GROUNDWATER RESOURCES ASSOCIATION OF CALIFORNIA
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Summary of GRA's Annual Legislative Symposium

By Tim Parker, GRA Legislative Committee Chairman
Chris Frahm and Rosanna Carvacho, GRA Legislative Advocates

On April 29th, GRA hosted its Annual Legislative Symposium at the Citizen Hotel in Sacramento. The topic was *The Infancy of California's Sustainable Groundwater Management Act – What's Next?* The Symposium was again hosted in cooperation with the California Groundwater Coalition, and sponsored by the Metropolitan Water District of Southern California, Cadiz, Golden State Water Company, Water Resources Consultants, Inc., Gordon Hess & Associates, Inc., and Brownstein Hyatt Farber Schreck.

Martha Guzman-Aceves, Deputy Legislative Affairs Secretary for Environment, Energy, Water and Agriculture, is a key advisor to the Governor on water and discusses current and future Administration plans.

SWRCB Board Member Dorene D'Adamo discusses the Board's actions to implement the Governor's statewide mandatory urban water conservation measures, SGMA implementation, and Proposition 1 funding availability.

The Symposium featured a diverse group of speakers, including Legislators and other state officeholders, such as Governor Brown's Deputy Legislative Affairs Secretary Martha Guzman–Aceves and Water Board Member Dorene D'Adamo. Each distinguished speaker shared with symposium attendees their perspective on recent and ongoing developments in state water policy, overlaying the ever-present backdrop of the drought.

Martha Guzman-Aceves provided an update on meetings the Governor was having with various parties throughout the state, proposed elements included in the upcoming Governor's revised budget release, and his latest executive order detailing a 40% reduction in greenhouse gases. Although she could not elaborate, Martha alerted the attendees that the

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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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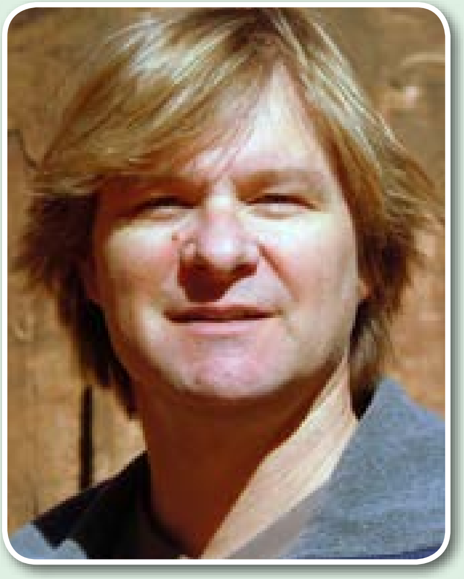
HYDROVISIONS is the official publication of the Groundwater Resources Association of California (GRA). GRA's mailing address is 1215 K Street, Suite 940, Sacramento, CA 95814. Any questions or comments concerning this publication should be directed to the newsletter editor at editor@grac.org or faxed to (916) 231-2141.

Blame It on Blob?

By Ted Johnson



Greetings GRA Members and other groundwater enthusiasts, and welcome to another edition of "…and the [drought] beat goes on…"

In my last article, I was trying to jinx the drought by saying how dry it had been, hoping that would break the curse and cause copious amounts of rain and snow in March and April. Unfortunately, that didn't happen. With the exception of an unusual late-season storm on April 24 that brought over an inch of rain to Sacramento and a foot of snow to the Sierra Nevada, this season is in the books as another dry year, and California's 4th year of drought.

It is interesting to hear of the weather phenomena attributed to the drought. I have previously described the persistent "Ridiculously Resilient Ridge"—the high-pressure zone blocking the cold Alaskan air and storms from dropping down into California, Oregon, and Washington. Now I have been introduced to a new weather demon simply known as "The Blob." I love these technical terms.

The Blob is a large mass of unusually warm water—on average 3.6 degrees Fahrenheit greater than normal—in the Pacific Ocean, originally measuring 1,000 miles long by 1,000 miles wide, and 300 feet deep. It was first noticed in the fall of 2013 and has grown in size, now extending from Mexico to Alaska. The Blob was named by Nick Bond, a University of Washington climate scientist and the Washington State Climatologist at the Joint Institute for the Study of Atmosphere and Ocean in Seattle. The warm water is impacting cycles of marine life, but also may be contributing to our drought by causing air passing over the Blob to become warmer than normal, resulting in drier conditions as it moves onshore. Is this why San Francisco set the record for the driest January–March period on record, or why the Sierra Nevada snow pack was measured at an astonishing 80% lower than its previous all-time low? Blame it on Blob?

In response to the drought, Governor Jerry Brown on April 1 ordered mandatory water-use reductions for the first time in California's history, declaring that the drought had reached near-crisis conditions. He directed the State Water Resources Control Board to impose a 25% reduction on potable urban water usage (from 2013 usage) through February 28, 2016, which the Board has done by developing a detailed reduction plan for each water agency, including potential penalties of up to $10,000 per day for non-compliance. On April 28th, the Governor raised the heat by releasing a proposal to grant cities and counties the power to assess fines of up to $10,000 per occurrence on serious water wasters. On May 5th, the State Water Resources Control Board adopted the 25% mandatory water conservation regulation.

This is serious stuff. I recently read an article that described how over 1,000 water wells (1,013 to be exact) have gone dry in Tulare County alone due to this current drought. Tulare County, which is in the southeastern San Joaquin Valley between Fresno and Bakersfield, has a long history of undesirable results from groundwater pumping, including large groundwater-level declines and land subsidence. Even so, it is alarming that the latest figures on well failures in Tulare County account for more than half of the wells that have gone dry in all of California since January, 2014. Families are literally without water, and only those with enough money can afford to drill new, deeper wells. Unfortunately, they have to wait in line for as long as two years for a new well due to the high demand for drilling rigs these dry days.

Groundwater basins can and should be managed sustainably to not only provide some or all of a water resources portfolio for the overlying users and environment, but also as an emergency savings account to tap into during drought. To do that successfully, the groundwater basins must be in good shape before the drought starts. There will always be more droughts. I work at the Water Replenishment District of Southern California, where we have the general philosophy "fill up the basins in the good times to survive the droughts we know are coming." We operate the groundwater basins like a surface storage reservoir, filling and draining them as needed, but under managed and controlled conditions. So far this has worked, but it took adjudications to reduce pumping, importing surface water to make up for the reduction in pumping, conservation, extensive managed aquifer recharge projects using recycled and imported water, and intensive and continued monitoring. It

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Blame It on Blob? – *Continued*

can be done, but it isn't easy or cheap. The alternative is running out of usable groundwater and causing undesirable effects, such as seawater intrusion, land subsidence, streamflow depletion, and severe disruption to the economy and human welfare.

The new Sustainable Groundwater Management Act of 2014 (SGMA) requires all medium- and high-priority groundwater basins in the state to reach sustainability. The SGMA is a fantastic accomplishment for the state, but many basins might be decades away from reaching true sustainability because of the challenges, controversies, expense, and legal battles that will ensue. Will expedited adjudications become a popular alternative solution? Can basins become sustainable without access to sufficient replenishment sources? Will the drought be over next year, or is this just the beginning of a mega-drought lasting two or more decades?

