

# HYDRO VISIONS

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GROUNDWATER RESOURCES ASSOCIATION  
OF CALIFORNIA

Fall 2000

## The Impact of Global Positioning Systems on Groundwater Resources

BY JEFFERSON K. PHILLIPS AND JAMES A. JACOBS  
FAST-TEK ENGINEERING SUPPORT SERVICES

**ABSTRACT** Most groundwater resources professionals use maps containing locations for water, soil or vapor samples. Other environmental and engineering professionals need accurate locations for installing or finding existing wells, pipelines, sewer lines or hydrangers. Global Positioning Systems (GPS) can be a cost-effective way to obtain digital vertical and horizontal location information. Most differential GPS units currently operate with sub-meter accuracy in "real time," and with post-processing can achieve decimeter and even centimeter precision. Typical project sites that might benefit from GPS would include sites having more than a dozen sample locations, sites with areas or lines requiring mapping, or sites where pre-determined point

coordinates are to be found or grids to be outlined. GPS surveying often costs far less than traditional methods. A one-man crew can locate over one hundred points in a day under ideal conditions. The digital data can be downloaded and stored in a personal computer (PC) and exported to virtually any mapping geographic information systems (GIS) program.



*Navigating to sample locations.*

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

**GPS TECHNOLOGY:** Global Positioning Systems technology uses signals from a network of twenty-four orbiting satellites to determine geographic locations with near pinpoint accuracy. GPS uses a receiver that is capable of tracking four or more satellites at a time and calculating a geographic

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## USGS Scientist Named Interim Science Leader of CALFED

**H**ailed as the world's largest water management effort, the CALFED Bay-Delta Program, a partnership between the state of California and the federal government, has announced the assignment of Dr. Samuel N. Luoma, a scientist with U.S. Geological Survey (USGS), as the Interim Science Leader of the CALFED Science Program.

"The efforts to manage and restore the Bay-Delta estuary, improve California's water supply, protect water quality, and protect delta levees are perhaps the most complex ever proposed," said Luoma. "It is the role of science to reduce the uncertainties with relevant, authoritative and unbiased information."

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# President's Message

BY TIM PARKER

Summer is two-thirds gone and we are only days away from our Year 2000 Annual Meeting in San Jose, California September 19-26. Program plans for the Annual Meeting are coming together really well, and you have no doubt all received the Program with Abstracts, which is also posted on our web site at [www.grac.org](http://www.grac.org). I would just like to take this opportunity to point out a few of the groundwater specific opportunities at the Annual Meeting including:

## Field Trips:

Silicon Valley Groundwater - September 25 - All Day

Engineering Geology West Side of San Joaquin Valley: Aqueducts and Groundwater Subsidence Issues - September 25 & 26 - All Day

## Symposium/Technical Sessions:

Conjunctive Use/Groundwater Banking Symposium - September 22 - Afternoon

Groundwater Investigation Technical Session - September 23 - Morning

Environmental Forensics/Forensic Geochemistry Symposium - September 23 - Afternoon

Environmental Investigation and Cleanup Technical Session - September 24 - Morning

Innovative Environmental Technologies Symposium - September 24 - Afternoon

Geophysical Methods for Groundwater/Environmental Investigations Technical Session - September 24 - Afternoon

I have news to share from our August 12th Board Meeting. Our Technical Committee has put together a draft Position Paper on MTBE. Look for it in this newsletter (Page 3) and to be posted on our Web Page in the near future. The Board voted to select Joseph Birman as the recipient of the 2000 Lifetime Achievement Award. The Lifetime Achievement Award will be given at the GRA Annual Meeting in September. Our search for a new Executive Director is coming to a close as the Board discussed the candidates at the Board Meeting. We expect to make a selection in the next few weeks. We also wish to thank Harrison Phipps, our current Executive Director for continuing to support GRA in this very important role as we conclude our search for this replacement. In the spirit of groundwater education, GRA is sponsoring the training of 12 teachers from Long Beach Unified School District by Water Education Foundation in the WET Training Program this year. The Water Environment Federation is having a conference in Anaheim this year and has asked GRA to provide some support in the form of 1 to 2 groundwater professionals to present a water lesson and be available to answer questions on water/groundwater issues. Water Environment Federation has also asked for a list of names of groundwater professionals to be provided as resources to their members on water/groundwater issues. Our Web Page continues to move forward and provide more services to our membership. You should have noticed that we now have the ability to reach our membership via mass email to notify our members of upcoming events and meetings (if you didn't receive an email regarding the capability and our annual meeting, we don't have your correct email address - please contact us via our Web Page at [www.grac.org](http://www.grac.org)). We have recently installed a discussion page and are testing the utility of this feature. In the near future, we will be adding the capability to pay via credit card over the Web.

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HYDROVISIONS is the official publication of the Groundwater Resources Association of California (GRA). GRA's mailing address is P.O. Box 1446, Sacramento, CA 95812. Any questions or comments concerning the contents of this publication should be directed to the newsletter editor. The editor may also be reached by email.

**editor@grac.org**

EXECUTIVE DIRECTOR

**Harrison Phipps**

**Groundwater Resources Association  
(530) 758-3656 - e-mail: [execdir@grac.org](mailto:execdir@grac.org)**

DIRECTORS

**Vicki Kretsinger**

**Luhdorff and Scalmanini  
(530) 661-0109**

**Anthony M. Saracino**

**Saracino-Kirby, Inc.**

**(916) 329-9199**

**e-mail: [saracino@saracino-kirby.com](mailto:saracino@saracino-kirby.com)**

**Paul Dorey**

**Vista Irrigation District**

**(760) 806-3100 - e-mail: [wngk19@idt.net](mailto:wngk19@idt.net)**

**Tony Ward**

**ARCADIS Geraghty & Miller, Inc.**

**(714) 278-0992 - e-mail: [award@gmgw.com](mailto:award@gmgw.com)**

**Brian Lewis**

**Cal/EPA, Dept. of Toxic Substances Control**

**(916) 323-3632 - e-mail: [admin@grac.org](mailto:admin@grac.org)**

**David Abbott**

**Todd Engineers**

**(510) 595-2120 - e-mail: [jorysue@msn.com](mailto:jorysue@msn.com)**

**Susan Garcia**

**(562) 435-4055**

**e-mail: [73661.1162@compuserve.com](mailto:73661.1162@compuserve.com)**

**Jim Jacobs**

**Fast-Tek**

**(510) 232-2728 - e-mail: [augerpro@jps.net](mailto:augerpro@jps.net)**

**Jim Carter**

**EMAX Labs**

**(310) 618-8889**

**e-mail: [jcarter@emaxlabs.com](mailto:jcarter@emaxlabs.com)**

**Scott Slater**

**Hatch and Parent**

**(805) 882-1420**

**Tim Parker**

**California Division of Mines and Geology (CDMG)**

**(916) 322-6968 - e-mail: [tparker@jps.net](mailto:tparker@jps.net)**

EXECUTIVE OFFICERS

**President, Tim Parker**

**California Division of Mines and Geology**

**(916) 322-6968 - e-mail: [tparker@jps.net](mailto:tparker@jps.net)**

**Vice President, Tony Ward**

**Montgomery Watson**

**(626) 796-9141 - e-mail: [tony.ward@mw.com](mailto:tony.ward@mw.com)**

**Treasurer, David Von Aspern**

**Wallace - Kuhl & Associates**

**(916) 372-1434**

**[dvonaspern@wallace-kuhl.com](mailto:dvonaspern@wallace-kuhl.com)**

**Secretary, Jim Carter**

**EMAX Labs**

**(310) 618-8889**

**e-mail: [jcarter@emaxlabs.com](mailto:jcarter@emaxlabs.com)**

**Editor Floyd Flood**

**Newsletter e-mail: [editor@grac.org](mailto:editor@grac.org)**

## President's Message

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On the 11-13 of October, GRA is sponsoring a short course on Groundwater Modeling (see Page 11 of this newsletter for more info). The course will be held at the Sutter Galleria in midtown Sacramento, and includes hands-on computer training. GRA would like to thank Thomas Harter, Ph.D., of the University of California Cooperative Extension, Groundwater Hydrology Program for organizing the event. We would also like to thank Thomas Harter, Graham Fogg, Ph.D., and Peter Shchwartzman for being the course instructors for this high quality and high value course.

I continue to be impressed with our Branches and the high quality of talks they coordinate on monthly or bimonthly basis. For more on this subject please refer to our Branch updates contained within this newsletter. I want to take this opportunity to thank each and every one of our Branch Officers and the other volunteers in the Branches for your efforts in putting together the regional programs for our members. You are our organization and continue carrying the torch, spearheading our efforts to meet our mission of being dedicated to resources management that protects and improves groundwater through education and technical leadership.

I hope to get the opportunity to see you all at our Annual Meeting in San Jose. Until then...

