depends strongly on the actual species present in the water column or sediment.

Copper, in the form of cuprous (Cu^{+1}) oxide has been used for decades as an ingredient of antifouling paint, which inhibits the attachment of barnacles and algae. The paint continuously releases copper, which migrates to the water and sediment. Other sources of copper in surface water and sediment include stormwater runoff from roads which have received copper from the use in brake linings, pesticide residue runoff, and groundwater inputs. However, the cupric ion binds with ligands, such as humic and fulvic acids, which effectively reduce its toxicity. For example, recent studies have found that >99.9% of copper in San Francisco Bay is bound to ligands. To estimate the toxicity of copper, it is critical to measure the concentration of ligands using a surrogate, such as dissolved organic carbon (DOC), and/or measure cupric ion directly, using a copper selective ion electrode. Copper is recycled: a cupric ion binds with ligands, settles out on sediment, the ligands are decomposed, which releases cupric ion, which binds with ligands, and the cycle continues.

Harbors typically accumulate total copper in sediments and total dissolved copper in the water column in concentrations proportional to the number of boats in the harbor.

The conventional wisdom says that the bioavailability and toxicity of copper depends on the concentration of sulfides in sediment. An old draft procedure from an EPA report measures Acid-Volatile Sulfides (AVS) and Simultaneously Emitted Metals (SEM). The hypothesis was that if the AVS exceeded the SEM, the copper would be non-bioavailable and nontoxic. However, this hypothesis has not been confirmed by research. The AVS-SEM is uncorrelated with bioaccumulation by benthic organisms, and understanding the cycling of copper is critical to understanding the toxicity of copper in the water column.

TMDLs and other regulatory limits have largely been based on total dissolved copper concentrations. However, it is clearly critical to consider the speciation of copper in the site water. Toxicity of copper can be modeled using DOC, dissolved copper, temperature, and direct measurement of the free cupric ion.

Regulatory limits should be based on clear public health and environmental goals. Only then can strategies be created to meet the environmental goals. The dose makes the poison, and the chemistry makes the dose.

Bart can be reached at bartonps@aol.com.

Spatial and Temporal Trends of Nitrate Concentrations in California's Tulare Lake Basin and Salinas Valley

By Dylan Boyle, Luhdorff and Scalmanini Consulting Engineers, Woodland, CA
(Formally at University of California, Davis, Department of Land, Air, and Water Resources)

Introduction

Agricultural production in California has increased significantly during the past 60–70 years due in part to the availability of large-scale groundwater extraction technologies, widespread development of surface-water reservoirs, and the ability to synthesize nitrate, a key component of agricultural crop fertilizer. Nitrate is a critical nutrient for crops and an essential input for growing crops at the scale and intensity demanded by consumer markets. However, nitrate is often applied at rates exceeding crop utilization, and elevated nitrate concentrations are regularly detected beyond the root zone and into the deep vadose zone, shallow groundwater, and increasingly deeper portions of groundwater aquifers (Beller et al. 2005; Burow et al. 2007; Harter et al. 2005; Moran et al. 2005; Nightingale 1972).

A large portion of groundwater recharge in semi-arid agricultural landscapes is from diffuse agricultural return flows as reflected in regional groundwater flow models (Brush and Dogrul 2012; Faunt 2009; Montgomery Watson Americas, Inc. 1997; Wrime, Inc. 2007). As these sources typically contain elevated concentrations of nitrate, the long-term sustainability of groundwater as a critical social and economic resource comes into question. Importantly, water withdrawn from a typical supply well originates from a variety of sources and contains a wide distribution of travel times on the scale of decades to centuries (G. E. Fogg et al. 1999; George Kourakos et al. 2012; Weissmann et al. 2002). Only the "young" fraction of the water, recharged less than 60-70 years ago, likely contains elevated levels of nitrate (G. E. Fogg et al. 1999). However, as time moves on, the fraction of water recharged since the 1940s–1950s will increase, as will the potential for upward-trending nitrate concentrations, provided the sources of contamination have not been significantly reduced (G. E. Fogg et al. 1999; Weissmann et al. 2002).

Central to the question of groundwater sustainability is the issue of historical trends and how to define them with limited data. Furthermore, since some of the groundwater recharge is from non-agricultural sources, such as rivers and managed aquifer recharge operations, the issue of spatial trends and their responses to different recharge sources is also relevant. Here we provide a statistical test for trend on a large database of groundwater nitrate concentrations spanning more than 60 years for two agriculturally intensive regions of California: the Tulare Lake Basin (TLB) located in the southern portion of the Central Valley, and the Salinas Valley (SV) located in the Central Coastal Ranges. Additionally, spatial trends in nitrate concentrations and major ion water chemistry for the eastern alluvial fan portion of the TLB are explored as they relate to the interaction between low-nitrate river recharge and diffuse agricultural recharge.

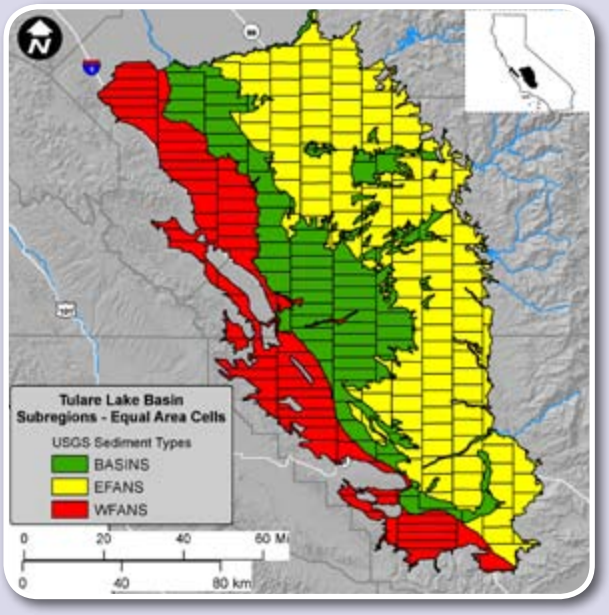

Figure 1: Study area equal area cells TLB

Study Area

The TLB is defined herein as the valley portion of the Tulare Lake Hydrologic Region, an area of over 20,000 km2 located in the southern portion of the Central Valley (figure 1). The northern border of the TLB is defined by the westward flowing San Joaquin River and a shallow watershed divide west of Firebaugh. The Kettleman Hills and the Temblor Range of the Central Coastal Ranges form the western boundary, the Tehachapi Mountains the southern boundary, and the Sierra Nevada foothills the eastern boundary. Annual average precipitation for the TLB varies from 18 to 33 cm, increasing eastward (CA Department of Water Resources 2003).