Time will provide the answers to these questions, but GRA and its members can be part of the answers too. There is plenty of opportunity for geoscientists, water resources professionals, academics, researchers, and others to help put the pieces together for responsible groundwater management. Just think of all the data collection, monitoring-well construction, development of conceptual and numerical models, geophysical exploration, remote sensing, and other techniques that will be applied to comprehend basin water budgets, monitor storage changes, and determine management options. A lot of work will need to be done by well-trained, skilled professionals.

GRA will continue to provide information and education on the emerging elements of SGMA as they unfold. Our Legislative Symposium on April 29, 2015, held in conjunction with the California Groundwater Coalition, was titled *The Infancy of California's Sustainable Groundwater Management Act – What's Next*? It featured many terrific high-ranking speakers from the State Water Resources Control Board, the California Water Commission, the Brown Administration, the Department of Water Resources, and the Metropolitan Water District of Southern California. We also had a roundtable discussion on the *Implementation of the Sustainable Groundwater Management Act: Approaches to Groundwater Sustainability Agency Formation*, and a panel discussion featuring diverse perspectives on Streamlined Adjudication.

Our Contemporary Groundwater Issues Council, a select group of invited groundwater and policy experts that advise GRA on potential actions and solutions to address the major groundwater issues of the day, met on May 28th at the UC Davis Buehler Alumni Center to discuss SGMA. The general theme of the meeting was "*Contributing to SGMA implementation, groundwater sustainability planning and best groundwater management practices in California.*" Our objectives were to provide input on key elements of SGMA implementation to the state, and to generate recommended actions for GRA on SGMA implementation over the next two years.

GRA will also hold over 10 webcasts (GRACasts) and/or conferences on SGMA to inform you of the latest developments and procedures for moving forward with Act compliance, so check our web page at www.grac.org for the latest program information. Please mark your calendars and plan on attending the 30th Biennial Groundwater Conference to be held October 6–7, 2015, in Sacramento, preceded by a field trip on the 5th. This conference, our biggest event of the year, has a 60-year history and will be two days of dual-track sessions on the drought, groundwater quality, and groundwater supply, all issues tied closely to sustainability.

Surely, with all of the information, talent, energy, motivation, science, and cooperation going on in our groundwater industry right now, the solutions will be found and sustainability will be reached. But if it isn't…just blame it on Blob.

Rock on!

TJ

Summary of GRA's Annual Legislative Symposium *– Continued from page 1*

SWRCB Chief Deputy Director Jonathan Bishop discusses regulation of hydraulic fracturing and deep injection of produced waste water, and interim monitoring of hydraulic fracturing sites.

Assemblymember Devon Mathis (R-Visalia), Member of Assembly Water, Parks and Wildlife Committee, discusses his bills on gray water and groundwater recharge.

Dave Orth, California Water Commissioner and General Manager, Kings River Conservation District, discusses Proposition 1's $2.7B in storage funding and the Water Commission's process for determining how to distribute the funding.

Governor was going to make an announcement on the Bay-Delta Conservation Plan the next day. We are always treated to a thorough and thoughtful presentation from Martha.

Legislators who presented during the symposium include Assemblymembers Williams, Levine, Salas, Mathis, Rendon and Perea. Attendees heard directly from the legislators regarding their focus to drive reliance on emerging technologies; the need to share and collaborate, and not compete; the need for long-term infrastructure; their priorities for Proposition-1 bond expenditures; streamlining the CEQA process to allow projects, including water recycling projects, to move forward faster; and the varying perspectives on surface water and groundwater. Those in attendance got first-hand updates on pending legislation from authors of the various bills and key committee chairs.

Our keynote speaker was Roger Patterson, Assistant General Manager of the Metropolitan Water District of Southern California, who gave us insight on the history of the District and its foresight regarding groundwater management. He advocated for new partnerships outside

Adjudication Reform Panel discusses future legislation in development to reduce the time and cost of groundwater rights litigation. Left to right, Moderator Tim Parker, Parker Groundwater; Gordon Burns, CalEPA Undersecretary; Ken Manning, Executive Director, San Gabriel Basin; Jack Rice, California Farm Bureau Federation; Dan Wendell, The Nature Conservancy; and Russ McGlothlin, Shareholder, Brownstein Hyatt Farber Schreck.

of California, since multiple states share the Colorado River. He also discussed the need to forge partnerships with the agriculture industry and not see them as a constant adversary.

In the morning, a panel discussed how to reform the adjudication process and ways to drive efficiency in this 15–20 year process. Panel participants included Dan Wendell, The Nature Conservancy; Gordon Burns, Undersecretary of the California Environmental Protection Agency; Ken Manning, Executive Director of the San Gabriel Basin Water Quality Authority and current President

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Summary of GRA's Annual Legislative Symposium *– Continued*

of the California Groundwater Coalition; Russell McGlothlin, Shareholder at Brownstein Hyatt Farber Schreck; and Jack Rice, Association Counsel for the California Farm Bureau Federation.

The panel discussed the need to make the adjudication process more cost effective and reconcile the process with SGMA, and what procedural reforms are necessary. As Ken Manning stated, "it [adjudication] cannot be a get out of jail free card," meaning basins subject to SGMA regulation cannot be allowed to use the adjudication process to delay compliance.

The afternoon panel was on the *Implementation of the Sustainable Groundwater Management Act: Approaches to Groundwater Sustainability Agency Formation*. Participants were Thad Bettner, General Manager of Glenn-Colusa Irrigation District; Mick Gleason, Supervisor for the First District in Kern County; Paul Hendrix, General Manager of the Tulare Irrigation District; Robert Johnson, Deputy General Manager of Monterey County Water Resources Agency; and Cory O'Donnell, Deputy County Counsel of Sonoma County.

Assemblymember Anthony Rendon, Ph.D., (D-Lakewood), Member Assembly Natural Resources Committee, Member Assembly Water Parks and Wildlife Committee, reviews his past water bond work and looks forward to his new roles in transportation.

Gary Bardini, Deputy Director, Integrated Water Management, California Department of Water Resources, discusses the drought and the Bay Delta Conservation Plan.

Metropolitan Water District of Southern California Deputy General Manger Roger Patterson gave a thorough and interesting history of Met's operational changes and a thought-provoking look to the future of California water management.

Rich Juricich, Principal Water Resources Engineer, Sustainable Groundwater Management Program, California Department of Water Resources, gives an important overview of DWR's draft Groundwater Sustainability Program Strategic Plan.

Assemblymember Marc Levine (D-San Rafael), Chair, Assembly Water, Parks and Wildlife Committee, shared some of his legislative experiences and thoughts about his new role as the Water Committee Chair.

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Summary of GRA's Annual Legislative Symposium – *Continued*

The panel participants shared where they were in the process of Groundwater Sustainability Agency formation, the challenges overcome, and those still remaining. In various ways, each described the process as being grueling, for differing reasons. It is an inherently difficult process, and there are many stakeholders that have to be engaged. Cory summed it up eloquently: "Keep Calm and Collaborate."

The 2015 Legislative Symposium was another success, providing attendees with timely information on what is being discussed in the Capitol. The GRA Legislative Committee has been lauded for delivering another outstanding program. Thank you, GRA members, for again supporting this event, making it the "go-to" groundwater event in the Capitol. GRA would again like to thank our sponsors and our partner for this event, the California Groundwater Coalition. Together we are educating policymakers through sound science.

Assemblymember Das Williams (D-Santa Barbara), Chair, Assembly Natural Resources Committee, Member Assembly Water, Parks and Wildlife Committee, touches on his bill to require underground injection well operators to monitor groundwater.