Best Regards, Tim. 💧

The next HYDROVISIONS due date for articles is October 30, 2000. We WELCOME your ARTICLES and PHOTOS. Articles may be emailed to [editor@grac.org](mailto:editor@grac.org)

# MTBE Paper - GRA Technical Committee Seeks Comments on Draft

JAMES JACOBS, BOARD LIAISON, AND PAUL PARMENTIER, CHAIR, OF THE TECHNICAL COMMITTEE

The technical committee is seeking comments on their draft position paper. Please send any comments to Paul Parmentier (949) 660-7510.

MTBE is a controversial issue critical to the protection of groundwater resources. A January 16, 2000 airing of the "60 Minutes" television program on MTBE highlighted the problem posed by this chemical to national groundwater resources. Last year, GRA endorsed Governor Davis' decision to phase out MtBE and the governor was awarded the GRA's Kevin Neese Memorial Award for that action. The following summary of facts and issues was prepared by the GRA Technical Committee to promote rational discussion and assist in sound groundwater policy implementation. A reference list is also attached.

- **PERSISTENCE IN GROUNDWATER:** Sampling of groundwater in California and other states has shown that MTBE is more persistent and more mobile than other fuel compounds.
- **TASTE AND ODOR:** Having a taste and odor like turpentine has made MTBE-contaminated ground water sources unusable for human consumption. The cost for bottled water for impacted areas or other large-scale treatment or water importation options may cost the nation billions of dollars over the next 50 years. Blending clean water with MTBE impacted water will continue into the future.
- **HEALTH RISKS:** Although MTBE is considered a potential health risk, there is inadequate evidence in humans that MTBE causes cancer. The strong odor and taste of MTBE at relatively low concentrations would make drinking of large amounts of high level MTBE contaminated water unlikely, thus reducing the exposure and potential resulting human health risks from MTBE. The U.S. National Toxicology Panel, the California Proposition 65 Committee or the International Agency does not list MTBE as a human carcinogen

for Research on Cancer. Limited evidence from an older Italian MTBE rodent study indicated that MTBE caused cancer in the experimental animals when administered in unrealistic doses of hundreds of times greater than any possible corresponding human exposure.

- **FATE AND TRANSPORT:** The MTBE problem is associated with gasoline leaking from underground storage tanks, surface spills of gasoline or from small gasoline engines. Even though the majority of underground tanks in this country have been upgraded, the amount of MTBE already released with gasoline into the environment is so large that the problem of ruined drinking water sources will exist for several decades. Compared to other fuel compounds, MTBE adsorbs to soils much less, is poorly biodegraded, and dissolves in groundwater at much higher concentrations. Due to these characteristics, MTBE migrates much faster and further in the groundwater than equal amounts of other gasoline compounds.

- **GROUNDWATER INVESTIGATION:** The investigation of a groundwater resource impacted with MTBE requires more detailed and more rapid sampling of soil and groundwater than other fuel-impacted sites due to the potential for faster and deeper migration of MTBE compared to other compounds. The presence of other oxygenates should also be tested at all sites containing MTBE.

- **REMEDICATION:** Due to the chemical characteristics of MTBE, remediation or clean-up of the contaminant is expensive, time consuming and technically difficult. New technologies might improve the remediation efficiency and cost, but at this point, the chemical is considered recalcitrant, or uniquely resistant to remediation. Although MTBE can be remediated by a variety of technologies, the cost and level of effort to remediate MTBE considerably increase for sites already facing remediation due to other fuel

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## The Impact of Global Positioning Systems on Groundwater Resources

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position based on the relative distances to the satellites. The government no longer scrambles the signals of the positioning satellites so that the accuracy of a standard GPS is now a few meters. GPS receivers that use only this primary data source have become relatively inexpensive and are commonly used for recreational navigation such as hiking, backpacking, and boating. Luxury automobile manufacturers have begun offering GPS units mounted in their automobiles, which allow the driver to view the car's geographic location on a computerized map displayed on the dashboard.

For more precise mapping applications, "differential GPS" units are available. Differential GPS uses a secondary signal such as a US Coast Guard beacon, private positioning satellite, or a GPS "base" receiver to make differential corrections and achieve sub-meter, decimeter, and even centimeter accuracy. In fact, some GPS receivers have become so accurate they can be used to measure microscopic movements along geologic faults! Differential GPS has been in use for specialized mapping and geographic purposes for some time, but only recently has the full potential for the technology began to be realized in the



Logging air sampling path.

common marketplace. GPS units are capable of operations that until now were only thought to be possible using standard land surveying techniques. Many consumers in a wide variety of occupations have been delighted to find the savings in cost, time, and hassle that using GPS technology has brought.

Most GPS units are capable of locating and

recording point, line, and area features. A GPS can be used to record the location of a known point, such as a soil sample location or a particular plant, and display the geographic coordinates of that point or plot it on a map. Or it can be used to navigate to a pre-determined location or known coordinates, such as returning to a soil sample location or staking a sample grid with predetermined coordinates for each grid node. A line can be logged such as the boundary of a flood plain, or the path of a worker walking with an air sampler. An area can be logged such as the circumference of a soil stockpile, or a region of fragile vegetation. After the GPS technician has circumnavigated the circumference of an area, many GPS units will calculate and display the surface area of the feature on the spot. For instance, highly accurate estimates of cubic yards in a soil stockpile can be calculated in just minutes.

**GEOGRAPHIC INFORMATION SYSTEMS:** Geographic Information System (GIS) software enables the user to tie a wide variety of geographic information to computer-based maps. There are as many GIS applications as there are users of the technology, and are beyond the scope of this article. However, GPS measurements taken in the field are quickly and easily plotted on street maps, topographic maps, geologic maps, aerial photographs and other graphical formats using GIS software. This versatility combined with the speed of data collection is the major advantages of the technology and the reasons for its rapidly expanding use.

**ADVANTAGES OF GPS:** GPS surveying often costs far less than traditional methods. While standard surveying usually requires two people in the field, just one easily records GPS measurements. A two-person survey team usually requires five to ten minutes to locate a point, whereas a single GPS operator can log a point in as little as two seconds. A one-man GPS crew can locate over one hundred points in a day under ideal conditions. GPS data can be gathered by trained technicians that are frequently far less expensive than certified surveyors. As a general rule, when GPS

can be used instead of traditional surveyors, clients can expect savings of fifty percent or more. In addition, clients often require a map showing the surveyed locations. GPS



*The photos reflect actual environmental projects that were enhanced with GPS technologies, saving the clients (all consultants) significant amount of time and money over more conventional surveying techniques. The GPS photos show various locations, including a landfill project, (above) an industrial in-situ remediation project and GPS project at the Golden Gate Bridge for lead sampling. One advantage of GPS is that it integrates well into Global Information Systems (GIS) computer data software so as to yield a variety of data on a specific map or aerial photograph. With the recent changes this year with the U.S. military allowing for more accurate signal definition from the satellites, enhanced GPS locations data are possible.*

data is easily downloaded into GIS programs, which can print quality maps in a matter of minutes.

**TYPICAL PROJECT SITES:** GPS technology is not practical for every site. Most differential GPS units available for rent or purchase offer sub-meter accuracy in "real-time," and decimeter accuracy with "post-processing." Post-processing means running the data through a computer program that uses comparisons from known points to increase the precision of the data. When the required accuracy exceeds these margins, standard-surveying techniques may be more appropriate. GPS units are capable of centimeter and better accuracy, however the residence time required per point increases from several seconds to half an hour or more and costs likewise increase. Another limitation of GPS technology is in areas with heavy overhead vegetation, or close to buildings

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or other obstructions. A variety of techniques, such as offsetting points, can be used to overcome these obstacles. However, at some point it becomes easier and more reliable to revert to standard surveying methods. When first assessing the need for geographic information on a site it is often useful to consult a professional familiar with both GPS and standard surveying techniques to find out what will work best. As a general rule, for sites that have a fairly clear view of the sky and require decimeter to meter accuracy GPS technology will be a better choice. This is especially the case when a site-map or digitized photograph showing the plotted locations is desired.

**ENVIRONMENTAL PROJECTS:**

\* GPS was used to log the position of over one hundred soil and concrete samples collected over a several-square-mile naval installation.

\* At the Golden Gate Bridge in San Francisco, GPS was used in locating over two hundred pre-determined sample locations in heavy brush as well as mapping site features.

**DETAILS OF ONE PROJECT:** At a closed landfill on a Navy base in California, a GPS unit was used as an integral part of an air and soil gas-sampling project. First, a digitized site map of the landfill was created and oriented to geographic coordinates. Next, locations of ambient air samplers were chosen based on prevailing wind patterns and the locations were plotted on the site map, which was given to the field crew. The field crew placed the ambient air samplers as close to the geographic coordinates shown on the map as the terrain would allow and used the GPS to record the final locations which were then corrected on the map.