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Spatial and Temporal Trends of Nitrate Concentrations in California's Tulare Lake Basin and Salinas Valley – *Continued*

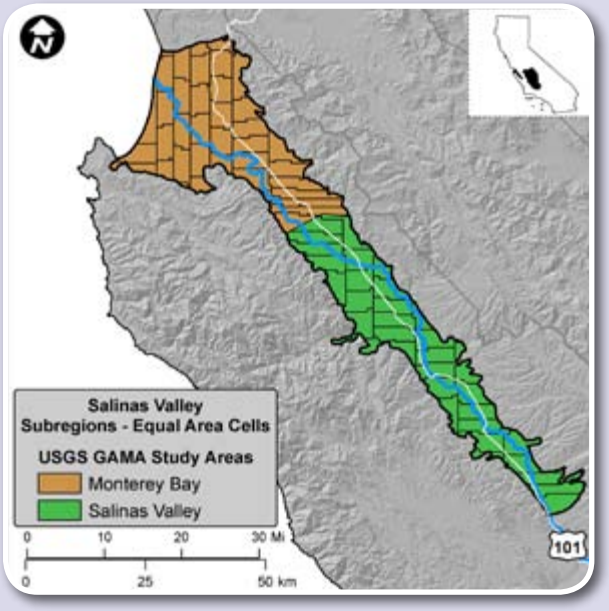

Figure 2: Study area equal area cells SV

The SV is a coastal valley in Monterey County, about 160 km south of San Francisco, CA (figure 2). The valley extends southeastward approximately 130 km from Monterey Bay to the town of San Ardo. It is bounded to the northeast by the Gabilan and Diablo Ranges, to the southeast by the Sierra de Salinas and Santa Lucia Ranges, and to the northwest by Monterey Bay. Annual average precipitation for the SV ranges from 30 to 43 cm, increasing toward the eastern and western margins (CA Department of Water Resources 2003).

The TLB and SV account for nearly 40% of California's irrigated cropland producing more than 80 different crops composed largely of cotton, grain, hay, and field crops (40%); vegetables (20%); alfalfa (10%); grapes (10%); nuts (10%); tree fruit (5%); and subtropicals (5%) (Viers et al. 2012). There are approximately 640 dairies in the TLB totaling roughly 1 million milking cows and an additional 1 million in support cattle (Viers et al. 2012).

Model results from the Central Valley Hydrologic Model (CVHM) suggests that the TLB receives about 78% of its recharge from diffuse landscape recharge (primarily irrigation return) with recharge from surface water (e.g., rivers, streams, canals) amounting to 22% of the total (Faunt 2009). Results from the Salinas Valley Integrated Groundwater and Surface water Model (SVIGSM) suggest that 39% of groundwater recharge for the basin as a whole comes from landscape recharge, and 54% comes from surface water recharge (Montgomery Watson Americas, Inc. 1997). Importantly, however, the SVIGSM shows that over 75% of surface water recharge in the SV occurs in the southern Salinas Valley subregion.

The large fraction of groundwater recharge from diffuse landscape recharge in both basins has resulted in widespread nitrate contamination. Recent studies by the United States Geological Survey (USGS) have been conducted in both the TLB and SV, with results showing that roughly 1 in 10 raw water samples from public supply wells tested for nitrate exceeded the Environmental Protection Agency's (EPA) Maximum Contaminant Level (MCL), established at 45 mg/L nitrate as nitrate (10 mg/L as nitrogen) (Burton and Belitz 2008; Kulongoski and Belitz 2007; Shelton et al. 2008).

Methods

Subregions and Equal Area cells

The TLB was divided into three subregions (figure 1), referred to as the Eastside Alluvial Fans, Basin, and Westside Alluvial Fan subregions, as delineated by the USGS (Burow et al. 1998). Alluvial fan deposits to the east are generally coarser as they originate from the granitic Sierra Nevada; sediments originating from the marine sedimentary rocks of the Coastal Range are generally finer. The Basin sediments area contains a combination of coarse-grained channel deposits and fine-grained flood deposits.

The SV is divided into two subregions (figure 2), the Monterey Bay subregion encompassing the northern portion of the SV, and the Salinas Valley subregion to the south. The areas are defined based on their similar geology as per a 2005 USGS GAMA study (Kulongoski and Belitz 2007). Aquifer conditions in the Monterey Bay subregion are considered confined to semi-confined, whereas aquifers in the Salinas Valley subregion are considered semi-confined to unconfined.

The subregions are further divided into equal area cells for the purpose of the temporal trend analysis. Equal area cells mitigate problems associated with clustering in spatial datasets by assigning a single value to each equal area based on the data contained within the cell. For the SV, equal area cells generated for a 2005 USGS GAMA study (Kulongoski and Belitz 2007) were used. For the TLB, the equal area cells were generated based on the methods used in the USGS GAMA studies (Scott 1990). First the yearly median nitrate concentration was determined for each well, for each year containing test data. Next, using these median concentrations for wells, the median annual concentration within each equal area cell was determined. The data were divided into two time periods; historical trends are represented by the years 1949–1999, and present trends are represented by the years 2000–2011.

Regional Kendall Test

The Regional Kendall (RK) test, a non-parametric regional statistical method, was used to test for long-term nitrate concentration trends in

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Spatial and Temporal Trends of Nitrate Concentrations in California's Tulare Lake Basin and Salinas Valley – *Continued*

the study area. Software developed by the USGS was used to perform the RK test (Helsel et al. 2006). The RK test applies the original Mann-Kendall test over many locations, and combines the results to determine if a trend exists over a region. The Mann-Kendall test operates on concentration differences between pairs of nitrate samples taken from the same location (equal area cells in this case). The RK provides a final tau correlation coefficient that ranges from -1 to +1. Additionally, it provides a p-value that represents the probability that there is no significant trend in the data (null hypothesis). For the RK test, the (Central) California Spatio-Temporal Information on Nitrate in Groundwater (CASTING) database was used (Boyle et al. 2012). At the time of analysis, the database contained 18,177 wells with 80,343 nitrate tests for the TLB and 2,109 wells and 16,663 nitrate tests for the SV. The raw data through time for the TLB is shown in figure 3.