Roundtable Discussion: SGMA Implementation – Approaches to GSA Formation

Thad Bettner, General Manager of Glenn-Colusa Irrigation District, discusses Glenn-Colusa challenges.

Mick Gleason, Supervisor for First District of Kern County, on Indian Wells Valley activities.

Paul Hendrix, General Manager of Tulare Irrigation District, talks about challenges in his area.

Robert Johnson, Deputy General Manager of Monterey County Water Resources Agency, talks about the interesting challenges in Salinas Valley.

Cory O'Donnell, Deputy County Counsel, Sonoma County, provides insight into the approach local agencies are talking about in the three medium-priority basins in Sonoma County.

Assemblymember Henry Perea (D-Fresno), Chair, Assembly Agriculture Committee, discusses his bill, which would allow mutual water companies to join a GSA.

Dennis O'Connor, Principal Consultant, Senate Natural Resources and Water Committee, talks about Senator Pavley's bill SB-20 to make well logs publicly available.

Dates & Details

GRA EVENTS & KEY DATES

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

GRA Board Meeting
Aug. 14, 2015 | Oakland, CA

GRA Conference
The New Groundwater Sustainability Plans: What's Required and What's Needed
Sep. 2, 2015 | Modesto, CA

30th Biennial Groundwater Conference &
24th GRA Annual Meeting
Oct. 6-7, 2015 | Sacramento, CA

For information on how to sponsor or exhibit at an upcoming event, please contact Sarah Kline at skline@grac.org.

SAVE THE DATE

Groundwater Resources Association of California presents:

The New Groundwater Sustainability Plans: What's Required and What's Needed

SEPTEMBER 2, 2015 – MODESTO, CA

Description:

The Sustainable Groundwater Management Act (SGMA) was signed into law September 16, 2014 and became effective January 1, 2015. The SGMA requires that approximately 100 high and medium priority basins form Groundwater Sustainability Agencies (GSAs) that are required to develop new Groundwater Sustainability Plans (GSPs) by January 31, 2020, or 2022, depending upon whether the basin is considered subject to critical conditions of overdraft or not.

A fundamental key purpose of the new plans is to make conditions in the basin sustainable within 20 years, and also to develop planning and forecasting on a 50-year planning horizon. The new plans are at a minimum required to include physical characteristics of the aquifer system, historical and projected water demands, map of existing and potential recharge areas, measureable objectives and milestones to achieve sustainability within 20 years, monitoring and management, and mitigation of overdraft.

The SGMA also requires that GSAs consider the interests of all beneficial uses and users of groundwater, as well as other Groundwater Sustainability Plans (GSPs). Public outreach and stakeholder involvement is clearly underscored in the SGMA and requires a clear framework of organization and thoughtful processes in place during GSP development and implementation.

Discussion topics are planned to include:

- Sustainability of groundwater – definition and yield
- Science and technology of sustainable yield
- Portfolio of Management Options for Physical Solutions
- Dynamic Water and Fee Allocations
- Developing successful GSPs.

Sponsor and Exhibitor Opportunities

If you are interested in exhibiting your organization's services or products, or being an event co-sponsor, please contact Sarah Kline at skline@grac.org.

Register for this event
http://grac.org/event/er_regform.asp?eid=415

SAVE THE DATE

Groundwater Resources Association of California presents:

30TH BIENNIAL GROUNDWATER CONFERENCE & 24TH GROUNDWATER RESOURCES ASSOCIATION ANNUAL MEETING

2015: Drought, Water Quality & Sustainability

OCTOBER 6-7, 2015 – SACRAMENTO, CA

Cooperating Organizations:

California Department of Water Resources, Water Education Foundation, Association of California Water Agencies, University of California Water Institute, State Water Resources Control Board, Regional Water Quality Control Boards, United States Geological Survey, California Department of Toxic Substances Control, California State University East Bay, The Nature Conservancy, Stanford University's Water in the West

Conference Details:

For more than 50 years, the Biennial Groundwater Conference has provided policy-makers, practitioners, researchers, and educators the opportunity to learn about the current policies, regulations, and technical challenges affecting the use and management of groundwater in California. This year's conference will focus on the challenges that California faces due to the ongoing drought, a wide range of water quality issues, climate change, and compliance with the Sustainable Groundwater Management Act of 2014.

The two-day conference features a plenary session, concurrent sessions on groundwater quantity/management and quality/contamination, lunch presentations by industry leaders, President's Reception, Collegiate Colloquium, GRA's 2015 Northern and Southern California David Keith Todd Lecturers, exhibitor booths, poster presentations, and a final general assembly. Session topics include the following (those in bold are open for abstract submissions):

- Status of California Water Resources
- **Water Quality Under Drought and Climate Change Conditions**
- **Managing Groundwater to Meet Challenges of Drought and Climate Change**
- **Inorganic and Organic Contaminants - New Trends, Methods and Regulations**
- **Managing Groundwater and Surface Water as One Resource**
- **New Perspectives in Oil, Gas, and Groundwater**
- **Maximizing Managed Aquifer Recharge and Conjunctive Use**
- **Remediation Technologies and Site Cleanup Objectives**
- **Land Use Planning in an Era of Sustainable Groundwater Management**
- **Innovative Tools for Data Management, Visualization and Modeling**
- Looking into the Future.

Call for Abstracts:

Abstracts are due by Friday, June 5, 2015 (This may be extended; check here for updates.)

Abstracts are being solicited for the October 6-7, 2015 Biennial Groundwater Conference in areas related to the topics listed above in bold. Click here to submit an abstract for a Paper or Poster presentation.

Collegiate Groundwater Colloquium

GRA seeks to increase participation by university and college faculty and students in its programming. The Collegiate Groundwater Colloquium presents students who are conducting highly relevant research in the general area of the conference theme. The Colloquium and reception provide students with an excellent opportunity to showcase their research and attendees an opportunity to learn from the frontier of groundwater science. For more information please use our online form to contact Jean Moran, Collegiate Colloquium Coordinator.

Sponsor and Exhibitor Opportunities

If you are interested in exhibiting your organization's services or products, or being an event co-sponsor, use our online form to contact the conference team.

Wells and Words

By David W. Abbott P.G., C.Hg., Consulting Hydrogeologist

Part 1 – Yield-Depression Curves for Evaluating Well Development Effectiveness or Whether to Rehabilitate a Well

When should well development continue or stop? When should a chosen well development method be replaced with a more aggressive method? When should rehabilitation (rehab) occur on an existing and operational production well? These are some of the questions often raised during well evaluation and Asset Management, rehab, or development programs. Well development and vigorous rehab programs are usually labor intensive and thus are an expensive part of well completion and ongoing well maintenance. These expenses are often recovered in the form of extended well performance and longevity[1], optimal well yields, reduced overall operational and pumping costs, and improved system reliability.

