

HYDRO VISIONS

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GROUNDWATER RESOURCES ASSOCIATION
OF CALIFORNIA

Summer 2001

IN-SITU REMEDIATION OF HEAVY METALS USING SULFUR-BASED TREATMENT TECHNOLOGIES

BY JIM JACOBS, ROY L. HARDISON, AND JIM V. ROUSE

THE METALS PROBLEM: Highly toxic and highly soluble metals are contained in numerous waste streams including those from power, chemical, electronics facilities, general manufacturing plants, and mining facilities. Lead, chromium, arsenic, zinc, cadmium, copper, and mercury are the most common metal contaminants found on remediation project sites (US EPA, October 2000). Cyanide is a common inorganic contaminant as well. Metal concentrations in excess of established health guidelines have been shown to create significant health risks to humans.

PAST REMEDIATION OPTIONS: In the past, conventional remediation of soil impacted by heavy metals has relied on excavation, which was expensive and disruptive. In addition, moving the soil

only moved the problem, without treating the soil or reducing the long-term liability. For groundwater, pump and treat remediation relied on pumps to remove groundwater from the aquifer through a series of extraction wells or trenches. The extracted water was then treated above ground or disposed of off-site. Pump and treat methods fail to address the source of



High-pressure remediation injection lance system for metals stabilization treatment.

the contamination in the vadose zone. Although the construction of passive permeable treatment walls containing zero valent iron filings can reduce some metals to less toxic varieties, the passive barriers are expensive and do not treat source areas (Thomasser and Rouse, 2001).

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Call For Nominations – GRA DIRECTORS

As a result of the recently passed By-law amendment, which increases the number of positions on the GRA Board of Directors, GRA is now soliciting nominations for candidates to fill these seats.

Please e-mail, fax or mail your nomination(s), including the nominee's organization and contact information, by JUNE 15, 2001 to:

Donna Geyen
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Fax: 916/442-0382
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The Groundwater Resources Association of California is dedicated to resource management that protects and improves groundwater through education and technical leadership.



President's Message

BY TIM PARKER

As we have just crossed the Vernal Equinox into our second quarter of 2001, the organization is doing great! We are having a successful and action-packed year, a year in which we are going to surpass all previous years in terms of activities. In fact, with all that is going on, the Board and Committees have adopted monthly working Board/Committee telephone conferences in order to stay connected and on top of it all.

It is of course only fitting we have a good performance this year, as it is our tenth year. I believe we are really coming into our own, not only as a viable, sustainable organization, but also as the premiere California organization of groundwater professionals. Look for some great GRA Tenth Year Anniversary activities around and during the Annual Meeting November 1 & 2 in Sacramento.

I want to personally thank all of you for the continued and new support we are receiving - we need your support to keep going as the dues cover less than half the income to support our activities. I also want to extend my thanks to our volunteer and contract staff. These people include our Branch Officers, Statewide Officers, Board of Directors, and contract staff.

Special thanks also to Jim Carter, GRA Seminar Committee Chair, who spearheaded the highly successful Hexavalent Chromium Summit in Glendale in January, where we had over 300 attendees. You da man Jim! Jim is also GRA's Statewide Secretary, and a GRA Director. Our hats go off not only to Jim, but all those volunteers who put this tremendously successful event on.

Our committees are charging ahead with lots to report. And even though we have lots to report, I urge you to please contact any GRA Director or Statewide Officer if you are interested in participating in any of the committees - we can always use more help and more ideas.

The Seminar Committee is planning two additional Groundwater Contaminant

Symposiums this year, one early next year, with three training classes on the horizon:

- Characterization & Remediation of Emerging & Recalcitrant Contaminants - San Jose, June 14 & 15, 2001
- Fundamentals of Geostatistics - two day course, location to be determined, in June/July 2001
- Groundwater Modeling - Sacramento, September 2001
- Arsenic - Sacramento, October 2001
- Groundwater Management - location to be determined, First Quarter 2002
- Hexavalent Chromium Update - Sacramento, First Quarter 2002
- Applied Environmental Statistics location to be determined, First Quarter 2002

The recent introduction of HydroFlash, the new GRA electronic news update service is being provided to you thanks to the leadership and work of Martin Steinpress, E-Communications Committee Chair. Martin is also one of GRA's Directors, and has helped re-energize GRA this year. Other E-Communications efforts include GRA website improvements including the addition of active legislative/regulatory site, online registration capabilities, and a discussion section. Please visit our website and let us know what you think.