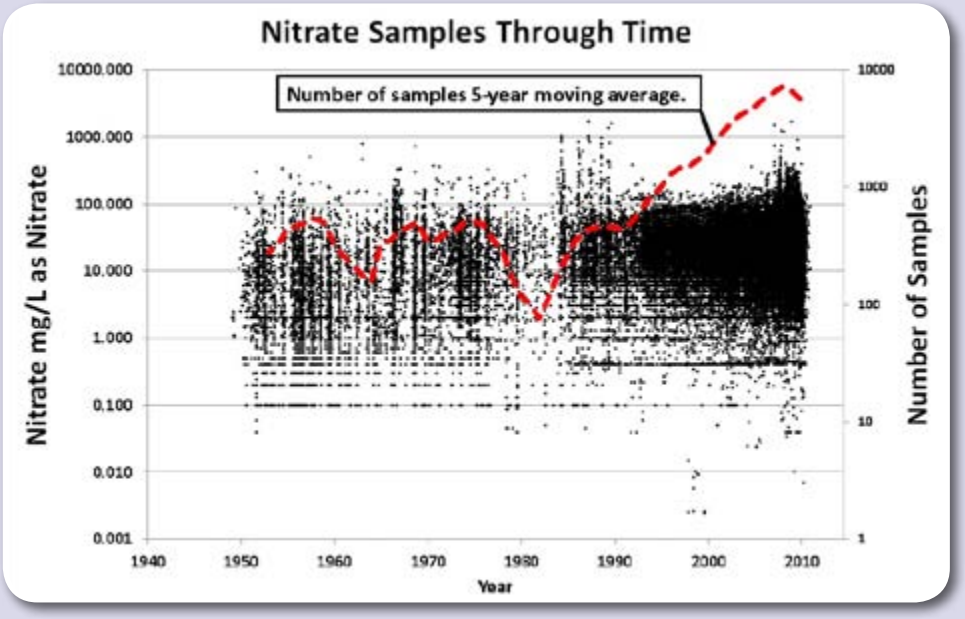

Figure 3: Samples through time

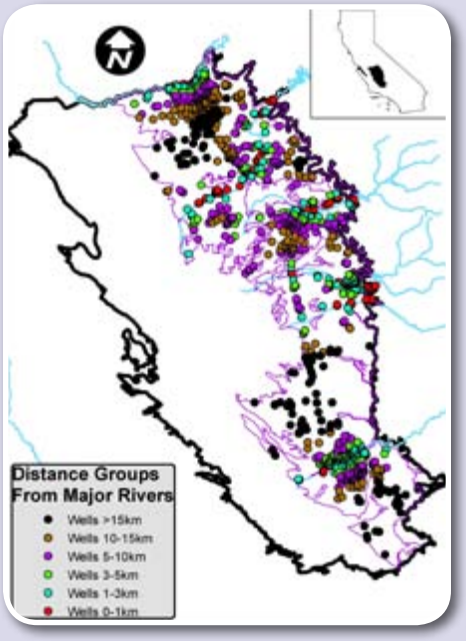

Figure 4: Well distances

Distance Groups for Spatial Trends

The TLB Eastside Fans subregion was chosen for investigation of spatial trends in major ion chemistry and nitrate concentrations because this area contains the greatest amount of well data, has relatively rapid infiltration rates due to the coarse grained sediment, and lacks laterally extensive confining layers. The California Drinking Water Source Assessment Program (CADWSAP) database was used for this analysis as it contains major ion analyses needed to construct Piper diagrams, which are used for visualizing relative concentrations of the major dissolved ions in water. Wells were divided into 6 groups based on their proximity to 6 major rivers (Kern, Kings, San Joaquin, Deer Creek, Tule, and Kaweah). Well distance groups consist of wells within 0-1km, 1-3km, 3-5km, 5-10km, 10-15km, and >15km of a major river (figure 4).

Results and Conclusions

Table 1 shows the results from the RK test. Three tests resulted in a p-value of greater than 0.01 (no significant trend at 99% confidence): the TLB Westside Alluvial Fans (2000–2011), and both time periods for the Salinas Valley subregion. The remaining regions and time periods resulted in positive trends that were statistically significant. The lack of a significant trend in the Westside Alluvial Fans is likely due to aquifer complexity imposed by the Corcoran Clay. The lack of a significant trend in the Salinas Valley subregion may be due to a combination of unconfined and semi-confined aquifer systems within one subregion, as well as a relatively large component of river recharge. Two reservoirs were constructed for the valley in 1957 and 1965 to increase river recharge by restoring perennial flow to the Salinas River. River recharge in the Salinas Valley subregion is now estimated to account for over 75% of the total stream recharge to groundwater for the valley. This shift in recharge, combined with heterogeneous aquifer conditions, likely obfuscates the detection of a clear trend over the entire subregion.

The spatial analysis shows increasing nitrate concentrations with distance from major rivers in the TLB's eastern

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Spatial and Temporal Trends of Nitrate Concentrations in California's Tulare Lake Basin and Salinas Valley – *Continued*

Region	tau	p	Annual Change in median NO_3^-
TLB Eastside Fans 2000-2011	0.148	<0.001	0.190
TLB Eastside Fans 1949-1999	0.136	<0.001	0.076
TLB Basin 2000-2010	0.141	0.001	0.012
TLB Basin 1950-1999	0.117	<0.001	0.021
TLB Westside Fans 2000-2010	0.089	0.350	0.000
TLB Westside Fans 1949-1999	0.097	0.003	0.040
Monterey Bay 2000-2011	0.175	0.001	0.400
Monterey Bay 1962-1999	0.163	<0.001	0.116
Salinas Valley 2000-2011	-0.143	0.147	-0.875
Salinas Valley 1962-1999	0.097	0.139	0.175