Well development is the application of a surging, acid-injection, or brushing process to a well for the purpose of repairing damage to the borehole wall caused by drilling procedures[2] and drawing fine material from the aquifer next to the well that results in the increase of the well yield[3] at a given drawdown (dd). Well rehabilitation is the restoration of a well to its most efficient condition using a variety of mechanical and chemical techniques that are often combined for optimum effectiveness[3]. The rehab process removes encrustations, biological matter, slimes, and films in order to increase the open area of the intake structure and decrease the entrance velocities[4,5,6]. *In general, the least aggressive development (or rehab) method is used first to evaluate the hydraulic and structural-integrity impacts on the well of such mechanical and chemical stresses.*

Well development and rehab are processes that typically include one or more of the following mechanical methods: airlifting, backwashing, bailing, brushing, circulating, flushing, jetting, over-pumping, pumping, surging, swabbing, or other operations on a well. These operations increase the well specific capacity (SC) by removing drilling fluids, fine sediments (clays, silt, and sand), and breaking down mechanical and bio-chemical blockages, thereby creating a well-packed, well-graded, and permeable filter pack envelop around the well screen[7,8,9]. Chemical cocktails are sometimes used to enhance and accelerate the effectiveness of these mechanical methods[10,11].

One way to evaluate the effectiveness of applied well development is to conduct informal or formal step-drawdown (step-dd) pumping tests that record the paired variations of discharge (Q) and dd during development (this can be coupled with observations of water quality changes). Because the SC is time dependent, these paired variations should be collected at roughly the same elapsed time of pumping. Measurements of these changes made during well development can be plotted on a graph of Q (x-axis) versus dd (y-axis); this provides a convenient tool for evaluating and tracking the effectiveness of well development programs or for determining whether an existing well should undergo rehab. These graphs are referred to as yield-depression (y-d) curves[12] and represent the sum[13] of the formation loss (BQ) and the well loss (CQ2) during pumping. If needed, B and C can be determined using other graphical methods[14,15,16], including plotting Q (x-axis) versus the specific discharge (y-axis); the specific discharge is the inverse of the SC. I usually plot the Q-axis increasing to the right and the dd-axis increasing downward; i.e., the graph origin is in the upper left-hand corner. This seems more intuitive to me than placing the graph origin in the lower left-hand corner where increases in dd are upward, but either way will do the job.

Figure 1: Yield-Depression Curve for Test Well (1977) During Well Development

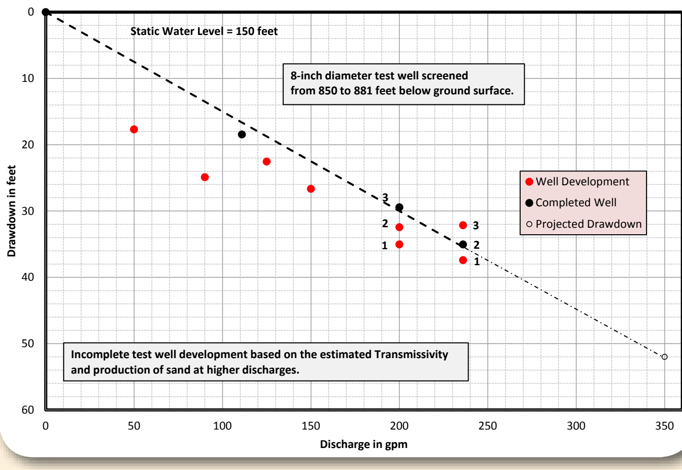

Figure 1 shows data from a test-well development program conducted in 1977 in Kitsap County, WA. The red dots scattered generally below the dashed line represent excessive values of dd measured for the Q values used during the development program, which consisted of backwashing and over-pumping methods. Prior to installing the test pump, the test well was developed (with little success) using airlift methods. Each successive backwash operation (for example at 1, 2, and 3 on Figure 1) at 200 gallons per minute (gpm) and at 235 gpm decreases the total dd. A final pumping test was conducted at 235 gpm; recovery data determined that the transmissivity (T) was between 24,000 and 56,000 gallons per day per foot (gpd/ft). If the actual T is at least 24,000 gpd/ft, then the SC for this test well can be expected to improve with more development. By extrapolating the data on Figure 1, it is reasonable to predict

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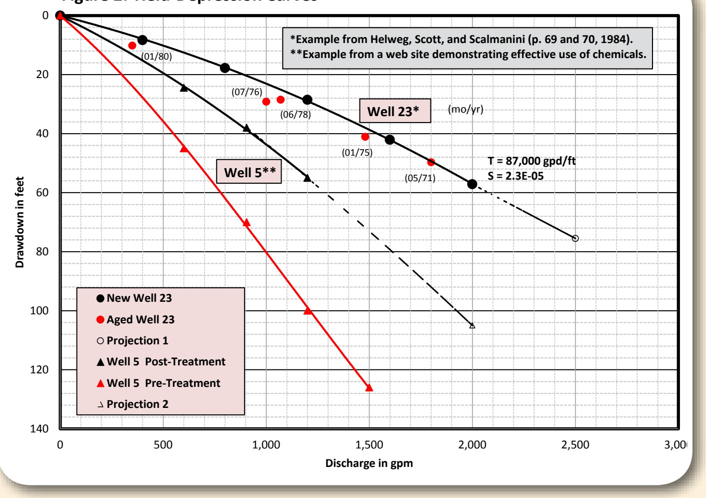
Wells and Words – *Continued*

Figure 2: Yield-Depression Curves



that the test well, in its present condition (under-developed), can yield about 350 gpm with a net dd of 52 ft or a pumping water level of 202 ft. A larger-diameter well drilled here could be expected to yield a considerably greater quantity.

Figure 2 shows two sets of data plotted on y-d graphs. Data for Well 23 is from Helweg et al.[17] and data for Well 5 (located near Truckee, CA) is from an online website promoting a proprietary well-development method. For Well 23, the SC data collected during well maintenance between 1971 and 1980 (shown on Figure 2 as red dots) indicates a small increase of the amount of dd from the initial step-dd data (upper black solid line) collected after well construction. This suggests that the well has become less efficient with age. From this graph, any well owner, let alone a professional, can easily predict what the dd will be for various values of Q or predict the Q for various values of dd. *In general, dd should not exceed 100 ft in alluvial (high-yield) aquifers and should not exceed 50 ft in fractured-rock (low-yield) aquifers until an operational and well-performance history has been developed for the well.*

Well 5, prior to well treatment (red triangles), was inefficient; 100 ft of dd corresponded to a Q of only 1,200 gpm. After well treatment (black triangles), the values of dd were much smaller, and the yield and efficiency of the well were significantly improved; 100 ft of dd corresponded to a Q of 1,920 gpm, or a 60% improvement in yield.

Tracking the Q and dd during well development, and during well operation as a regular maintenance procedure, provides valuable information on the effectiveness of well development methods and the decision to rehabilitate a well, respectively. These graphs (specific to each well) also demonstrate the ease with which untrained personnel can (1) choose a Q and the expected dd for selecting and designing a permanent pump, and (2) determine when rehab is needed to improve well efficiency and reduce operational costs.

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Legislative Update

By Tim Parker, GRA Legislative Committee Chairman,
Chris Frahm and Rosanna Carvacho, GRA Legislative Advocates

In the middle of a fourth year of drought, the focus on water remains. In the face of a worsening drought, Governor Brown signed on March 27th emergency legislation that fast-tracks more than $1 billion in funding for drought relief and critical water infrastructure projects. Then on April 1st, following the lowest snowpack ever recorded, Governor Brown ordered, for the first time in state history, the State Board to implement mandatory water reductions for urban water suppliers to achieve a statewide reduction of 25% in potable water use. On May 5th, the State Board adopted regulations that require reductions of between 8 and 36 percent in urban water usage throughout the state.