The GRA Technical Committee has published a white paper on MTBE, which is available at www.grac.org, and is currently working on a similar white paper for Hexavalent Chromium. Jim Jacobs is the Technical Committee Chair, as well as a GRA Director, and other committee members include Paul Parmentier, Terry Foreman, and Martin Steinpress.

The Annual Meeting Committee continues to work our event this year -

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Groundwater Resources Association of California (GAA),
the Northern California Fuel Oxygenates Committee, and the
Santa Clara Valley Water District Present:

The Series on Groundwater Contaminants CHARACTERIZATION AND REMEDIATION OF RECALCITRANT AND EMERGING CONTAMINANTS

June 14th and 15th, 2001 • Wyndham Garden Hotel, San Jose

What have we learned from the MtBE debacle? Although many advances have been made in characterizing and remediating MtBE and other fuel oxygenates in soil and groundwater, the challenge presented by the thousands of sites statewide remains daunting. MtBE has proven to be as difficult to remove and treat as many of the chlorinated solvents. This is largely due to its physical and chemical properties that cause it to be very recalcitrant in groundwater. Any successful cleanup strategy is largely dependent on a detailed understanding of site hydrogeology. The search for cleaner burning fuel formulations now includes intensive review of any changes that would increase the incidence of groundwater contamination.

Are there other 'surprise' contaminants on the horizon? For decades, industrial solvents have included a group of more than a dozen compounds collectively known as solvent stabilizers. These compounds serve to ensure proper performance in the intended industrial application, be it cleaning textiles, metals, or chips, by inhibiting reactions with acids and metals, or breakdown from exposure to heat, light, and oxygen. Most site investigations have completely ignored the presence of these compounds, and routine GC/MS lab analyses and site cleanup requirements do not address their presence at solvent release sites. Many solvent stabilizers are present at volumetrically insignificant mixtures, but some, such as 1,4-dioxane (not related to dioxin), are

present in the original solvent (1,1,1-TCA) as high as 2 to 8% by volume.

1,4-dioxane turns out to be a particularly vexing contaminant. It is more expensive to analyze, more difficult to remove than its host solvent; and, while it has a low action level, there is no regulated drinking water standard. It is fully miscible, resistant to air stripping or carbon adsorption, and generally not susceptible to microbial degradation. The California Department of Health Services has issued a drinking water action level of 3 ug/L, however there is no Public Health Goal, MCL Goal, or other clear regulatory limit to guide site cleanups. It is also listed as a probable human carcinogen by IARC. 1,4-dioxane has been discovered at numerous solvent sites and other groundwater contamination sites, sometimes at very high concentrations (340,000 ug/L), or has traveled much further than the 'host' solvent. How should this contaminant be regulated or remediated?

June 14-15 Conference: This conference will focus on four areas that, while seemingly disparate, are closely linked to the solutions for recalcitrant and emerging contaminants. It is widely accepted that the pump and treat solution to chlorinated solvents has significant limitations, as contaminant concentrations in groundwater asymptotically decrease to some multiple of the MCL. So how successful have the many recent applications of innovative in-situ treatment technologies been?

In the first session on Thursday June 14th, we'll hear of case studies and comparisons of carefully analyzed successes and failures in local Bay Area applications of permanganate, Fenton's reagent, molasses, permeable reactive barrier walls, and more. This session will be followed by a detailed review of solvent stabilizers, including occurrence, treatability, case studies, and toxicology, and implications for in-situ techniques. The first day will end with a policy round table discussion among key players and policy-makers on the issue of developing site cleanup strategies for emerging contaminants such as 1,4-dioxane, chromium VI, perchlorate, and others in the absence of MCLs or other clear regulatory guidance.