Table 1: RK results

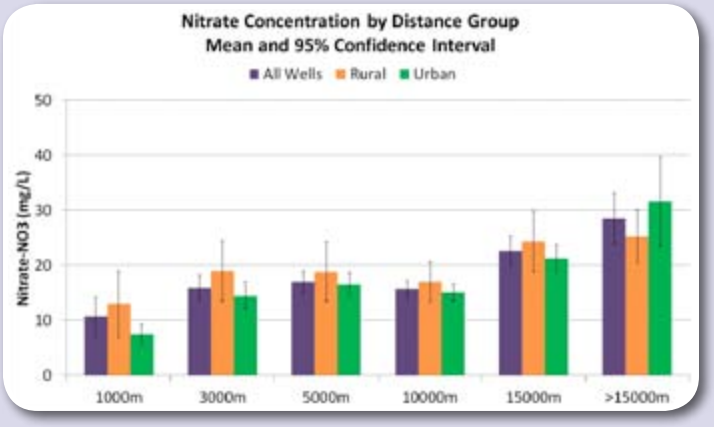

Figure 5: Samples through time

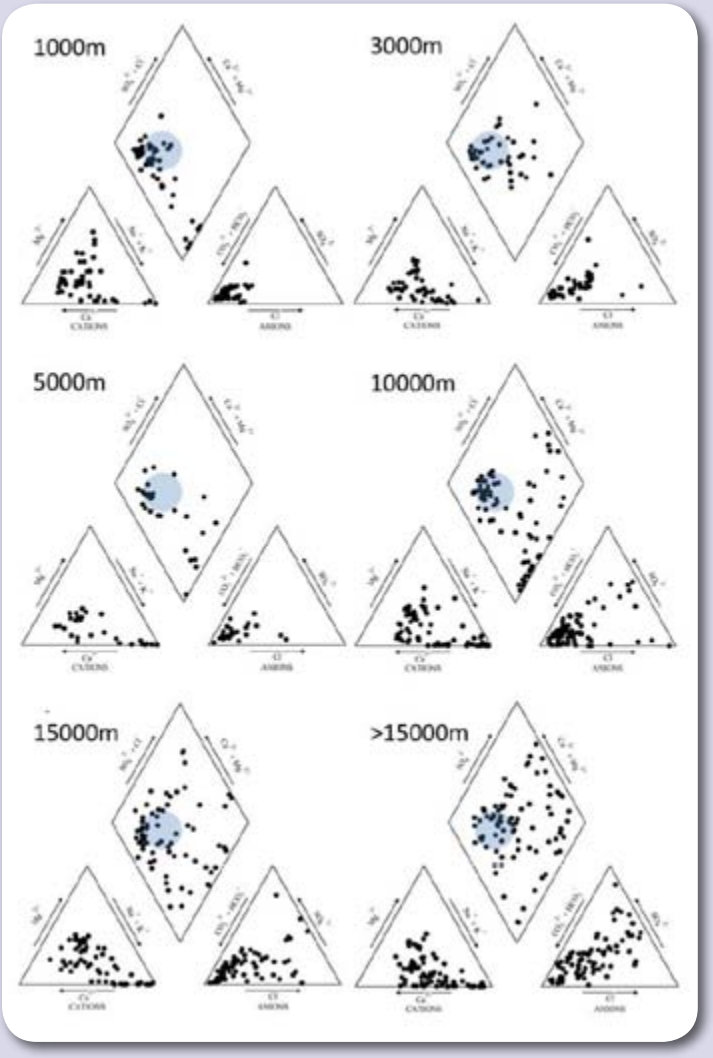

Figure 6: Piper

Alluvial Fans subregion (figure 5). Rivers provide a source of low-nitrate water to the subsurface, and as this water moves into the subsurface, it mixes with sources of diffuse recharge containing elevated nitrate. Additionally, the greater usage of flood irrigation with surface water on farms located near rivers likely dilutes nitrate concentrations in return flows compared to more efficient irrigation methods. The water withdrawn from wells located closer to major rivers likely consists of a larger fraction of low-nitrate recharge, resulting in lower overall nitrate concentrations. The farther a well is from a river, the greater the likelihood that the well is capturing recharge from more diverse, distributed sources. This is reflected in the piper diagrams (figure 6). Surface-water samples from major rivers draining the Sierra Nevada generally fall within the blue circle on the piper diagrams, indicating a narrow range of calcium-carbonate-type water. Samples from wells located farther away from major rivers generally plot outside of the blue circles, indicating a wider variety of water types reflecting different geochemical processes and sources of recharge.

These results agree with the projections of Fogg et al. (1999) and Weissmann et al. (2002), who presented a theoretical basis for increasing nitrate concentrations at the regional scale. Increasing trends at the regional scale support the theory that wells withdraw water with a wide distribution of ages, and that as time moves on, wells will draw in greater fractions of potentially contaminated water resulting in increasing nitrate concentrations in the combined output

Continued on the following page…

Spatial and Temporal Trends of Nitrate Concentrations in California's Tulare Lake Basin and Salinas Valley – *Continued*

from the well. The spatial trends presented here, however, show that there exists spatial variability in the levels of contamination, even though the region as a whole shows increasing trends in nitrate concentrations.

Recent attention on nitrate contamination has spurred advancements in fertilizer use efficiency at the field scale with the goal of reducing nitrate loading to groundwater. However, travel times to supply wells are typically on the order of decades to centuries, meaning that there will likely be a significant lag in time before the results are seen at a regional scale. Nonetheless, efforts made today to improve nitrate loading to the subsurface are necessary to ensure the long term sustainability of groundwater quality in California.

Acknowledgements

This research was made possible from financial support from the SWRCB via the UC Davis SBX2 1 Nitrate study. The author would like to thank Dr. Thomas Harter and Dr. Graham Fogg for their help and support.

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Making a Difference: National Groundwater Awareness Week

By Cliff Treyens, NGWA

Recently, a well owner called the National Ground Water Association with questions. His well's recovery time had worsened over the years and he didn't know what to do. After explaining some possible causes, NGWA referred him to its http://wellowner.org Website for more information and suggested he use the site's Contractor Lookup function to find someone to inspect his well.

His relief and gratitude were unmistakable. "This information is *really* helpful. I wasn't sure what to do. I *really* appreciate it!" he said, encouraged.