GRA's Annual Legislative Symposium

Please see the cover story in this issue of *HydroVisions* for a summary of GRA's Annual Legislative Symposium, titled *The Infancy of California's Sustainable Groundwater Management Act – What's Next?*

Sustainable Groundwater Management Act

The Sustainable Groundwater Management Act (SGMA) was passed by the Legislature and signed by Governor Brown in September, and went into effect on January 1, 2015. The focus for local agencies is now on implementation of SGMA with the formation of the Groundwater Sustainability Agencies (GSAs). The GSAs must quickly begin the task of creating a groundwater sustainability plan. To aid the GSAs with this task, the Governor's 2015–16 proposed budget includes $6 million from the General Fund for the Department of Water Resources (DWR) to provide additional technical assistance to these agencies on the development of their groundwater sustainability plans and the subsequent evaluation of those plans. The Governor's proposal also includes additional staff to implement specific requirements of SGMA, such as the adoption of basin boundaries and best groundwater protection practices. GRA remains engaged with staff at the DWR and the State Board responsible for implementation of the Act.

DWR has published a Draft Strategic Plan for its Sustainable Groundwater Program that outlines DWR's responsibilities, vision and key actions for developing regulations and providing assistance to local agencies in accordance with the SGMA. The draft plan is available at http://www.water.ca.gov/groundwater/sgm/index.cfm.

As expected, many bills have been introduced that are aimed at making changes to the Act.

GRA Supported/Opposed Legislation

Currently, GRA has taken a support position on one bill, described below. The Legislative Committee is continuously reviewing bills as they are amended and is closely monitoring all groundwater bills.

SB 20 (Pavley) – Makes well completion reports available to the public with specific requirements: a) request must be on a form identifying requestor's name, address and reason for request; b) a disclosure statement regarding the appropriate use of the data; c) release must comply with the Information Practices Act; and d) authorizes DWR to charge a fee for providing the reports.

Continued Changes in the Legislature

With the election of former Senator Mark DeSaulnier to Congress on November 4, 2014, a vacancy was created in Senate District 7. The primary election was held on March 17, 2015. No candidate captured more than 50% of the vote, so a runoff election between Assemblymember Susan Bonilla and fellow democrat Mark Glazer will be held on May 19, 2015.

There have been changes in the committees most important to GRA. Senator Vidak replaced Senator Fuller on the Senate Natural Resources and Water Committee. Also, in early April, Assemblymembers Gray and Ridley-Thomas were replaced by Assemblymembers Dababneh and Salas on the Assembly Water, Parks and Wildlife Committee by Assembly Speaker Toni Atkins.

Appointments

On March 11, 2015, Governor Brown made three appointments to the California Water Commission: Paula Daniels, Jose Del Bosque, Jr., and Maria Herrera; all require Senate confirmation. Paula Daniels is a Pritzker Environment and Sustainability Education Fellow for 2015. She has worked on issues related to food systems, water, and climate as a volunteer at the Governor's Office of Planning and Research. Jose Del Bosque, Jr. was reappointed to the Commission where he has served since 2010, and is a member of the Western Growers Association and the California Farm Bureau Federation. Maria Herrera is a community development specialist at Self-Help Enterprises. Prior to this, she was a community advocacy director at the Community Water Center

Continued on the following page…

Legislative Update – *Continued*

from 2008–2014 and a former ag-aid inspector at the California Department of Food and Agriculture.

Looking Ahead

As 2015 continues, the importance of water policy and regulation only increases as the State tries to find a balance between urban users and agricultural users, the implementation of SGMA and the potential for groundwater storage. The continued persistence of the drought, surface-water depletion and expanded groundwater pumping will keep both the Administration and Legislature focused on groundwater into the foreseeable future.

As the year and legislative session progresses, GRA's Legislative Committee and its Legislative Advocates will continue to monitor issues and legislation important to GRA. GRA will continue to be a key source of information and sound science for Legislators and the Administration.

The Federal Corner

By Jamie Marincola, U.S. EPA

EPA Awards Brownfield grant to Fresno for revitalization effort

EPA awarded $175,000 to the City of Fresno to assist with planning for cleanup and reuse of potentially contaminated sites as part of the Brownfields Area-Wide Planning program. Brownfields sites are property that may not be used or revitalized due to possible contamination. With the grant funds, the city will work with the community and other stakeholders to develop an area-wide plan and implementation strategy for the Elm Avenue Corridor in southwest Fresno. This 2.25-mile-long corridor connects several southwest Fresno neighborhoods considered to be economically disadvantaged. With this project, the city expects to develop a strategy for cleanup and reuse to assist in the transformation of the corridor to more community-serving uses. Nationwide, EPA awarded approximately $4 million in these planning grants to 20 communities in 16 states across the country. The funds will be used to engage communities and conduct planning for Brownfields revitalization. For more information on the recipients, check out: http://epa.gov/brownfields/areawide_grants.htm.

Home on the California Range, Year 2100: Land Use and Climate Change Could Impact Wildlife, Water Supplies

Grassland habitats on rangelands in California's Central Valley and surrounding foothills could decline by as much as 37 percent by 2100 due to changes in land use and climate, according to new scientific projections by the U.S. Geological Survey. Rangelands are the largest land cover by area in California, covering more than half of the state. Although more commonly known for livestock grazing, rangelands provide multiple benefits, including "ecosystem services," such as habitats for fish and wildlife and carbon sequestration. Rangelands also provide opportunities for surface and subsurface water collection and storage. To better understand the potential detrimental effects of climate change and land use change on rangeland ecosystem services, scientists worked with ranchers and land managers to develop 6 scenarios for the Central Valley and surrounding foothills. The model scenarios were consistent with three emission scenarios from the Intergovernmental Panel on Climate Change. For more, visit: http://ca.water.usgs.gov/news/2015/HomeOnTheCaliforniaRange.html.

EPA Concurs with California Plan to Return to Compliance with UIC Requirements

The California Division of Oil, Gas, and Geothermal Resources, which is delegated primary responsibility for implementing a portion of the oil and gas underground injection control ("UIC") program, has recently identified injection wells that may be injecting into non-exempt aquifers. Aquifers that are not exempt from protection under the Safe Drinking Water Act may potentially be used as a source of drinking water. As a result of a 2011 audit and 2012 review of aquifer exemptions, EPA directed the state to submit a Program Revision Plan. In February 2015, the state submitted a plan that EPA has concurred with to establish an effective process for reviewing and approving aquifer exemptions and achieve full compliance with the SDWA by February 2017. For more, go to: http://www.epa.gov/region9/mediacenter/uic-review/index.html.

Snowpack Melts Early Across the West

The western snowpack is melting earlier than usual, according to data from the fourth 2015 forecast by the United States Department of Agriculture's Natural Resources Conservation Service (NRCS). Historically, April 1 is the peak snowpack. This year, the peak came earlier. There was little snow accumulation in March, and much of the existing snow has already melted. A consequence of the early snowmelt is that western states will have reduced streamflow later this spring and summer. To view the water-supply outlook for each western state, visit http://www.wcc.nrcs.usda.gov/state_outlook_reports.htm.

EPA Issues Cleanup Plan for Former McClellan Air Force Base

In March, EPA issued a cleanup decision for a large area of the McClellan Air Force Base Superfund site in Sacramento, California. EPA's Record of Decision selects cleanup actions for contaminated soils across 130 acres in 43 separate areas at the former base. The cleanup will excavate and remove 60,988 cubic yards of soils contaminated with solvents, metals and other hazardous wastes and require land-use restrictions to protect people and the environment from low levels of remaining contamination. For more information, visit: http://go.usa.gov/3aevj.