A large sampling grid pattern was plotted on the computer site map. The grid consisted of over twenty sampling squares, each covering an area of fifty thousand square feet. After the grid was plotted on the computer-based site map the coordinates of the sample square nodes were provided to the field crew which used the GPS to locate and mark the locations in the field, and then string the boundaries of the squares with fluorescent string. An

air-sampling technician then sampled each square. The technician wore the GPS unit, which was set to log both the path taken by the sampler and the rate at which the air sample was collected. The sample paths were then plotted on the site map for inclusion in the project report.

**SUMMARY:** GPS offers significant savings over traditional survey techniques, and provides data in an ideal format to import into digitized site maps, aerial photos, or three-dimensional site models. Standard differential GPS operates in real time with submeter accuracy and with post-processing can achieve decimeter and even centimeter precision. 💧

*Authors: Jefferson K. Phillips is an Environmental Scientist specializing in GPS at FAST-TEK. James A. Jacobs, C.H.G., is President of FAST-TEK. They can be reached at FAST-TEK Engineering Support Services, 247 B Tewksbury Ave., Pt. Richmond, CA 94801; (510) 232-2728.*

**ENVIRONMENTAL APPLICATIONS FOR GPS TECHNOLOGY:**

*Mapping individual sample locations*

- Import site features into CADD, ArcView, ArcInfo, and other mapping software
- Import sample locations or site features onto digitized aerial site photographs
- Create a 3-D site model
- Outline areas such as wetlands, endangered species habitat, or exclusion zones
- Create sample grids
- Navigate to pre-determined points to install a trench, pipeline, well or collect a sample
- Record and map sample/monitoring well locations
- Map fire hydrants, electrical transformers, sewer lines, and other utilities
- Ecological/environmental mapping: Endangered species habitat, wetlands, flood planes, and coastal erosion zones

**EXAMPLE:** Consider the following example of an environmental project perfectly suited for GPS use:

A county park is to be created on a portion of a former Naval installation. A soil sampling project is to be carried out to assess the environmental condition of the site. A total of six hundred soil samples are to be collected over a several square acre parcel. The total project budget is around \$200,000 dollars. The surveying requirements consist of the following tasks:

Task A: Navigate to 100 pre-determined focus sample locations and mark for sampling.

Task B: Log the location of 500 randomly collected soil samples.

Task C: Map the circumference of three areas of stained soils, each approximately fifteen yards in diameter with uneven edges.

Task D: Provide a scaled site sketch showing the locations of logged features.

TASK	CONVENTIONAL SURVEY TEAM	COST: \$140/HOUR	GPS TECHNICIAN	COST: \$85/HOUR	SAVINGS
A	16 Hours	\$2,240.00	8 Hours	\$680.00	70%
B	80 Hours	\$11,200.00	20 Hours	\$1,700.00	85%
C	6 Hours	\$840.00	1 Hour	\$85.00	90%
D	2 Hours	\$280.00	1 Hour	\$ 85.00	70%
TOTAL:	Three Weeks	\$14,560.00	Less than one week	\$2,550.00	82%

## MTBE Paper-GRAC Technical Committee Seeks Comments on Drafts

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compounds, and can be very high at sites where the presence of MTBE is the trigger for remediation.

Due to the high mobility of MTBE in the environment, remediation of sites impacted with MTBE has to be rapidly implemented.

• **MTBE-SPECIFIC REGULATORY GUIDELINES:** In March 2000, the California State Water Resources Control Board (SWRCB) prepared guidelines on prioritization of the investigation and remediation of MTBE-impacted sites. The guidelines are based on potential risks of impact to water supply wells and aquifers. Site-specific groundwater supply conditions or hydrogeology characteristics should also be critically considered in prioritization of sites or evaluation of risk-based approaches to site closures.

• **AIR POLLUTION:** There is still controversy as to the source of reductions in air pollution in recent years. Part of the improvement is attributable to newer and more efficient engines with computer controlled ignition. The reformulated gasoline, containing MTBE, may be related to some of the improvement in air quality, however, various conflicting air studies exist.

• **COST OF REPLACEMENTS:** If other oxygenates are added to gasoline to lower vehicle emissions, the price and availability of the replacements, such as ethanol, will increase the cost of fuel over the costs for MTBE. Replacements for MTBE must be evaluated carefully as to the fate and transport of any chemicals into the subsurface. Life cycle studies focusing on the potential release into the air, soil and groundwater environments should be performed prior to introducing any new chemicals into a chemical as widely used as gasoline.

• **RECOMMENDATIONS:** The characteristics of MTBE in the subsurface make assessment and remediation of MTBE impacted sites challenging. Therefore, competent environmental professionals should be used in the assessment and remediation of MTBE impacted soil and groundwater resources. The GRA Board urges continued state and federal legislative support for the ban of MtBE and for the adoption of immediate standards for MtBE in drinking water. 💧

### REFERENCES

#### *General Health Risks*

1. California Dept. of Health Services <http://www.dhs.cahwnet.gov/ps/ddwem/chemicals/mtbe/mtbeindex.htm>
2. US EPA FACT SHEET: Drinking water advisory: Consumer Acceptability Advice and Health Effects Analysis on MTBE. Fact Sheet EPA-822-F-97-009 December 1997

#### *MTBE and Groundwater Resources*

3. USGS has a reference site for MTBE: <http://water.wr.usgs.gov/mtbe/>
4. USGS: Environmental Behavior and Fate of MTBE: <http://water.wr.usgs.gov/mtbe/fs20396/>
5. The California State Resources Control Board's Draft Guidelines on MTBE contains technical documentation on MTBE fate and transport in the subsurface: [http://www.swrcb.ca.gov/cwphome/ust/mtbe\\_finaldraft.doc](http://www.swrcb.ca.gov/cwphome/ust/mtbe_finaldraft.doc)

#### *General Basic Reference*

6. Jacobs, J., Guertin, J., and Herron, C., ed., 2000, MTBE: Effects on Soil and Groundwater Resources, CRC Press/Lewis Publishers, Boca Raton, FL, 250 p.

## USGS Scientist Named Interim Science Leader of CALFED

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As put forth in the recently released CALFED document, "California's Water Future: A Framework for Action," science will continue to be central to the success of the program, since much of CALFED is based on adaptive management. Along with hiring "a nationally-recognized scientist to coordinate the science effort," the Governor of California and the Secretary of Interior will appoint an Independent Science Board to provide oversight and peer review for the overall program. CALFED plans to invest nearly \$300 million in scientific programs during the first stage of the effort.

According to Luoma, "The Interim Science Leader will define the role of the permanent Science Leader who will be appointed

following this 18 month assignment. The Science Program will help reduce the contentiousness of the debate by increasing our knowledge of the issues and the system."

Dr. Luoma is a senior research hydrologist with the U. S. Geological Survey in Menlo Park, California. He has worked on water issues in San Francisco Bay since 1975, and is part of a multi-disciplinary team of USGS, San Francisco Bay researchers that have published more than 300 scholarly articles and books on the Bay-Delta. His specific research interests are in water quality and pollution issues, specifically heavy metal effects in estuaries and rivers. His 1984 textbook, Introduction to Environmental Issues (MacMillan, Inc.) illustrated his broad interests in the scientific underpinnings of environmental issues. He is editor of the international journal Marine

Environmental Research, and editorial advisor to Marine Ecology Progress Series. He is a Fellow in the American Association for the Advancement of Science and has been awarded the U. S. Department of Interior's Distinguished Service Award.

As the nation's largest water, earth and biological science and civilian mapping agency, the USGS works in cooperation with more than 2,000 organizations across the country to provide reliable, impartial, scientific information to resource managers, planners, and other customers. This information is gathered in every state by USGS scientists to minimize the loss of life and property from natural disasters, contribute to the sound conservation, economic and physical development of the nation's natural resources, and enhance the quality of life by monitoring water, biological, energy and mineral resources. 💧

# POPs

BY BART SIMMONS, PH.D.

# Chemist's Corner

**P**ersistent Organic Pollutants, or POPs, are gaining increasing concern as we find contamination which was previously undetected. The tools for measuring environmental contamination are very limited, and almost all data used today for environmental management are for traditional pollutants, such as the original "priority pollutant" list which was developed for the Clean Water Act. This list included chlorinated pesticides, common volatile organics and semi-volatile organics which were believed to have potential for water pollution. The "priority pollutant" list is now largely irrelevant, since it has been replaced by specific industry targets or other lists.

Recent research, largely in Europe, has found a varied mix of non-traditional contamination such as brominated diphenyl ethers (PBDEs), brominated dibenzodioxins and dibenzofurans, caffeine, estrogen, and components of synthetic musk.