Similarly, National Groundwater Awareness Week (March 10-16) is a chance for groundwater professionals everywhere to educate the public about groundwater and wells, and—in the process—showcase your expertise, professionalism, and concern for the public's welfare. A side benefit may be that as you provide news the public can use, you may find potential customers knocking at your door.

Part of the Awareness Week message is to communicate the value of groundwater and the need to protect it. For those who rely on private wells for their water supply, Awareness Week also is a great time to stress the importance of proper well construction, regular well maintenance and water testing, and water treatment if necessary.

By sharing your expertise with the public, you also are marketing your company. This often translates into business. For example:

- One NGWA member in Minnesota has done radio interviews and presentations at civic club meetings, resulting in both connections and business
- Another member in Illinois has used pre-produced radio spots during Awareness Week, resulting in customers
- A number of NGWA contractors have promoted Awareness Week on their company Web sites and Facebook pages, reaching both current and prospective customers.

So how do you begin? Just go to www.ngwa.org, click on the "Media Center," and from there you can click on "Awareness Week."

Once you arrive on the Awareness Week Web page, look over all the content under "Awareness Week" in the left-hand navigation bar, but particularly:

- Get Involved
- Sample news release
- Sample radio spots
- Promotional tools for NGWA members.

These materials can easily be copied or modified for use in news releases, letters to the editor, guest columns, newspaper advertising, handouts, presentations, or booth displays. To learn more about how to raise public awareness, get an electronic copy of NGWA's Public Awareness Toolbox by emailing NGWA Public Awareness Director Cliff Treyens at ctreyens@ngwa.org.

Participating in Groundwater Awareness Week is a win-win—a win for the public and a win for your business.

GRA Requests Nominations for the 2013 "Lifetime Achievement" and "Kevin J. Neese Awards"

The purpose of the GRA Awards Program is to recognize noteworthy projects and exceptional individual contributions related to the understanding, protection, and management of groundwater resources. The objectives of the annual Awards Program are:

1. To provide recognition to individuals who have demonstrated leadership and continuous dedication in groundwater hydrology
2. To provide recognition for unique contributions to groundwater hydrology in 2012–2013.

All nominations for the Lifetime Achievement and Kevin J. Neese Awards must be received by David W. Abbott (dabbott@dbstephens.com or 607 Chetwood Street, Oakland, CA 94610-1433) no later than **Friday, June 21, 2013**.

Nominations should be completed using the nomination forms available on the GRA website at http://www.grac.org/awards.asp. Nominations should not exceed one page, identify the award for which the nomination is made, and include justification for the award based on the criteria listed below.

The GRA Awards will be presented to the recipients selected by the GRA Board of Directors during the 29th Biennial Groundwater Conference and the 22nd GRA Annual Meeting in Sacramento, CA, October 8-9, 2013.

Awards

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

Previous Lifetime Achievement Award recipients include:

- 2012 – Anne J. Schneider*
- 2011 – Joseph C. Scalmanini
- 2010 – John A. Cherry, Ph.D.
- 2009 – T.N. Narasimhan, Ph.D.
- 2008 – Perry L. McCarty, Ph.D.
- 2007 – Herman Bouwer, Ph.D.
- 2006 – Glenn A. Brown
- 2005 – Luna P. Leopold, Ph.D.
- 2004 – John D. Bredehoeft, Ph.D.
- 2003 – Rita Schmidt Sudman
- 2002 – Thomas W. Dibblee
- 2001 – Carl J. Hauge
- 2000 – Joseph H. Birman, Ph.D.
- 1999 – David Keith Todd, Ph.D.
- 1998 – Eugene E. Luhdorff, Jr.

*posthumously.

Kevin J. Neese: recognizes significant accomplishment by a person or entity within the most recent 12- to 24-month period that fosters the understanding, development, protection, or management of groundwater.

Previous Kevin J. Neese Award recipients include:

- 2012 – David L. Orth, General Manager of the Kings River Conservation District for his leadership and dedication to the collaborative initiatives to develop the Upper Kings River Basin Integrated Regional Water Management Plan
- 2011 – Sacramento County Environmental Management Department for its Abandoned Well program, the first of its kind in California
- 2010 – Senator Fran Pavley for leadership in the enactment of the comprehensive, statewide groundwater level monitoring legislation in California
- 2009 – U.S. Geological Survey, California Water Science Center for development of a new 3-dimensional groundwater-modeling tool for California's Central Valley and report "Groundwater Availability of the Central Valley Aquifer," Professional Paper 1766
- 2008 – Orange County Water District for its Groundwater Replenishment System (GRS), a new water purification plant
- 2007 – University of California Cooperative Extension Groundwater Hydrology Program for its efforts to engage scientists, regulators, farm advisors, dairy industry representatives, and dairy farmers to better understand the effects of dairy operations on water quality

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GRA Requests Nominations for the 2013 "Lifetime Achievement" and "Kevin J. Neese Awards" – *Continued*

- 2006 – Senator Sheila Kuehl for her work to improve the production and availability of information about California's groundwater resources
- 2004 – California Department of Water Resources for publication in 2003 of its updated Bulletin 118: "California's Groundwater."
- 2002 – Glenn County Water Advisory Committee for formulating a significant groundwater management ordinance that was adopted by the Glenn County Board of Supervisors
- 2001 – American River Basin Cooperating Agencies and Sacramento Groundwater Authority Partnership for fostering the understanding and development of a cooperative approach to regional planning, protection and management of groundwater
- 2000 – Board of Directors of the Chino Basin Watermaster for delivering a remarkable OBMP that created a consensus-based approach for making water supplies in the Chino Basin more reliable and cost effective
- 1999 – Governor Gray Davis for his work and leadership in addressing MTBE.