Jamie Marincola is an Environmental Engineer at the U.S. Environmental Protection Agency, Region 9. He works in the Water Division on Clean Water Act permitting and community outreach. For more information on any of the above topics, please contact Jamie at 415-972-3520 or marincola.jamespaul@epa.gov.

Trends

By Bart Simmons

Looking back, I see some trends in groundwater concerns. First, groundwater concerns have truly become multimedia concerns. Banning the use of volatile organics for cleaning automobile parts affects the wastewater composition, and in turn influences the discharges from wastewater treatment facilities. Fracking increases the concern about carbon footprint, but also includes the potential for groundwater and surface-water contamination from fracking chemicals and hydrocarbon releases.

There was, and still is, the contaminant-of-the-month phenomenon: MTBE, perchlorate, PFOS and PFOA, brominated flame retardants, pharmaceuticals, estrogen-like substances, nitrate, and so on. The concerns about groundwater contamination have leap-frogged with the improvement in analytical techniques. Concern for perchlorate accelerated when a part-per-billion (ppb) liquid chromatographic method emerged. Liquid chromatography-mass spectroscopy (LC-MS) has become a major tool for measuring water-soluble organics, and in the process, has increased concern for this large class of contaminants.

Climate change has emerged, appropriately, as an overriding environmental issue, and monitoring and remediation have been affected as well. Pump-and-treat technology has largely been replaced with in situ treatment and intrinsic bioremediation. Air stripping now has a carbon concern.

Arguably, the quality of environmental measurement has improved. The California Environmental Laboratory Accreditation Program (ELAP) and the National Environmental Laboratory Accreditation Program (NELAP) have moved labs to a more consistent standard of quality, largely based on the international standard, ISO 14025. Although field sampling and measurement standards were developed by NELAC (C is for Conference), they have not been widely adopted. The pressure on labs to produce "perfect" data packages has continued to increase, which occasionally has resulted in laboratory fraud.

An ongoing weakness is the field-lab interface. Botched preservation and poor documentation is still common. Due to commercial and legal constraints, a lab will still do what the client asks, regardless of the contamination which goes unreported.

In California, water supply has joined water quality among the major issues. Thorny issues, such as legacy contamination and stormwater regulation, continue to challenge.

Toxicology and testing have slowly developed a symbiotic relationship. Testing has become more specific; for example, "dioxins" testing now includes quantitation of the individual congeners, e.g., 2,4,7,8 tetrachlorodibenzo-*p*-dioxin, and the calculation of Dioxin Toxicity Equivalents (TEQs). Hexavalent chromium coupled with total chromium is a common request.

Finally, groundwater concerns have become more international. The mass arsenic poisoning of Southeast and Southern Asia has alarmed the environmental community.

This all pales in comparison to water-borne infectious disease, which is rare in the industrialized countries, but a scourge world-wide. Our local water-supply infrastructure is sophisticated; hopefully, the transfer of environmental science and technology to the rest of the world will accelerate.

Bart can be reached at bartonps@aol.com.

Hydraulic Conductivity Estimation using Groundwater Mean Age Information

By Mohamed K. Nassar[1,2,3] and Timothy R. Ginn[1]

Introduction

The calibration of groundwater flow model parameters to fit hydraulic head data is an inverse problem that is generally ill-posed, i.e., the solution may not exist, may be nonunique, and/or may not depend continuously on the data (Hadamard, 1902). Ill-posedness arises because we generally have incomplete observations, noise in the available observations, and/or unknown error in the model structure (e.g., Sun, 1994). The mathematical facts of this calibration problem are that it is a first-order partial differential equation (PDE), and as such, requires Cauchy data (i.e., flux or the hydraulic conductivity) for proper formulation as a boundary-value problem (Nelson, 1960; Ginn et al., 1990). This data requirement is universal, and impacts all groundwater model calibrations.

Recently, a number of studies have highlighted how groundwater age-related data can assist in model calibration (e.g., Portniaguine and Solomon, 1998; Konikow et al., 2008; Troldborg et al., 2008; Ginn et al., 2009; Leray et al., 2012), but theoretical explorations of the way age data can help stabilize inverse problem in even simple cases are rare. The purpose of this work is to demonstrate that steady-state groundwater mean age can satisfy the Cauchy data requirement of the inverse problem, when the mean age at all influent boundaries is zero (i.e., recharge waters are very young). We solve the inverse of the one-dimensional mean age equation at steady-state along a conceptual streamtube, following the way that Nelson (1960b) and Neuman (1980) solved the one-dimensional inverse flow equation. This demonstration covers the cases of one-dimensional steady flow and two-dimensional steady flow in the stream function/potential function coordinate system description of the flow net, of which the one-dimensional streamtube is a member.

Cauchy problem

The formal mathematical statement of the hydrogeological inverse problem was first developed by Nelson (1960a) as a first-order PDE obtained from the groundwater flow equation when the hydraulic conductivity is the dependent variable and the hydraulic head gradient is known. For one-dimensional steady flow in a streamtube with unit cross-section, the inverse problem can be written as:

$$\frac{d}{dx}\left[K(x)h_x(x)\right]=0 \qquad (1)$$

where $K(x)$ is unknown hydraulic conductivity, $[LT^{-1}]$; $h(x)$ is the known hydraulic gradient [dimensionless], and x is distance along the respective 1D flow path. This classical expression of the inverse problem requires "Cauchy information" that is the value of the unknown conductivity at some point x_o, $K(x_o)$. In two-dimensional flow, the requirement generalizes to knowledge of K on a curve crossing all streamtubes. This is known as the "Cauchy data" requirement needed to solve first-order ODEs. The inverse solution is then obtained by direct integration of equation 1:

$$K(x)=\frac{h_x(x_o)}{h_x(x)}K(x_o) \qquad (2)$$

This demonstrates that, even in the simplest case, the formal solution of the inverse problem requires knowledge of the hydraulic conductivity at some point x_o on any flow path. In multidimensional problems, this requires not merely K data distributed in space, but K data distributed particularly on a path crossing all flow paths; such data generally are unavailable in practice.

How Age Data Replaces Cauchy Data Requirement on Hydraulic Head

The mean age of water is often inferred from environmental tracers (e.g., Glynn and Plummer, 2005); however, the mean age is not equal to radiometric age inferred from a single decaying tracer (e.g., Varni and Carrera, 1998; Massoudieh and Ginn, 2011). The actual mean age should be constructed from multiple tracer data (if available) used to describe the age distribution, as outlined in Massoudieh and Ginn (2011) and Massoudieh et al. (2012). The mean age in the case of steady-state, one-dimensional flow with unit cross-sectional area and no dispersion/diffusion for simplicity is (Goode, 1996):

$$\frac{d(q(x)A(x))}{dx}=n(x) \qquad (3)$$

where $A(x)$ is the mean of the distributed groundwater age [T]; the Darcy flux $q(x) = -K(x)\ h_x(x)$, and n(x) is the porosity. Combining equation 3 with $q(x) = -K(x)\ h_x(x)$, we can rewrite the governing mean-age equation as:

$$\frac{d}{dx}\left[K(x)h_x(x)A(x)\right]+n(x)=0 \qquad (4)$$

Continued on the following page...