## *The Dioxin Family*

The techniques used to measure ug/L (ppb) or ng/L (ppt), such as High Resolution Gas Chromatography Mass Spectrometry (HRGCMS) while very sensitive and selective, are limited by the extraction, concentration, clean-up, sample introduction and measurement techniques. As a result, the protocols are generally limited to a class of related compounds, such as the polychlorinated dibenzodioxins and dibenzofurans (PCDD/Fs). Although the methods for PCDD/Fs have been available for decades, there is still a disconnect between the measurements and the regulations.

The HRGCMS methods provide concentrations for the various congeners - congeners are related compounds; in this case, the congeners differ by the number and position of chlorine atoms. Toxicology studies have resulted in Toxicity Equivalent Factors (TEFs), which can be used to weight the congeners by their relative toxicity. The sum of the weighted concentrations, called the toxic equivalents (TEQs), is used for assessing the risk of the mixture of PCDD/Fs. However, some permits and regulations are still written for only one compound: 2,3,7,8-TCDD. This compound was recognized as the most toxic component, but current science widely accepts the notion of toxic equivalents, and the permits and regulations need to change to be consistent with current science.

## *A new role for PCBs*

Relatively new to the PCDD/Fs problem is the recognition that some congeners of polychlorinated biphenyls, PCBs, also have dioxin-like toxicity. U.S. EPA is currently involved in a reassessment of the toxicity of dioxin-like compounds, and it seems likely that it will include PCB congeners with dioxin activity. Because this is relatively new development, there is a need for analytical methods for air, water, and soil which will identify and measure the PCB congeners.

## *New Actors*

Beyond the PCDD/Fs and PCBs, a whole new spectrum of POPs has been found, although the analytical methods and regulations are lagging behind. PBDEs have been found in mother's milk in Sweden in exponentially increasing

concentrations, and recent work done in California shows that PBDEs have also been increasing in seal fat. This discovery is unusual in that the PBDEs were found in mother's milk before the environmental source was identified. Decabromodiphenyl ether is used as a flame retardant, but a compound found in tissues is a tetrachlorodiphenyl ether, and the source is unknown.

Other POPs are showing up. Polybrominated dibenzodioxins and dibenzofurans, relatives of the PCDD/Fs, may have similar toxicity and may have an environmental presence. While there is concern for estrogen-mimicking compounds, estrogen itself may be a significant problem. Estrogen can pass through wastewater treatment plans and be discharged to surface water. Caffeine was proposed as a tracer for wastewater discharge in the Puget Sound until it was found that caffeine was very widespread in the area. Ingredients of synthetic musk have been found in rivers in Germany, and may be present in U.S. surface water as well.

All of these non-traditional POPs pose challenges to the environmental community. Once monitoring data and toxicity studies reveal the extent of the problem, we will be faced with setting priorities for a much more varied collection of pollutants. 💧

*Bart Simmons is Chief of the Department of Toxic Substances Control's Hazardous Materials Laboratory. Bart can be reached at [bsimmons@dtsc.ca.gov](mailto:bsimmons@dtsc.ca.gov).*

# American Ground Water Trust Sponsors One-Day Conference, September 29, in Anaheim

**A**NAHEIM, CALIF. —An upcoming landmark California Supreme Court decision affecting ground water management and other key water issues will be discussed at American Ground Water Trust's "Ground Water Law and Management in California: Recent Developments," a one-day conference on Friday, September 29 at the Anaheim Marriott Hotel in Anaheim, California.

By conference time, the California Supreme Court is expected to have decided on *Mojave Water Agency v. City of Barstow*. "The Mojave River decision presents a number of important issues that will affect water policy throughout the state," says Scott Slater, board member of American Ground Water Trust. "Since the California Supreme Court's last significant ground water-related pronouncement, *City of Los Angeles v. the City of San Fernando*, in 1975, questions have persisted that go to the heart of water policy: In times of shortage, who will receive water, who will be required to pay more for water and finally, who may go without?"

Discussing its ramifications to California water districts will be attorneys James Marksman with Richards, Watson and Greshon, Robert Dougherty with Covington & Crowe, and Bill Brunick with Brunick, Alvarez & Battersby and general counsel, Mojave Water Agency. "Methodologies for Valuing Water Rights: What's Your Ground Water Worth?" will be another session held at the conference. The speaker is Rodney Smith, Ph.D. of Stratecon & Associates.

The conference will also look at the Fox Canyon Groundwater Management Agency. Speakers are Ken Ortega, water superintendent, City of Oxnard, Doug Breeze, director of Public Works, City of Port Hueneme, Don Kendall, general manager, Calleguas Municipal Water District and Dana Wisheart, general manager, United Water District.

The Chino Groundwater Basin is one of Southern California's largest groundwater aquifers. A recent agreement setting aside


decades of conflict over the Basin spells relief for California water agencies seeking ground water storage opportunities. Speaking on the agreement in three different sessions are Geoff Vanden Huevel, representing the Agricultural Pool, Dr. Patrick King, council member, City of Ontario, Josephine Johnson, board member, Monte Vista Water District, Art Kidman, with McCormick Kidman and Behrens and attorney for Monte Vista Water District, Gene Tanaka, with Best, Best & Krieger and attorney for the Cucamonga County Water District, Dan McKinney, with Reid & Hellyer and the attorney for overlying agricultural land owners, Ken Jeske, director of Public Works, City of Ontario, Ray Wellington, board member, Santa Ana Water Company and Richard Atwater, general manager, Inland Empire Utilities Agency.

Groundwater contamination and the latest legal and legislative protections will be the topic of one of the afternoon sessions headed by Steven A. Amerikaner, an attorney with Hatch and Parent. Attorneys Tom Bunn with Lagerlof, Senecal, Bradley and Swift and Jeffery Speich with Hatch and Parent will talk on the Water Replenishment District of Southern California's intention to desalt

water. The laws of physics as they relate to ground water will be the topic of a session by Andrew Stone, executive director, American Ground Water Trust.

The keynote luncheon speaker is State Assemblyman Mike Machado, chair of Assembly Parks and Wildlife. He has recently proposed legislation to address ground water use on a regional basis. The move comes on the heels of efforts by counties to control ground water use and transfer within their boundaries.

The cost of the conference is \$250 and includes handouts, lunch and a hosted reception. The conference is geared to water consultants, attorneys, water managers, district engineers and those involved in the regulatory aspects of ground water. Attorneys will earn six hours of MCLE Credit. For more information, contact the American Ground Water Trust, 603-228-5444, [www.agwt.org](http://www.agwt.org).

The American Ground Water Trust, headquartered in Concord, New Hampshire, is a national non-profit membership organization founded in 1986 to act as an objective and independent source for consumer education about ground water. 

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# Water Quality Issues in Conjunctive Use Projects <sup>1</sup>

G. FRED LEE, PH.D., PE, DEE AND ANNE JONES-LEE, PH.D.

With increased attention being given to conjunctive use of surface and groundwater in California as part of developing future water supplies to meet increased population demands and agricultural irrigation and wildlife needs, there is increased recharge of contaminated surface waters in conjunctive use projects. Lee and Jones-Lee (1993, 1994a, 1995, 1996) have discussed the need to more appropriately consider water quality impacts of constituents in incidental and enhanced groundwater recharge. They find that often-limited attention is being given to the potential impacts of the chemical constituents and pathogens present in the recharged surface waters on the quality of the groundwater recovered in a conjunctive use project.

One of the most significant errors that is being made is the assumption that if a recharged water meets drinking water MCLs, that this water will not be adverse to the use of the recovered water for domestic or other purposes. This assumption ignores the fact that there are about 75,000 chemicals used in the US today. Only about 100 to 200 of these are regulated. The recent discovery of perchlorate as a pollutant in groundwater points to the importance of being ever mindful that the current regulatory approach can fall far short of providing for public health and environmental protection especially for those situations where the recharged waters contain constituents derived from domestic and industrial wastewater as well as agricultural runoff. Lee and Jones-Lee (1994b) have discussed the reasons why it is inappropriate to assume that a water or soil that contains complex chemical mixtures that meets a current regulatory standard is safe for public health and the environment.

It is frequently assumed in conjunctive use projects that the aquifer system will “treat” the recharged surface waters to remove pollutants present in these waters. While aquifer systems have the ability to treat/remove some constituents in recharged surface waters, there are constituents that are not removed that can pollute recovered groundwater and/or build up within the aquifer.

Another problem area is that frequently inadequate attention is given to the potential for constituents in the recharged surface waters to effect the physical and chemical characteristics of the aquifer. Lee and Jones-Lee (1993) point out that failure to properly consider the characteristics of the recharged surface waters on groundwater and aquifer quality can cause significant problems including failure of conjunctive use projects.

A comprehensive monitoring/evaluation program that characterizes the physical, chemical and biological characteristics of the surface waters that are proposed to be recharged to the aquifer should precede all conjunctive use projects. This monitoring evaluation program needs to be more comprehensive than typically used in conjunctive use projects. Also, the physical and chemical characteristics of the aquifer should be evaluated. This information should be used to predict whether the characteristics of the surface waters that are proposed to be recharged in a conjunctive use project could lead to impaired groundwater quality and/or aquifer quality. Lee and Jones-Lee (1994).