GRA Welcomes the Following New Members

NOVEMBER 17, 2012 – FEBRUARY 22, 2013

Michael Akoto	Geocon Consultants Inc.
William Alley	National Ground Water Association
Nathan Anderson	Layne Christensen Company
Diane Barclay	California State Water Resources Control Board
Greg Barclay	Conestoga-Rovers & Associates
Dylan Boyle	Luhdorff & Scalmanini C.E.
Reid Bryson	Luhdorff & Scalmanini C.E.
Thomas Cervantes	San Francisco State University
Julie Chambon	Geosyntec Consultants
Reuben Childress	Foothill Conservancy
Dean Coblish	National, EWP
Michael Crews	Gannett Fleming
Bryan DeMucha	Wood Rodgers
David Dixon	Roux Associates Inc.
Scott Drew	Golder Associates
Jennifer Duffield	AMEC Environment & Infrastructure, Inc.
Dylan Duverge	Dudek
Marina Feraud	UCSB
Laura Frost	Blue Oak Design
Thomas K. Gallagher	Nevada Water Solutions, LLC
Bruce Godfrey	Curtis & Tompkins, Ltd.
Joseph Gonzales	AMEC Environment & Infrastructure, Inc.
John Goyette	Curtis & Tompkins, Ltd.
Robert Greenberg	Todd Engineers
John Gregory	Farella Braun + Martel LLP
Julie Grim	UDSA-NRCS
Karen Gruebel	Erler & Kalinowski, Inc.
Julie Haas	Department of Water Resources
Yonas Habtemichael	Florida International University
Benjamin Hagedorn	
Simon Hague	Curtis & Tompkins, Ltd.
Laura Hall	Quad Knopf
Kelly Hoggan	Haley & Aldrich, Inc.
Chris Liyama	Cardno ATC
Jaime Oscar	Roscoe Moss Manufacturing Company
Robert Johnson	Monterey County Water Resources Agency
Christy Kennedy	RMC Water & Environment
Robert Krimmer	Arnold LaRochelle Mathews VanConas & Zirbel LLP
Peter Kwiek	Monterey County Water Resources Agency
Anthony La	Water Replenishment District of Southern California
Garry Lawler	Morgan Stanley
Katherine Lockhart	UC Davis
John Mathews	Arnold LaRochelle Mathews VanConas & Zirbel LLP
Casey Meusel	Pajaro Valley Water Management Agency
Danielle Moss	Larry Walker Associates
Ye Myint	EMAX Laboratories, Inc.
Peter Navas	Los Angeles County Sanitation Districts
Craig Pelletier	Iris Environmental
Elizabeth Peters	San Francisco State University
Jon Philipp	Johnson Wright, Inc.
Steve Quintero	Roscoe Moss Manufacturing Company
Richard Raymond	Terra Systems, Inc.
Bruce Rucker	CE2 Corporation
Benjamin Scandella	MIT
Debora Sharpless	West Coast Well Logging Services
Justin Shobe	Luhdorff & Scalmanini C.E.
Alka Singhal	ENVIRON International Corporation
Marisa Van Dyke	Regional Water Control Board
Chinh Vu	URS Corporation
Jake Wilson	Conestoga-Rovers & Associates
Ailco Wolf	Clear Creek Associates
Ryan Woodward	Woodward Drilling Company, Inc.
Don Zdeba	Indian Wells Valley Water District
Mark Zirbel	Arnold LaRochelle Mathews VanConas & Zirbel LLP

2013 Contributors to GRA – Thank You

(as of 2/22/13)

FOUNDER *($1,000 and up)*
Brownstein Hyatt Farber Schreck
Janie McGinn
Nossaman LLP
Roscoe Moss Company

PATRON *($500-$999)*

CORPORATE *($250-$499)*

CHARTER *($100-$249)*
David Abbott
Stanley Feenstra
Thomas Harter
Mary Kean
Sally McCraven
Steven Phillips

SPONSOR *($25-$99)*
Michael Akoto
Cathy Aviles
Thomas Ballard
Diane Barclay
Richard Booth
Ahnna Brossy
Kevin J. Brown
Mary Rose Cassa
Bruce Castle
Julie Chambon
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Pawan Sharma
Linda Spencer
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Michele Staples
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Michael Wright
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Gus Yates
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Tim Rumbolz
Jeffrey Zane

2013 Directors Election Results

The election for GRA's 2013 Board of Directors is officially completed. Board incumbents David Abbott, Brad Herrema, Sarah Raker and Jim Strandberg were re-elected, and Adam Hutchinson was elected as a new director.

Roy Herndon retired from the Board at the end of 2012 after serving for six years. GRA extends its sincere appreciation to Roy for his dedicated service.

Roy Herndon (left) receives GRA's Director Appreciation Plaque from GRA President Sarah Raker (right)

Central Coast

By Jeff Kubran
Branch Secretary

The November meeting featured Marc Wuttig of CH2M Hill, who discussed an EPA Superfund site in Ventura County. The site is the former Halaco Engineering Co. that processed scrap metal from 1965–2004. The south side of the property was used for dumping waste from the scrap metal operation, which amounted to a large unstable pile. Constituents of potential concern include metals, salts, ammonia, radionuclides, dioxins/furans, PAHs, PCBs, and other organic compounds. Lead may be the most important environmental concern at the site.

There is a semi-perched aquifer over a confining clay layer above four main aquifers that supply water to agriculture and municipalities. Sampling was conducted at multiple depths to identify contamination in the perched and main aquifers. So far, no contaminants have been detected in the main aquifers. Groundwater movement is generally towards the ocean, but the contaminant plume, which moved down the perched aquifer and laterally over the clay layer, appears to be stable. Water quality contours were generated for TDS levels up to 100,000 ppb. Next steps for the site are to complete the risk assessment, develop soils and sediment cleanup levels, install new wells as needed, assess groundwater quality impacts, continue waste reuse evaluation, and conduct a feasibility study.

In January, Nicole Blute of Hazen and Sawyer talked about treatment options for hexavalent chromium, perchlorate, and nitrate. Chromium can be naturally occurring or from chrome plating or other anthropogenic sources. The reduced form of chromium is trivalent chromium, or Cr(III), which is required for some metabolic functions. However, hexavalent chromium, or Cr(VI), is a known carcinogen. A new MCL is expected to be released in July of 2013; this could affect over 7,000 sources within California. A study began with the City of Glendale and other interested groups to determine the most effective treatment solutions. A pilot project was built that had a 100 gpm reduction-coagulation (RCF) system and a 425gpm weak base anion exchange (WBS) system. RCF uses a reducing compound to reduce the chromium to Cr(III), then a coagulant is added and the solution is filtered through a sand and anthracite medium. The WBS system uses a resin media in a lead-lag tank configuration that captures the chromium using an anion exchange process.