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Hydraulic Conductivity Estimation using Groundwater Mean Age Information – *Continued*

Equation 4 is converted to an inverse problem by treating the age as known and the hydraulic conductivity as unknown. As for the flow inverse problem, this inverse problem also needs its own Cauchy data—the age at the inlet boundary, $A(x_o)$, which is set equal to zero assuming all water entering the system is either surface/river recharge or well-injection, or is lateral inflow of very young water. The inverse solution is obtained by direct integration of equation 4:

$$K(x)=\frac{\int_{x_o}^{x}[n(x')]dx'}{-h_x(x)A(x)} \qquad (5)$$

Equation (5) solves the inverse problem for the hydraulic conductivity field, assuming the porosity is known, using only mean-age data. That is, the classical Cauchy data for flow are not required. This result is restricted to the case of zero mean age at recharge boundaries. Cases involving multiple recharge sources with differing mean ages, such as snowmelt in conjunction with lateral groundwater flow, would not be appropriate for this analysis.

It should be noted that equation 5 can be written also as:

$$A(x)=\frac{\int_{x_o}^{x}[n(x')]dx'}{-K(x)h_x(x)} \qquad (6)$$

This form links to the usual definition of mean residence time. Hence, for constant porosity n, and x_o=0, Equation 6 gives $A(x)={}^{x}/_{v(x)}$, where $v(x)={}^{q(x)}/_{n}$ is the average linear velocity.

Conclusion

Groundwater age has been identified as potentially valuable information for model calibration (e.g., Sanford, 2011). The mathematical basis for the direct inverse method for the groundwater mean-age equation is presented for the continuous case given steady head and mean age for the one-dimensional steady flow case. The explicit relation that enables us to estimate the hydraulic conductivity uniquely is obtained without the need for classical Cauchy data on these hydraulic properties or on the flux itself. In fact, this inverse problem is freed from the classical Cauchy data requirement by substitution of the groundwater mean-age data through inversion of the mean-age equation instead of the flow equation. This result requires age at inflow boundaries to be zero, as in recharge cases. If the model inflow boundaries are lateral groundwater flow and do not coincide with zero-age recharge boundaries, the nonzero mean age at the model boundary will be needed and hence boundary hydraulic conductivity is needed too. In the particular case where all inflow boundary fluxes have the same age, one may use a relative age concept and shift all mean-age data within the domain by the mean age at that boundary. This will make the mean age at the model boundary equal to zero and enable the use of this approach.

From a practical point of view, as it is challenging to obtain mean-age data, $A(x)$, for each single point along the flow line, we suggest applying equation 5 for only one step from xo per flow line. For subsequent steps, one can apply equation 2, which does not require mean-age data.

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GRA Welcomes the Following New Members

MARCH 1 – MAY 5, 2015

Abhold, Kristyn	UC Berkeley Goldman School of Public Policy
Al Kuisi, Mustafa	The University of Jordan
Baldwin, Samantha	UC Hastings
Bardsley, Brett	NCE
Bates, Matthew	CSUDH Earth Science
Boisrame, Gabrielle	UC Berkeley
Boner, Ria	UCSB
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Coppinger, Jan	Lake County Special Districts
Corbin, Todd	Jurupa Community Services District
Corona, Claudia	SFSU
Cortez, Robert	BC Laboratories, Inc.
Davis, Courtney	Allen Matkins
Ely, Katherine	Confederated Tribes of the Umatilla Indian Reservation
Esposito, Elizabeth	Brownstein Hyatt Farber Schreck
Evans, Noah	City of San Luis Obispo
Franz, Brian	GSI Water Solutions
Fuson, Gabriel	Northgate Environmental Management, Inc.
Genetti, Jennifer	SFSU
Gorham, Tim	
Hale, Marcia	UCLA
Hamel, Dave	CACHUMA RCD
Hejazian, Mehrdad	SFSU
Henderson, Curtis	Cgeoil LLC
Hiltbrand Consoli, Julian	University of California, Santa Barbara
Kindermann, Diane	Abbott & Kindermann,LLP
Klaus, Reinhard	Sigmund Lindner GmbH
Kouba, Claire	Dudek
Langlois, Don	Sigmund Lindner GmbH
Lindquist, John	Oneida Total Integrated Enterprises (OTIE)
Linscott, Katherine	ENVIRON
Lucas, Wesley	University of Oregon
Mangan, Pandian	Bharathidasan University
Matyac, Scott	Yuba County Water Agency
McCoy, Ryan	Cameron-Cole LLC
Mills, Michael	Stoel Rives LLP
Morrison, Gregorgy	Brownstein Hyatt Farber Schreck
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Pasini, Michelle	Princpal Consultant
Phares, Natalie	Bren UCSB
Philipp, Jon	
Phillips, Renee	CSUS
Plecker, Richard	City of Roseville
Postigo Lafarga, Sergio	
Prakash, Pavithra	Fresh Ph.D Graduate
Repede, Alin	BC Laboratories, Inc.
Sanchez, Alejandra	Olam West Coast Inc
Seles, Nolan	Wildermuth Environmental
Sellers, Scott	Environmental Defense Fund
Stanley, Curtis	Shell
Stone, Shaun	Jurupa Community Services District
Studer, James	InfraSUR LLC
Subramanyam, Neha	AECOM
Tock, Robert	Jurupa Community Services District
Treguboff, Ed	Sacramento State
Truax, John	Yellow Jacket Drilling Services, LLC
Uecker, Joshua	RMC Water and Environment
Valles, Richard	Woodward Drilling Company, Inc.
Van Proosdij, Ward	Amec FW
Williams, Kate	California Water Foundation
Wong, Alan R.	SFPUC - Water Quality Division
Wong, Melanie	Golder Associates
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Xiong, Zhong	Haley & Aldrich, Inc.

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Central Coast

By Bryan Bondy
Branch Secretary

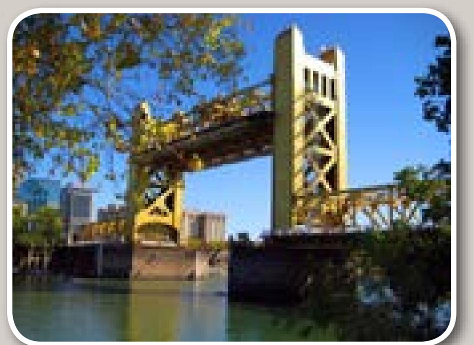
In February, Kevin Murdock, P.E., R.G., Hydrogeologist and Senior Project Manager with CH2M Hill Engineers, Inc. presented *Site Characterization, Tracer Studies, and Permanganate Injection for a Remediation Pilot Test in Fractured Bedrock at the Santa Susana Field Laboratory, Ventura County, California*. Mr. Murdock's presentation summarized the history of the Santa Susana Field Laboratory (SSFL), a conceptual model for groundwater impacts, the uses of high-resolution characterization tools, heated-water and dye-tracer studies, and pilot permanganate-injection testing for remediation of trichloroethylene (TCE) in the fractured bedrock aquifer. The SSFL is a former rocket-engine and propulsion-systems research and development facility, which was active from 1949 to 2006. Historically significant rocket-engine testing was performed at the site, including engines used in the Atlas, Saturn, Thor, Delta, and Space Shuttle rockets. Site assessment and remediation is being completed under the RCRA Corrective Action Program with California DTSC oversight.