Once the conjunctive use project is operational, a detailed monitoring program of the recharged and recovered groundwater, as well as the waters within the aquifer, should be conducted. Further, information on the potential build-up of pollutants within the aquifer system should be evaluated through examination of the

fate of the recharged chemical constituents. As discussed by Lee and Jones-Lee (1994a), this evaluation is essential to ensure that the build-up of hazardous chemicals within the aquifer does not ultimately lead to a “Superfund” site-type situation that will require remediation of the contaminated aquifer.

Guidance is provided in the author’s publications listed below on the pre-operation and operation monitoring/evaluation programs that should be conducted in conjunctive use projects.

G. Fred Lee and Anne Jones-Lee can be reached at (530) 753-9630 or email: gfredlee@aol.com.

## References and Additional Information

*The following references are available from [www.gfredlee.com](http://www.gfredlee.com) in the Reuse of Reclaimed Wastewaters section or by request from [gfredlee@aol.com](mailto:gfredlee@aol.com).*

Lee, G. F. and Jones-Lee, A., “Public Health Significance of Waterborne Pathogens in Domestic Water Supplies and Reclaimed Water,” Report to state of California Environmental Protection Agency Comparative Risk Project, Berkeley, CA, 27pp, December (1993).

Lee, G. F. and Jones-Lee, A., “Water Quality Aspects of Incidental and Enhanced Groundwater Recharge of Domestic and Industrial Wastewaters.” Proc. Symposium on Effluent Use Management, TPS-93-3, pp. 111-120, American Water Resources Association, Bethesda, MD (1993).

Lee, G. F. and Jones-Lee, A., “Groundwater Quality Protection: A Suggested Approach for Water Utilities,” Report to the CA/NV AWWA Section Source Water Quality Committee, 8pp, August (1993).

Lee, G. F. and Jones-Lee, A., “An Approach for Improved Ground Water Quality Protection in California,” In: Proc. 19th Biennial Conference on Ground Water, *Are California’s Ground Water Resources*

<sup>1</sup> Derived from a presentation at the National Ground Water Association West Coast Conference session on Conjunctive Use held in San Francisco, CA February, 2000. A copy of the slides used in this presentation is available from [www.gfredlee.com](http://www.gfredlee.com) in the Landfills and Groundwater Quality Protection section in the Groundwater Quality Protection subsection as “Issues in Recharge of Contaminated Groundwaters in Conjunctive Use Projects.” This paper also presents information on water quality issues associated with groundwater recharge with reclaimed wastewaters.

*Continued on page 10*

## Water Quality Issues

Continued from page 9

*Sustainable?* University of California Centers for Water and Wildland Resources, University of California, Davis, CA, p. 155 (1994).

Lee, G. F. and Jones-Lee, A., "Does Meeting Cleanup Standards Mean Protection of Public Health and the Environment?," *In: Proc. of Superfund XV Conference*, Hazardous Materials Control Resources Institute, Rockville, MD, pp 531-540 (1994).

Lee, G. F. and Jones-Lee, A., "Guidance on Pre-Operational and Post-Operational Monitoring of Ground Water Recharge Projects," Report of G. Fred Lee and Associates, El Macro, CA, April (1994).

Lee, G. F. and Jones-Lee, A., "Total Dissolved Solids and Groundwater Quality Protection," *In: Proc. of the Second International Symposium on Artificial Recharge*, American Society of Civil Engineers, New York, NY, July (1994).

Lee, G. F. and Jones-Lee, A., "Water Quality Aspects of Groundwater Recharge: Chemical Characteristics of Recharge Waters and Long-

Term Liabilities of Recharge Projects," *In: Proc. of the Second International Symposium on Artificial Recharge*, American Society of Civil Engineers, New York, NY, July (1994).


Lee, G. F. and Jones-Lee, A., "Monitoring Reclaimed Domestic Wastewater Usage on Public Parkland Vegetation to Reduce Risks," *Water Engineering & Management*, 142:28-29, 37 (1995).

Lee, G. F. and Jones-Lee, A., "Public Health and Environmental Safety of Reclaimed Wastewater Reuse," *IN: Proc. Seventh Symposium on Artificial Recharge of Groundwater*, University of Arizona Water Resources Research Center, Tucson, AZ, pp. 113-128, (1995).

Lee, G. F. and Jones-Lee, A., "Appropriate Degree of Domestic Wastewater Treatment Before Groundwater Recharge and For Shrubbery Irrigation", *AWWA, WEF 1996 Water Reuse Conference Proceedings, American Water Works Association*, Denver, CO, pp. 929-939 February (1996).



## GRA Offers Lapel Pins

If you would like to buy a lapel pin, attend your nearest branch meeting or order a pin now. Pins cost \$7.00 at a branch meeting or \$8.00 thru the mail. Send your checks to: GRA, P.O. Box 1446, Sacramento, CA 95812. 


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Sutter Square Galleria, 2901 K Street (located between 29th & 30th and J & K Streets) Class size is limited so early enrollment is suggested. Cost \$669 to \$775 depending if GRA member or not and if early or late registration. Early registration cut-off requires a postmark by September 20. Questions? Contact Tim Parker (916)322-6968. For registration form and more information GRA web site: [www.grac.org](http://www.grac.org) or E-mail question to: [admin@grac.org](mailto:admin@grac.org) 

GRA's Lifetime achievement for 2000  
will be presented to Joseph H.  
Birman, Ph.D. The awards ceremony  
will be during GRA's Business  
Meeting on September 24<sup>th</sup>.  
Don't forget to sign-up.

## Legal Point of View

### Conjunctive Use in the Chino Groundwater Basin

The use of dewatered space in groundwater basins as storage reservoirs for surface supplies, often referred to as "conjunctive use," has become a popular concept because it avoids the many detrimental environmental impacts of surface reservoirs. The primary difficulty with this type of conjunctive use, however, is that available sub-surface space cannot be "constructed" in the way that surface reservoirs can. Furthermore, when an appropriate location is found, the feasibility of large-scale conjunctive use projects is contingent upon the existence of a proper institutional environment. Ultimately, the relationships between the overlying landowners and other stakeholders will determine whether a conjunctive use project is viable. These institutional factors become even more important for large-scale conjunctive use projects where there can be several hundred landowners as well as many different public agencies overlying the groundwater basin.

The Chino Groundwater Basin, located at the foot of the San Bernardino mountains about 25 miles east of Los Angeles, is poised to become an ideal spot for such large scale conjunctive use projects. How this has come about is a story of transfiguration as the stakeholders in the Basin were able to apply win-win negotiation strategies between themselves that will allow them to turn an environmental liability into a marketable asset.

The Chino Groundwater Basin has historically been plagued by both water quantity and quality problems. On the

quantity side, overpumping for most of this century has reduced the amount of water in the Basin from approximately seven million acre-feet to under six million acre-feet. Accompanying this overpumping have come all of the associated problems of decreased well pressure and groundwater levels, and, in some areas of the Basin, significant land subsidence.

On the quality side it has been alleged that, years of agriculture, intensive dairy production, industrial use, and historical recharge patterns have contributed to significant water quality degradation. Since the land area overlying the Basin is experiencing some of the most rapid urbanization of any place in California and discharges directly into the Santa Ana River, these contamination problems are becoming increasingly more significant.

In the mid-1970s the Chino Groundwater Basin was adjudicated, and in 1978 a Judgment was entered in this adjudication titled, *Chino Basin Municipal Water District v. City of Chino*, San Bernardino Superior Court Case No. RCV 51010 ("Judgment"). Since that time the stakeholders have been working to create an Optimum Basin Management Program ("OBMP"), as required by the Judgment, to resolve the many groundwater issues facing the Basin. In 1998, a San Bernardino Superior Court Judge ordered the parties to complete the OBMP by June 30, 2000. Following a frenzied effort over the past six months, the many municipalities, water agencies, and overlying users officially agreed upon a Final OBMP on June 29. The

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## Legal Point of View

Continued from page 11

Judge approved the OBMP on July 13 and full ratification of the program was complete on August 1.

The OBMP addresses both the water quantity and the water quality issues. To address the quantity issues, a Chino Basin Watermaster was created by the Judgment to oversee and regulate groundwater production within the very broad allocation parameters established by the Judgment and according to procedures and policies described in the OBMP. To address water quality issues, the OBMP contemplates the construction of a series of desalting facilities. These facilities constitute a large part of the expense of the OBMP, and deciding how they will be funded was a major hurdle inhibiting completion of the OBMP.