Perchlorate, another pollutant of concern, comes from solid rocket fuels, Chilean fertilizers, and other sources. Strong base anion exchange, biological treatment, and reverse osmosis are the leading treatment technologies. Nitrate, another common contaminant, is often treated using strong base anion exchange, biological remediation, and reverse osmosis.

Anion exchange is gaining popularity due to its simplicity and low cost. Water quality issues dictate the type of resin needed and chlorine must be added downstream of the treatment. Biological remediation is also possible using a fixed bed reactor; however, it can be a complex process and the outflow water needs to be treated to surface-water standards.

Sacramento

By Troy Turpen,
Branch Secretary

November's meeting featured an informative presentation by Rodney Fricke, PG, CHG of Aerojet Environmental Remediation on "Biodegradation of Nitrate and Perchlorate in a Gravel Bed Reactor." Several bioremediation methods have been tested and utilized at Aerojet's Inactive Rancho Cordova Test Site. Mr. Fricke's outstanding presentation described the current operation of a gravel bed reactor (GBR) for treating nitrate and perchlorate. Citric acid is the electron donor and indigenous bacteria utilize the oxygen from nitrate and perchlorate during the respiration of the citric acid. The GBR was constructed using a 40-foot shipping container, PVC liner, and ¾-inch crushed rock; it has a pore volume of about 7,200 gallons. The GBR is currently operated at about 30 gallons per minute (gpm) but has a probable hydraulic capacity of 100 gpm. Influent nitrate concentrations varied from 10–13 milligrams per liter (mg/l) during 2012; effluent concentrations have been 'non-detect' to 0.2 mg/l. Perchlorate concentrations varied from 0.1–0.3 mg/l in the influent, but have been 'non-detect' in effluent during 2012. Much higher perchlorate concentrations could be treated in the GBR, based on a column study of the process. Sulfate can be reduced in the GBR if the Oxidation-Reduction Potential (ORP) is too low. Iron and manganese are mobilized by the low ORP but have generally declined in concentration.

Continued on the following page…

Sacramento – *Cont.*

The Gravel Bed Reactor at Aerojet

The December meeting was the traditional joint holiday meeting with the Association of Engineering Geologists and featured Dr. John W. Williams, Professor Emeritus at San Jose State University; his presentation was on "Professional Ethics—An Essential Element of the Geoscience Profession." Dr. William's presentation tackled a potentially dry topic and made it engaging. In contrast to personal ethics, professional ethics are described as the use of specialized knowledge and skills by a profession to provide services to the public. This moral activity is governed by a set of standards—codes of ethics, adopted by the professional community. The medical, legal, and engineering professions have had formal standards for many years with the formalization of medical ethics dating from the Hippocratic Oath; legal ethics were reinvigorated by the events of the 1972 Watergate break-in; and the 1986 Challenger disaster caused changes in the engineering community. More recently, the growth of state geological licensing has influenced the creation of formal geoscience codes of ethics.

To evaluate the implementation of formal geoscience codes of ethics, many factors should be considered, including:

- The commonly held belief that ethics are established early in life by family experiences, religious teachings, peer interaction, etc., and, therefore, the assumption is made that upon entering a profession one already has a pattern of knowing and doing right or wrong
- There is confusion over the important differences between personal and professional ethics
- Currently there is limited formal education in professional ethics in the geoscience classes of colleges and universities
- The public perception is that professional ethics are not really enforced in many professions and thus by default are meaningless
- Only a portion of one generation of geoscience practitioners has been exposed to formal codes of ethics
- Until recently there was limited scientific evidence that members of the profession place significant emphasis on the importance of professional ethics.

Against this challenging backdrop, there are some positive signs of improvement such as:

- An increase in the number of formal codes of ethics associated with state licensing
- The allocation of personnel and other resources at the state level for ethics enforcement
- Expanded availability of public information about ethics enforcement
- The increase in professional ethics instruction in academic settings
- The inclusion of professional ethics questions on national licensing examinations

- Professional ethics workshops and presentations at professional society meetings
- Increasing recognition that geoscientists are more involved in increasingly complex technical and ethical situations with greater consequences for poor quality work.

We can be optimistic that increased emphasis in geoscience professional ethics will lead to a greater confidence by the public in the quality of our work.

San Francisco

By Jacob Gallagher
Branch President

Every year the Regional Water Quality Control Board's regulatory update is the highest attended meeting for the San Francisco Branch. The January 2013 meeting was no different and kicked the year off to a fantastic start. Stephen Hill, Mary Rose Cassa and Chuck Headlee brought everyone up to date on changes within the Board's organization, and presented accomplishments of 2012, and future goals, guidance, policies and plans. For 2013, in addition to continuing work that supports the office's stormwater and TMDL goals, the Board is hoping to focus more on quarries and mines. The primary focus in 2013 is naturally going to be centered on implementation of the newly adopted low threat closure policy (LTCP), and on completion of the ESL update that has slowly been coming to fruition.

The basic structure of the UST LTCP was presented, followed by a discussion of how the Board intends to implement it. The Board's key goals are as follows:

- All sites reviewed by Regulatory Agency by August 2013
- Review results must be publicly available
- Generate uniform LTCP review reports.

With proper implementation, the Board hopes to minimize the number of open cases when the UST fund sunsets, to have no LUFT-impacted supply wells or human health exposure, and to reduce costs and agency response times.

An exciting development in 2012 was filling the staff toxicologist position, which paved the way for significant progress to be made on the ESL update. An excel workbook will be published on the Board's website, and a revised guidance document will be published shortly. A brief discussion on the magnitude and difficulty of tackling the state's dry cleaner spill sites concluded the meeting. With the elimination of redevelopment agencies, cleanup efforts are increasingly relying on insurance for funding, which presents significant regulatory, legal and financial challenges.

The Branch thanks Confluence Environmental, the January scholastic sponsor.