The SSFL is underlain by sandstones with siltstone interbeds of the upper Cretaceous Chatsworth Formation. Site assessment activities to delineate the nature and extent of TCE impacts, included rock coring, multi-level monitoring well installations, and tracer testing using heated water and fluorescein dye. Rock core analyses helped evaluate the vertical distribution of TCE mass in the sandstone matrix, and tracer testing helped identify the degree of fracture connectivity. The site assessment data showed that groundwater flow and TCE transport are controlled by the fracture system within the formation and numerous faults in the project area. Although the plume is well defined and relatively stable, the site assessment results revealed that TCE mass is likely to have diffused from the fractures into the sandstone matrix over time, posing a significant challenge to site remediation.

Pilot testing has been initiated to assess the feasibility of implementing in-situ chemical oxidation (ISCO) using potassium permanganate to address TCE impacts. The testing is focused on assessing TCE reductions, manganese oxide precipitation, oxidant attenuation due to natural oxidant demand, and oxidant diffusion into the sandstone matrix. Pilot testing and monitoring will continue through fall of 2015.

Sacramento

By Scott Furnas,
Branch President



On February 10, 2015 the Sacramento Branch welcomed Jeanny Wang, who discussed *Climate Change Adaptation Projects in the Mekong*. Her presentation focused on enhanced water harvesting and water management in the agricultural communities in Laos. Jeanny has travelled extensively through the region and her presentation was accompanied by some wonderful slides that were taken over several visits. She also informed us about the links and interactions between surface water and groundwater in the wetlands and made comparisons of the conservation and restorations efforts in the United Sates and Asia.

Our March meeting was held at the Alumni Center at CSU Sacramento, and as always we had a wonderful turnout consisting of GRA members and students studying to become future leaders in our industry. Our primary speaker was Jacob Gallagher from National Exploration, Wells & Pumps. Jacob provided a lively talk on well destruction 101, which revolved around observations from many years in the industry and the general confusion and misunderstandings regarding well destruction practices in the industry, specifically in California. In addition to Jacob speaking, Tim Parker of Parker Groundwater, and Chair of GRA's Legislative Committee, gave our audience a brief overview of recent groundwater legislation and the myriad of bills being circulated around the Capitol. We were also excited to hear from Sacramento State Geology graduate student Gen Sparks regarding her work involving groundwater recharge along Putah Creek, near Davis, CA. Our meeting at the Alumni Center is special to our Branch because we use this time to present two checks to the Sacramento State Geology Department, which is a long-standing tradition of our Sacramento Branch. These funds come from our Scholastic Sponsors who generously donate to our Branch Scholastic Fund and present at our Branch meetings, and the State GRA's scholastic fund matches what we are able to generate. It was our pleasure to present Professor and Department Chair Tim Horner with two checks totaling $3,200.

April 8, 2015 was our 2015 David Keith Todd Distinguished Lecturer Series and we were excited to have Dr. John "Izzy" Izbicki. John's presentation was on *Using Disparate, Process-Oriented Data to Solve Hydrologic*

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Sacramento – *Continued*

Problems. Dr. Izbicki used his time to point out that groundwater hydrologists have traditionally incorporated data from a wide range of disciplines into their work, often skillfully integrating geology, chemistry, physics, and other disciplines to solve hydrologic problems. Information from each discipline has strengths and limitations; collaboration between scientists having different skill sets can help interpret the disparate data sets developed by scientists from diverse backgrounds. These data sets are often process-oriented, and may incorporate results from laboratory and field-scale experiments, or integrate high-frequency data collected across a range of physical and temporal scales. As such, process-oriented data may differ greatly in scale and scope from more traditional hydrologic data collected in response to regulatory-driven mandates. For the purposes of this presentation, the specifics of groundwater source, movement, and age; trace-element occurrence, mobility, and pathways to wells; and anthropogenic contaminant movement through, and reaction within, the unsaturated and saturated zones (for example) are less important than the process-oriented approach used to understand and address these issues. The goal of process-oriented work and collaboration is to produce "more-correct" interpretations, in support of traditional field-data and model analyses, than is possible for individuals having limited perspectives and skill sets working alone or in "bureaucratic silos." Over the years, large societally-important problems have traditionally driven basic, multidisciplinary, process-oriented research. Successful solutions to these large problems have often required the creation of diverse data sets and a high degree of collaborative interpretation by numerous researchers. For local-scale agencies responsible for addressing smaller-scale hydrologic problems, scientific collaboration is expensive, and process-oriented work often appears excessively detailed or unnecessary. Why not simply respond solely to regulatory-driven mandates by just measuring water levels or only reporting data on regulated contaminants? However, as even small-scale hydrologic problems have become increasingly complex and as regulatory demands increase, the challenge is to apply the optimal mix of innovative and basic science, collaboration, and communication to solve those problems. Our Branch members soaked up his discussion and John was nice enough to stay after to make sure all questions had been answered; the meeting was well attended.

Southern California

By Emily Vavricka,
Branch Secretary

On February 25, 2015, the Branch hosted the Southern California GRA 2015 David Keith Todd Distinguished Lecturer, Dr. John Izbicki. Dr. Izbicki has worked for the U.S. Geological Survey for over 30 years and has focused much of his research on the use of chemical and isotopic tracers to better understand the physical hydrology of coastal and desert aquifer systems. Dr. Izbicki's lecture, titled *Using Disparate, Process-oriented Data to Solve Hydrologic Problems*, was an overview of his work regarding recharge in California's Mojave Desert. His presentation focused on the unsaturated zone's capacity to adsorb dissolved metals, which could be taken advantage of for filtering groundwater containing dissolved metals during managed aquifer recharge. He began with an overview of the geology and description of the alluvial deposits of the Victorville Fan and the characteristics of the unsaturated zone. He emphasized the importance of knowing the physical flow of water in the unsaturated zone and having a good understanding of the heterogeneity and hydraulic conductivity, and presented clear graphics illustrating the subsurface heterogeneities of the unsaturated zone. With hydraulic conductivity data, one can use the hydraulic conductivity curve as a predictive tool to estimate recharge. In part two of his presentation, Dr. Izbicki described the trace element occurrence and geochemistry of the unsaturated zone, focusing on chromium and arsenic and how these elements react in the unsaturated zone. Dr. Izbicki concluded that a good understanding of both the flow of water and geochemistry of the unsaturated zone may yield to effective management of artificial recharge where these trace elements occur.

The Branch would again like to thank all GRA Members and Non-members for attending the February event. Special thanks also go out to The Source Group for sponsoring the Branch scholastic fund, and to all of the 2015 DKT Lecture Series sponsors, including Regenesis, Geosyntec Consultants, Luhdorff & Scalmanini Consulting Engineers and Todd Groundwater.

The Miocene Santa Cruz Mountains

The Miocene Santa Cruz Mudstone (7 to 9 million years old), with carbonate vent structures, is beautifully exposed on this marine terrace. Garrison et al. (1999) identified the following characteristics associated with these structures: 1) brittle, highly fractured silica-rich (porcelanite) layers composed of opal-CT, 2) different geometric shapes (pipes and slabs), 3) circular conduits, and 4) relationships between fractures and elongate orientation of the vents. The carbonate structures formed as gases and liquids migrated from organic-rich layers through fractures and shallow, sub-seafloor sediments at low temperatures. Similar structures are associated with modern-day carbonate seeps found in Monterey Bay.

This seascape was photographed during a Northern California Geological Society (NCGS) field trip to observe the Monterey-Santa Margarita petroleum system of the Santa Cruz County coast in April, 2015.

Photographed along West Cliff Drive and Swift Street in Santa Cruz.

by John Karachewski, Ph.D.
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