In recognition of the interconnection of the various business, policy, and legal challenges to the creation of the OBMP, the parties in the Basin were forced to work together and develop what they have called the “Peace Agreement,” so called because it resolves many of the long standing differences between the parties. In the process, the

parties agreed to work as a unit in order to conduct a large-scale conjunctive use program that will allow them to maximize the benefits available through the use of the dewatered portion of the Basin as storage space.

As described above, the historical overpumping in the Basin has left a valuable empty “hole” that can potentially hold up to a million acre-feet of water. Unlike many areas, the Chino Groundwater Basin is a well-defined basin, and because of the many years of scrutiny and negotiation, extensive analysis of the hydrology of the Basin has been performed so that the accounting of water storage and withdrawal in the Basin is fairly precise. In addition, the Basin is within the service area of the Metropolitan Water District of Southern California, and already has elaborate water delivery and removal infrastructure in place. In fact, it has been noted by at least one observer that the only factor that has prevented the initiation of a large-scale conjunctive use program in the Basin is the historically contentious institutional relationship between all of the various entities in the Basin.

By coming to agreement, the Chino Basin parties have been able to put aside their traditional grievances so that they might unify and invest control of the available storage space in the Basin with a single entity: Watermaster. By agreeing that the Watermaster will control and regulate any conjunctive use program, the parties will be able to market the storage space to entities outside of the Basin in order to generate a revenue stream that can be used to help finance other parts of the OBMP such as the water quality remediation elements. Thus, the stakeholders, through a negotiated alteration of the institutional environment, have been able to turn a historical negative (overpumping) into a marketable asset (storage space) that will have the greatest overall value for everyone. 💧

*Michael Fife is an attorney with the law firm of Hatch & Parent specializing in water rights and water quality issues, especially in the context of complex multi-stakeholder processes. He can be reached at [mfife@hatchparent.com](mailto:mfife@hatchparent.com).*

GRA's Key-Note Speaker for Our Business Meeting on September 24<sup>th</sup> is Judith L. Connor, Ph.D. Dr. Connor's talk will be on "Exploring the Depths of Monterey Bay and Beyond."

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## California Groundwater Management Manual Targeted for Reprinting

GRA would like to acknowledge the organizations and firms that have pledged their funds for reprinting the "California Groundwater Management" Manual. We are almost halfway to our target of \$18,000. GRA will be writing to firms requesting their contributions to the reprinting. If you do not receive a letter, but would like to contribute, please contact Harrison Phipps at (530)758-3656 or email [execdir@grac.org](mailto:execdir@grac.org). Thank you to those that have generously pledged funds:

List of donors toward second printing of Groundwater Guidance Manual (as of 5/27/00):

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New members who have joined GAA  
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# Welcome!

Kevin Aardahl	Environmental Support Technologies, Inc.	SC
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David Gardner	Fugro West, Inc.	CC
Mika Greenfield	Field-Portable Analytical, Inc.	SAC
Bill Hannell	Acculabs, Inc.	SAC
Ryan Harding	Tetra Tech, Inc.	CC
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Timothy Nicely	Fugro West, Inc.	CC
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# Understanding the History and Future Role of California's Water

## Unique Books Available at the AEG/GRA 2000 Conference

During the AEG/GRA 2000 Annual Meeting, a special Ice Breaker reception will be held on Thursday September 21 from 6 to 8 pm. The reception includes a very special book signing event that will provide the opportunity for conference attendees to purchase signed books that all ground-water professionals should have in their libraries. The two books that will be available include *Water & the Shaping of California* by Sue McClurg and *Groundwater and Geologic Processes* by Steven Ingebritsen and Ward Sanford.



### *Water & the Shaping of California*, by Sue McClurg

The story of California is the story of water. No book tells that story better than *Water & the Shaping of California*.

Filled with gorgeous color photos and a treasury of water literature and famous sayings, this beautifully designed oversized book discusses the engineering feats, political decisions and popular opinion that reshaped the nature of the state's most vital resource - water. The book explores the forces of nature - flood and drought - and society - gold, grain and growth - that led to the water projects that created the California we know today.

Written by the Foundation's Chief Writer, Sue McClurg, *Water & the Shaping of California* follows the history of the precious resource from the Spanish settlement period, when the first mission in San Diego had to be moved to gain a more reliable water supply, through the Gold Rush period and the subsequent ban on destructive hydraulic mining. It tells about the rise of irrigated agriculture and the

development of the projects that put water to work, eventually making California the world's eighth largest economy and producer of 50 percent of the nation's fruits and vegetables.

Portrayed along with the building of the great projects is the rise of the conservation movement from John Muir's Sierra Club to the environmental movement of the 1960s to 1990s, and its impact on water. The book ends with the 21st Century focus on finding balance between economics and the environment.

But this is not a book just about the facts of water. It is about the soul of water and what it does to our hearts. It's about the power of water and how it moves us; the beauty of water and how it gives us peace.

*Water & the Shaping of California* features literary works by some of California's best known authors including Mary Austin, Joan Didion, John McPhee, William Saroyan, Gary Snyder, and John Steinbeck. The foreword is by California State Librarian Kevin Starr, author of *The Americans* and the

*"Trying to resolve California's age-old water wars has been compared, not always favorably, with the process of brokering truce in the Middle East. Consensus comes slowly, through understanding and trust. This textured book helps us move closer toward the peaceful restoration and reconciliation, by compiling the wisdom, images and experience of battlefield veterans."*

— Bruce Babbitt

*California Dream* series. Sepia toned illustrations and photographs along with excerpts from journals and magazine articles by William Henry Brewer, Clarence King, John Muir, Mark Twain and others paint a picture of the California of yesterday.

This coffee table style book (12"x9") features more than 120 color photos, including some 40 images donated by National Geographic Photographer Rick Rickman. Published in conjunction with Heyday Books. Please call the Water Education at (916)444-6240 for additional information.

Special thanks go to the Hans and Margaret Doe Charitable Trust for providing a major portion of the book's development funds.▲

### *Groundwater in Geologic Processes*, by Steven E. Ingebritsen and Ward E. Sanford

Historically, interest in groundwater and other subsurface fluids has been largely confined to a few specific disciplines in the earth sciences. These disciplines have tended to be applied in nature, with practitioners concentrating on the immediate and practical problems of water supply, water quality, mine dewatering, deformation under structural loads, and the location and recovery of fluid hydrocarbons. Interest in groundwater and other subsurface fluids has heightened in recent years. Hydrogeologists and geologists are now actively exploring the role of subsurface fluid, particularly the occurrence and movement of groundwater, and its effect on a wide range of fundamental geologic processes including crustal heat transfer, hydrocarbon migration, earthquakes, diagenesis, and

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## Sacramento Branch Highlights

BY DAVE ZUBER  
SECRETARY

Sacramento Chapter activities included two of our best-attended meetings of the year as we eased into our reduced summer schedule. In June, our own chapter member David C. Sederquist, C.E.G., C.H.G. of Youngdahl and Associates, Inc. presented “Wastewater Disposal: Why Should Hydrogeologists Care?” Mr. Sederquist reviewed the various aspects of septic tank permitting, construction and installation and discussed potential threats to shallow groundwater resulting from improper design.

In August, Carl Hauge Chief Hydrogeologist for the Department of Water Resources and Anthony M. Saracino President of Saracino-Kirby, Inc presented on Conjunctive Use. California has a water management problem: too much when we don’t need it and too little when we do. Mr. Saracino and Mr. Hauge discussed several water management options that are being evaluated to help improve water supply reliability in California, including conjunctive use and groundwater banking. However, the technical challenges presented by these two options have been insignificant related to the institutional and political obstacles. Although classic “win-win” scenarios between local agencies and potential banking partners have been developed, the political constraints have led to chaos and controversy - with an occasional burst of creativity. The conjunctive use experience is a case study in how politics often supersedes science, and as demand for water increases, solutions become more elusive. In the past, many successful water management projects were completed—some local, and some state or federal. Today’s challenges revolve around the issue of providing local benefits, while increasing regional and statewide supply reliability.

Our next meeting is scheduled for October and we are currently scheduling a fall field trip to Iron Mountain Mine. 💧

## S.F. Branch Highlights

BY LINDA SPENCER  
PRESIDENT, SF BRANCH

Our branch has worked over the past year to build our South Bay membership (e.g., San Jose, Palo Alto, San Mateo, and Fremont) by holding meetings in Oakland and in San Jose. In July we were fortunate to have staff from the Santa Clara Valley Water District (District) make joint presentations. The topic was “Evaluation of MtBE Occurrence at Fuel Leak Sites with Operating Uses.” Jim Crowley gave the presentation in Oakland. The next night Cris Tulloch spoke in San Jose. The topic was timely; over 70 people packed these mid-summer night meetings. Here is a summary of what we learned from our excellent presenters.