Friday will begin with a focused session on Advances in MtBE Remediation, including exciting new developments for aerobic biodegradation and other technologies. This technical session will be followed by a round-table discussion that will feature highlights from the world of MtBE litigation and feature a distinguished panel of attorneys and government representatives speaking candidly about the latest developments and implications of international, class action, and water purveyor lawsuits. The conference will close with a dynamic session on hydrostratigraphy, profiling excellence in site characterization, regional studies to improve the basin-wide

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In-Situ Remediation of Heavy Metals

Continued from page 1

SULFUR-BASED TREATMENT TECHNOLOGY: Recently, sulfur-based metals treatment technologies have been the focus of an increasing number of research studies and commercial applications for treating metals contamination in soil and groundwater. The solubility of these metals is highly pH dependent. A reagent, such as calcium polysulfide (CaS₄; brand name: Cascade[®]), precipitates the highly soluble metals (arsenic, lead, copper, zinc, cadmium, molybdenum, uranium) as less soluble, and non-toxic sulfides. As shown in Figure 1, metal sulfides are far less soluble than metal hydroxides. Metal hydroxides change solubility with changes in pH. Metal sulfides remain insoluble within a pH range of about 5 to 9.

Hexavalent chromium is reduced from Cr (VI) to trivalent chromium, Cr (III), and then precipitates as chromium hydroxide (US EPA, October 2000). The cyanide ion, a common inorganic contaminant, reacts with calcium polysulfide to form thiocyanate, which is further degraded with excess calcium polysulfide or lime to ammonia, calcium carbonate and gypsum, eliminating the CN⁻ radical.

Cascade[®] has a pH of 11.3 to 11.5, a specific gravity of 1.273 and is deep

orange-red solution. Calcium polysulfide is water-soluble and comes as 29% active ingredient solution. Polysulfide has been used to conduct in situ remediation of uranium, selenium, arsenic, copper, and chromium contamination.

REMEDICATION PHASES: The authors recommend a review of the existing physical and chemical data, including pH, permeability, lithology, and water depth, concentrations of metals, alkalinity, and other data and a simple bench test which can take a few days. Pilot scale tests are recommended to verify treatability. The in-situ pilot-scale or full-scale remediation can be performed shortly after the bench test results are available.

DELIVERY SYSTEM: In-situ delivery is one of the key factors in successful remediation, since the treatment chemicals must fully contact and react with the contaminant. High-pressure injection technology, also called jetting, uses a direct push method as well as a specialized lance system for the delivery of treatment chemicals has proved successful for metals remediation (Jacobs, 2001). Adjustments to pH of the treatment liquids can enhance the metals precipitation process.

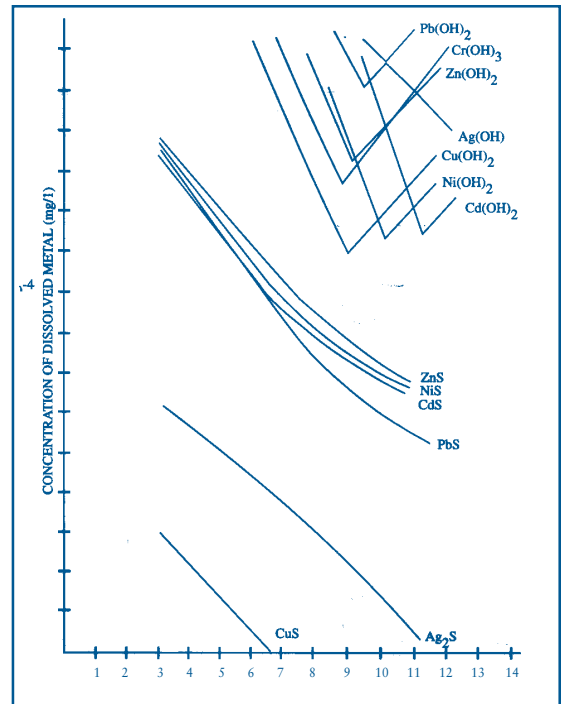


Figure 1– Solubility of Metal Hydroxides and Sulfides as a Function of pH (EPA, 1981)