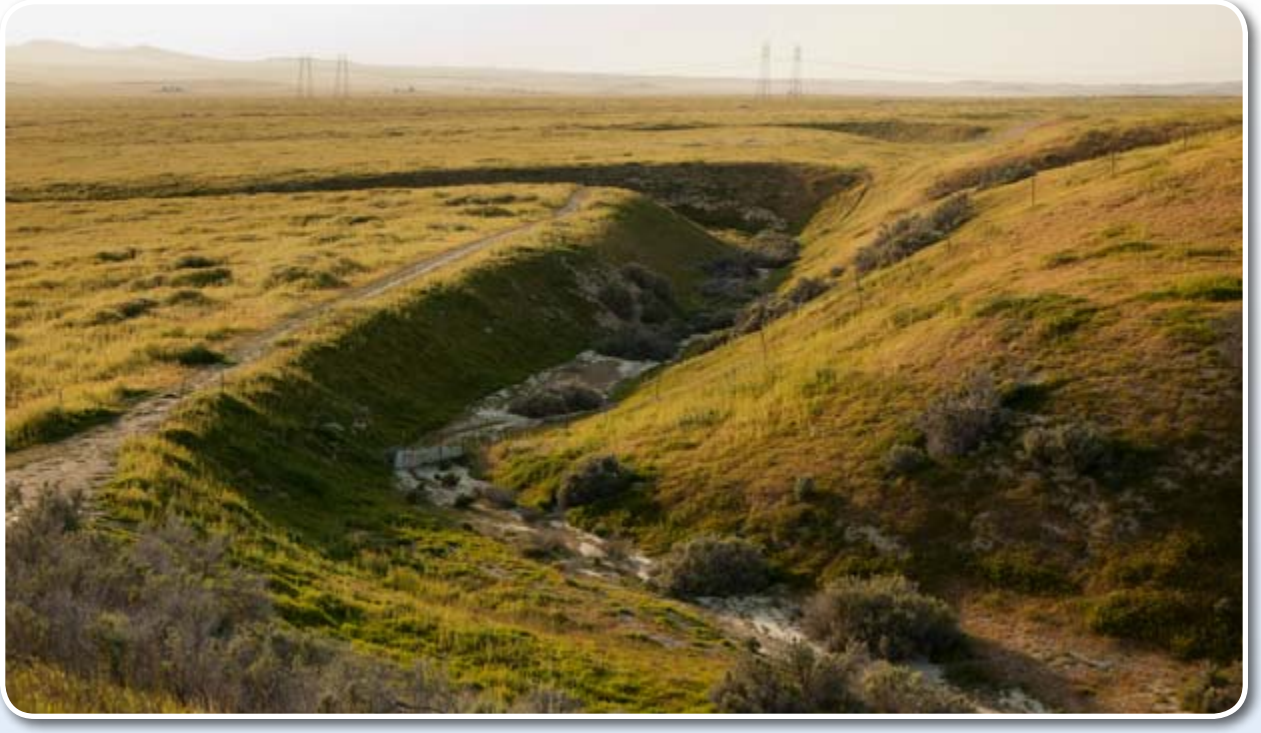
In February, the Branch met at its South Bay venue in Santa Clara. Dr. William Alley presented the 2012 David Keith Todd Lecture: Communicating Groundwater Science: From Real-Time to a Million Years. The talk served as a travelogue in time with a series of examples that examined temporal scales ranging from real-time measurements to forecasting a million years into the future. One of the great challenges facing groundwater hydrologists is to communicate the highly variable spatial and temporal characteristics of groundwater systems and their responses to human and natural stresses. From annual responses to droughts to decadal-to-millennial scale responses to pumping, and forecasts for nuclear waste disposal, Dr. Alley covered a broad range of the orders of magnitude we encounter in the geosciences in the context of the human (particularly politics and policy) time scale.

Southern California

By Emily Vavricka,
Branch Secretary

On December 12, 2012, the GRA Southern California Branch held its Annual Holiday Celebration and GRA Member Appreciation event. In an effort to promote end-of-the-year spirit and to show appreciation to GRA Members, the Branch hosted a free of charge event with food provided. Southern California Branch Officers gave a presentation and overview of GRA, highlighting membership benefits, GRA State and local events, and described the many opportunities for members to become involved in GRA, including participation on GRA Committees and the potential of serving as a local Branch officer. As part of this event, the Southern California Branch also welcomed and provided collaboration opportunities with other water organizations, including Water for People, Charity Water, Engineers Without Borders, and Lifewater International. In an effort to continue and develop its local Scholastic Fund, the Branch also held a holiday raffle, for which all proceeds went to the Branch's Scholastic fund. The Branch would again like to thank both GRA Members and non-members who participated in the holiday raffle in support of the local Southern California GRA Branch Scholastic fund for the December meeting.

Active participation of local Branch Members is important to the long-term health of the organization. During 2013, the Branch encourages everyone to contribute by regular meeting attendance, providing ideas for speakers and events, and active participation at the officer level.



The San Andreas Fault

Geomorphic features and tectonic landforms associated with the San Andreas Fault are beautifully exposed and well dated at Wallace Creek in the Carizzo Plain National Monument, located about 125 miles northwest of Los Angeles. The fault crosses the photo from lower left to upper right. When the channel of Wallace Creek was first eroded, its path was straight across the fault. During the past 3,700 years, the channel has been offset about 430 feet in a right-lateral sense. Wallace Creek was also offset approximately 33 feet during the 1857 Fort Tejon earthquake.

Remnants of an older beheaded channel are still visible to the right and below the central transmission towers. About 10,000 years ago, the beheaded channel lined up with the upstream segment of Wallace Creek shown in the right foreground.

Radiometric dating of offset features at this locality demonstrates that the San Andreas Fault has been slipping at an average rate of 1.4 inches per year for the past 13,000 years. This rate is only 60 percent of the total relative velocity between the North American and Pacific Plates, which indicates that significant motion must also be accommodated by other structures throughout the western US.

In this northerly view along the San Andreas Fault, the Temblor Range is on the North American Plate (right) and the Carizzo Plain is on the Pacific Plate (left).

Photographed along the Wallace Creek trail (GPS coordinates: 35.27112167, -119.82667833)
John Karachewski, PhD (DTSC), www.geoscapesphotography.com

Additional information about the remote Carrizo Plain National Monument is available at:
http://www.blm.gov/ca/st/en/fo/bakersfield/Programs/carrizo.html.

Trail guides to the geology of the Carrizo Plain and San Andreas Fault at Wallace Creek are available at:
http://www.scec.org/wallacecreek/pdf/.