The District conducted this MTBE study to:

- Evaluate if high and/or increasing concentrations of MTBE in groundwater at fuel leak sites is from known or undetected releases from UST systems
- Determine possible release scenarios
- Identify potential UST system weaknesses
- Provide recommendations to address weaknesses in fuel management and groundwater vulnerability from MtBE

Based on past investigations, the District was suspicious that MtBE releases were from new or upgraded USTs. Unfortunately, in 1997 MtBE impacted a major production well in Santa Clara Valley. At the time, an operating gas station was the suspected source. The next year the Governor’s UST advisory Panel found specific problems with newly installed systems and recommended further studies to test double walled tanks.

Concurrently with participating on the advisory panel, the District began their own study in 1998. They screened 150 open LUST sites with operating USTs. They selected 16 sites with new or upgraded UST

systems for the study. The sites all had a maximum concentration of at least 35,000 ug/l MtBE in groundwater, increasing trends over time, and a prior release that had been stopped. They did a detailed review of the system construction and inspection records and evaluated MtBE and TPHG trends. To learn more about the District’s MtBE study and other related MtBE work, visit their MtBE web page at [www.scvwd.dst.ca.us](http://www.scvwd.dst.ca.us)

The study revealed that for most sites, significantly increasing MtBE trends appear to be the result of undetected releases from new or upgraded UST systems. New or upgraded USTs do not afford 100% protection against fuel releases. What are the causes of this problem? Inadequate or lacking secondary containment and improper monitoring are reoccurring themes where undetected MtBE releases are suspected.

Although MtBE use will be phased out by the end of 2002, the District has concluded that undetected releases are a serious threat to valuable groundwater resources and nearby wells. They asked both the San Francisco and Central Coast Regional Boards to require groundwater sampling at operating UST facilities in Santa Clara County. In response to this request, the Regional Boards will require limited groundwater investigations at facilities closest to water supply wells. Stay tuned for the results of these follow-up investigations.

I would like to thank Branch Officers Mark Wheeler, Jim Ulrich, and Gary Foote for helping to arrange these joint meetings. Miraculously, the meetings went without a hitch, even with our Branch workhorse, Dave Abbott, on vacation! 💧



## Central Coast Branch Highlights

BY TERRY FOREMAN  
PRESIDENT


It has been a busy summer for the members of the Central Coast Branch of GRA. In addition to hosting two successful meetings, we elected a new Treasurer, our past Treasurer had a baby boy, and our GRA Board Representative got married. Ryan Harting of Tetra Tech was elected Treasurer. Ryan replaces long-time Treasurer Jennifer Harting (no relation to Ryan), also of Tetra Tech. Jennifer is taking time off to spend with her newborn baby, Frank Phillip Harting, who was born at 12:07 PM Saturday May 13, 2000. On May 27th, Scott Slater, our GRA Board representative married Margaret Falk, then they flew off to Aruba to spend their honeymoon. We are looking forward to a presentation on the groundwater resources of Aruba!

We have had two excellent speakers this summer. First was a presentation by Dr. Donald R. Kendall, General Manager, Calleguas Municipal Water District. Dr. Kendall spoke about the Las Posas Basin Aquifer Storage and Recovery (ASR) Project. Calleguas Municipal Water District relies on imported water from the Metropolitan Water District of Southern California for 100 percent of its water supply for 600,000 people in eastern Ventura County. Calleguas is developing a groundwater storage project in the Las Posas Basin in eastern Ventura County, CA. This project will increase the reliability of Calleguas' water supply to meet seasonal peak, emergency and drought demands. The storage project involves the installation of 30 new ASR wells, which are dual-purpose injection and extraction wells. This project is the largest ASR project in California and has won many statewide and national awards for innovative water resources management.

Our second speaker was Randy Hanson, Hydrologist, U.S. Geological Survey, Water Resources Division. Mr. Hanson's topic was: *Simulation of Ground-water and Surface-water Flow in the Santa Clara-*

*Calleguas Basin, Looking at the Past and Future.* Over the past 7 years the U.S. Geological Survey has completed a regional study of the coastal aquifer systems in the Santa Clara - Calleguas basin. Combined with installation of monitoring wells, extensive water-quality sampling, and the completion of a GIS, the Survey completed a ground-water/surface-water model of the entire basin and simulated over a century of flow. The Ventura model has been used to evaluate planned and potential projects, has been linked to global climate models for the simulation of the interannual probable future water conditions, and has been linked to spectral estimates of future water conditions for the simulation of the interdecadal probable water conditions.

One of the goals of the Central Coast Branch is to keep members apprised of upcoming events throughout the water world at large. A partial list includes the following:

- Sept. 12-15:** Sustainable Water Use: Industry, Environment & Idealism (WaterReuse)
- Sept. 19-26:** AEG/GRA Joint Annual Meeting, Linking Tradition and Innovation, San Jose, CA
- Sept. 29:** Ground Water Law and Management in California: Recent Developments, Anaheim Marriott Hotel, Anaheim, CA (American Ground Water Trust)
- Oct. 19:** Optimizing Use of Groundwater Resources, Focus on Water Supply Wells and Well Design, American Ground Water Trust and CA/NEV Section American Water Works Association, Lakewood, CA
- Nov. 8-10:** Association of California Water Agencies (ACWA) 2000 Fall Conference, Hilton Anaheim, Anaheim, CA
- Dec. 14-15:** Assoc. of Ground Water Scientists and Engineers, Annual Meeting and Conference, Las Vegas, Nevada
- Dec. 15-19:** AGU Fall Meeting, San Francisco, CA 

## Southern California Branch Highlights

BY PAUL PARMENTIER  
AND ROBERT RUSCITTO

The Southern California Branch's two recent meetings focused on groundwater issues along the Santa Ana River and in Orange County. A May 2000 talk by Mr. Mark Norton of the Santa Ana Watershed Project Authority (SAWPA) described the groundwater and surface water-related projects affecting this critical Southern California watershed. A July field trip to the Orange County Water District's recharge facilities further highlighted all the issues associated with groundwater supplies in this part of the state.

The exciting activities of the Orange County Water District (OCWD) were presented by Roy Herndon and all participants got a chance to have a hands-on look at the groundwater recharge facilities.

### *Recharge Operations*

Groundwater recharge operations require careful balance in stream flow control, maintenance of recharge basins, and chemical monitoring. The hydrogeologic conditions in the northeastern part of Anaheim are uniquely favorable for recharge of the aquifers underlying Orange County further to the south: high permeabilities in the vicinity of the river and the presence of former gravel pits that can be converted to recharge basins. The large basins used for groundwater percolation typically lose recharge capacity within a few months to a year due to sediment deposition, and to biological/chemical deposition of a "crust" that lines the bottom of the basin. Through graphs, the OCWD showed us the change in infiltration rates from water level changes observed in a series of multiple-depths monitoring wells surrounding a recharge basin. GRA participants got to touch this crust in one of the drained basins at the Tustin Lakes facility and received a better understanding

*Continued on page 18*

of OCWD’s challenges in dealing with the loss of recharge capacity.

The traditional method for re-working a basin that lost its recharge capacity is to drain and mechanically scrub the floor of the basin, a complicated and costly process. OCWD is currently perfecting prototype underwater “scrubbing” equipment that will allow the removal of the floor crust while the basin is still underwater, at considerable cost and time savings.

Other challenges faced with the recharge operations at the OCWD include high property acquisition costs for additional recharge areas, regulatory concerns about reclaimed water recharge, and local aquitards. Additionally, the increased control of the Santa Ana River upstream from the recharge areas has reduced the amount of sand flowing in the river. This has reduced the “scrubbing/washing” power of the river to clean the floor of the riverbed, with resulting lower infiltration of water through the river bottom.

**Sea Water Intrusion**

The groundwater withdrawal inland from the Orange County coast has resulted in the invasion of sea water into the groundwater basin, and OCWD is actively maintaining a sea water intrusion barrier network of wells. This activity requires detailed monitoring and constant adjustment of the infiltration and localized extraction operations.

**Basin Studies**

OCWD is directing exciting research in tracer studies of groundwater migration in the area. Using hydrogeologic information from wells, groundwater modeling and tracer studies, OCWD presented a cross-section of the Basin to demonstrate the estimated age of groundwater. Ages ranged from recent groundwater (a few years old) in the vicinity of the recharge areas near Anaheim, to a few hundred years for groundwater at depth under the southern part of the county, to groundwater about 9,000 years old in the deeper, southern part of the Basin.

The OCWD has conducted innovative tracer studies using three main tracers:

- $O^{18/16}$  to “trace” the distinct signature of Colorado river water in the basin
- Helium/Tritium to age-date water 2 years old or older,
- $SF^6$  inert gas
- $Xe^{124/129/136}$  to date water younger than one year.

These tracer studies have enabled the OCWD to vertically and laterally map the migration of water infiltrated in the recharge basins, where lateral migration rates of about 25-30 ft/day have been measured.

An extensive groundwater model is also used by OCWD to determine the potential total infiltration capacity of the Basin to meet the expected demands of the growing population in Orange County. 💧

**Groundwater in Geologic Processes**

Continued from page 15

metamorphism. The authors’ philosophy about the need for greater understanding of subsurface fluid processes addresses a much needed area of emphasis as groundwater professionals attempt to understand and address historical and continuing problems (including salt water intrusion in coastal areas, basin-wide salt loading and transport, overdraft and subsidence) and also the complex groundwater problems of the future.

A unique aspect of the study of groundwater and

geologic processes is the importance of the couplings of groundwater flow with heat transport and deformation, in addition to solute transport. Everyone of these couplings is important to a given problem.

Groundwater in Geologic Processes first develops the basic theory of groundwater motion, solute transport, and heat transport. The second section applies flow and transport theory in a generalized geologic context, and focuses on particular geologic processes and environments.

The systematic presentation of theory and application make this book ideal for graduate-level hydrogeologists and geologists with background calculus and intro-

ductory chemistry. It will also be an invaluable reference for professionals in the field.

Groundwater in Geologic Processes is available in hardback and paperback (341 pp.). It is published by Cambridge University Press. Please contact Dr. Matt Lloyd, Editor, Cambridge University Press West Coast Office, Stanford University, (650)723-9490, for additional information.

The authors, both of whom are with the U.S. Geological Survey, provide grateful acknowledgments to numerous persons, especially colleague reviewers (many of whom are also with the USGS), and the USGS itself. It is their view that the USGS has a strong organizational interest in the topic of groundwater in geologic processes.💧

*“Groundwater in Geologic Processes is a pioneering work in that it successfully consolidates principles, knowledge, and methods developed to date regarding the role of groundwater in several subsurface processes.”*

— Jozsef Toth,  
University of Alberta,  
Canada

# B R A N C H C O N T A C T S

San Francisco Bay Branch  
e-mail: [sf.branch@grac.org](mailto:sf.branch@grac.org)

**President:** Linda Spencer  
San Francisco Bay Regional Water Quality  
Control Board  
(510) 622-2420  
[ls@rb2.swrcb.ca.gov](mailto:ls@rb2.swrcb.ca.gov)

**Vice-President:** Gary Foote  
Geomatrix Consultants  
(510) 663-4260  
[gfoote@geomatrix.com](mailto:gfoote@geomatrix.com)

**Secretary:** J.C. Isham  
The IT Group  
(925) 288-2381  
[julian.isham@theitgroup.com](mailto:julian.isham@theitgroup.com)

**Treasurer:** David Abbott  
Todd Engineers  
(510) 595-2120  
[jorysue@msn.com](mailto:jorysue@msn.com)

**Technical Chair:** Jim Ulrick  
Ulrick & Associates  
(510) 848-3721  
[julrick@ulrick.com](mailto:julrick@ulrick.com)

**South Bay Coordinator:**  
Mark Wheeler  
Crawford Consulting  
(408) 287-9934  
[mark@crawfordconsulting.com](mailto:mark@crawfordconsulting.com)

**Past President:** Clifton Davenport  
Waterstone Environmental  
(510) 533-6710  
[cdavenport@waterstone-env.com](mailto:cdavenport@waterstone-env.com)

Central Coast Branch  
e-mail: [cc.branch@grac.org](mailto:cc.branch@grac.org)

**President:** Terry Foreman  
CH2MHill  
(805) 371-7817, x 207  
[tforeman@ch2m.com](mailto:tforeman@ch2m.com)

**Vice President:**  
Stephanie Osler Hastings  
Hatch and Parent  
(805) 963-7000, x 415  
[shastings@hatchparent.com](mailto:shastings@hatchparent.com)

**Secretary:** Michael Burke  
Furgo West, Inc.  
(805) 650-7000  
[mburke@fargo.com](mailto:mburke@fargo.com)  
**Treasurer:** Jennifer Harting  
Tetra Tech, Inc.  
(805) 681-3100, x 415  
[jennifer.harting@tetratech.com](mailto:jennifer.harting@tetratech.com)

Southern California Branch  
e-mail: [socal.branch@grac.org](mailto:socal.branch@grac.org)

**President:** Paul Parmentier  
IT Corp  
(949) 660-7510

**Vice President:** Kirby Brill  
San Gabriel Basin Water Authority  
(626) 859-7777  
e-mail: [kirby@wga.com](mailto:kirby@wga.com)

**Treasurer:** Robert Ruscitto  
IT Corp  
(949) 660-7510

**Secretary:** Carmen Guzman  
ARCADIS Geraghty & Miller  
(714) 278-0992  
e-mail: [cguzman@gmgw.com](mailto:cguzman@gmgw.com)

**Member At Large:** Steve Zigan  
Environmental Resolutions  
(949) 457-8952

Sacramento Branch  
e-mail: [sac.branch@grac.org](mailto:sac.branch@grac.org)

**President:** Barbara Heinsch  
Yolo County Solid Waste Division  
(530) 757-5574  
[bheinsch@jps.net](mailto:bheinsch@jps.net)

**Vice President:** Richard Shatz  
LAW Engineering & Environmental Services  
(916) 979-7871  
[rshatz@lawco.com](mailto:rshatz@lawco.com)

**Secretary:** Dave Zuber  
Brown & Caldwell  
(916) 444-0123  
[dzuber@brwncald.com](mailto:dzuber@brwncald.com)

**Treasurer:** David Von Aspern  
Wallace•Kuhl & Associates, Inc.  
(916) 372-1434  
[dvonaspern@wallace-kuhl.com](mailto:dvonaspern@wallace-kuhl.com)

**Member At Large:** Steve Phillips  
USGS  
(916) 278-3002  
[spPhillip@usgs.gov](mailto:spPhillip@usgs.gov)

South San Joaquin Valley Branch  
e-mail: [ssjv.branch@grac.org](mailto:ssjv.branch@grac.org)

Gary Corbell  
Welenco, Inc.  
(805) 834-8100

## Marc Reisner 1948 - 2000

Every once in a while in the normal course of things, we stumble upon an inspiration. One such inspiration for me occurred a number of years ago when I met Marc Reisner, who, by any measure, was an inspiration and then some. I met Marc at GRA's first annual conference in San Francisco where he gave the keynote speech. I was familiar with his landmark book, *Cadillac Desert*, but really knew nothing else about him since my negotiations to get him to speak were done solely through his agent.

As fate would have it, we struck up a conversation at lunch that day and ended up working on a project together in an attempt to provide supplemental water for winter flooding of rice fields in the Sacramento Valley. It was clear by this point that Marc was more than a good researcher and writer. He also had a gift - a unique combination of charisma, enthusiasm, intelligence, humor and, as he often pointed out, a low tolerance for bullshit. Even though he was frank and people often disagreed with him, few would deny their admiration and awe of the magic he created when telling a story. Such a story was told at an ACWA conference where he opened his speech by saying that it was amazing that ACWA (Association of California Water Agencies) would invite him, an avowed environmentalist, to speak at their conference: "It's kind of like Rush Limbaugh sitting down to watch Clinton home videos," he said. By the end of his speech, he received one of the most enthusiastic rounds of applause I have heard at an ACWA conference.

To say it's a loss that Marc Reisner died at 51 of cancer is certainly an understatement. I think one measure of the quality of life is the number of inspirational people we happen upon during our lifetime. Already in short supply, we now have one less. 🌿

—Anthony Saracino

# Positions Available

## LUHDORFF AND SCALMANINI CONSULTING ENGINEERS

### *HYDROGEOLOGIST/ENGINEER POSITIONS*

Luhdorff and Scalmanini, Consulting Engineers, a firm that specializes in ground-water resources, is seeking experienced candidates for two positions: staff to project level hydrogeologists/engineers. Candidate must have a minimum of B.S. in hydrogeology/engineering with ground-water hydrology courses (M.S. a plus); 1 to 5 years experience in hydrogeology/engineering; excellent oral and written communication skills; computer skills in data evaluation/presentation; field experience. Well construction inspection experience desirable. Salary commensurate with qualifications and experience. Excellent benefits. Send letter of interest and resume to LSCE, 500 First Street, Woodland, CA 95695. No phone calls please. EOE/AA M/F/D/V

Don't forget  
to register for  
the AEG-GRA  
9th Annual  
Meeting

## Dates & Details

### 2000 BOARD OF DIRECTORS' MEETING DATE AND OTHER KEY DATES

ALL MEMBERS WELCOME

9th Annual Meeting .....	September 19-26, 2000
Thursday-Sunday	DoubleTree Hotel, San Jose Airport
Flow & Transport Modeling Course .....	October 11-13, 2000
Wed-Friday	Sacramento, CA
Next Hydrovisions' Due Date .....	October 30, 2000
Monday	Email: editor@grac.org
Board Meeting .....	November 4
Saturday	Wallace Kuhl & Associates West Sacramento, CA

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