Metal	Arsenic	Lead	Copper	Zinc
Treatment notes:	Acid medium only forms various arsenic sulfides; pH>7; arsenic-sulfur compounds are soluble; pH<7 the compounds are insoluble.	Wide Range (pH: 4-9); forms lead sulfide	Close to neutral (Optimal pH; 5-7); forms copper sulfide	Wide range (pH: 4-9); forms zinc sulfide
Metal	Cadmium	Molybdenum	Uranium	Cyanide
Treatment notes:	Wide range (pH: 4-9); forms cadmium sulfide	Wide range (pH: 4-9); forms molybdenum sulfide	Wide range (pH: 4-9); forms uranium sulfide	Chemical conversion produces thiocyanate*

*Thiocyanate can be biotreated, or it can be treated with lime, producing calcium carbonate, gypsum and ammonia. Chromium (Cr VI) can be treated with calcium polysulfide, and the Cr (VI) is reduced to Cr (III), which is then precipitated as chromium hydroxide.

CASE STUDY:

UKIAH, CALIFORNIA WOOD TREATING PLANT: A high-pressure injection delivery system was developed for a Cr (VI) project in Ukiah, California. The site had been subjected to more than a decade of conventional pump and treat remediation, with little impact on the contamination. Up to 300 gallons (up to 20 gallons per minute) of calcium polysulfide was injected into the groundwater in 114 injection ports to a maximum depth of 20 feet in 1997. The result was an almost instant decline in chromium concentration in the groundwater (Thomasser and Rouse, 2001). A second injection program was used to address local areas of remaining contamination. The site is now conducting a program of monitoring of existing wells.

SUMMARY:

Sulfur based metals treatment technologies show promise in being able to precipitate toxic and highly soluble metals into less soluble, less toxic metal sulfides for arsenic, lead, copper, zinc, cadmium, molybdenum, and uranium. Mobile hexavalent chromium is reduced to the insoluble chromium hydroxide, while cyanide forms less toxic thiocyanate. In all cases, treatment is pH dependent and can be an attractive remedial action compared to more conventional metals remediation methods such as excavation and pump and treat.

ACKNOWLEDGEMENTS:

The authors thank Rick Thomasser of Montgomery Watson, a firm that has

pioneered in sulfur-based metals treatment technologies. The authors also thank Marc Ashcroft of FAST-TEK Engineering Support Services for developing and improving efficient in-situ remediation injection technology over the past three years.

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Installation of treatments liquids using the high-pressure Remediation Injection Process (RIP®)

specialized in metals stabilization technologies. He has been involved with numerous metals treatment projects. rhardison@att.net

Jim V. Rouse is a geohydrologist with almost 40 years of relevant experience in the subsurface behavior of heavy metals and radionuclides. He developed the concept of in-situ metals remediation in the early 1980s, and has been involved in projects across the United States and Australia. He is Principal Geohydrologist with Montgomery Watson in Colorado. jim.rouse@mw.com

GRA President Testifies on AB 791

GRA President Tim Parker testified April 24, 2001, on Assembly Bill 791. The bill, introduced by Assembly Member Chavez, would add Section 111187 to the Health and Safety Code, related to drinking water labeling, under the purview of the State Department of Health Services. This bill would require that all determinations regarding source water (for example spring water) be

supported by a certification report from a registered geologist (including certified hydrogeologist), subject to regulation by the State Board of Geologists and Geophysicists pursuant to California Business and Professions Code Chapter 12.5. Currently, there is no such requirement for certification reports on these source water assessments. GRA is sponsoring the bill, and Hatch & Parent

attorney Chris Frahm is providing lobbying support on behalf of GRA. The bill received an "amend and do pass", pending some additional language modification to help address some concerns provided by some environmental groups. Visit the GRA Web site Legislation page at www.grac.org to read more on current groundwater legislation.

The Series on Groundwater Contaminants

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perspective, and advances in geostatistical methods for anticipating contaminant migration. Of course, the best element of GRA's widely acclaimed conferences is the opportunity to come together with your peers and discuss the contemporary issues that many are independently solving, and come away with new ideas, information, and contacts.

Registration and Additional Information: Make your plans today to attend this two-day conference at the Wyndham Garden Hotel in the heart of San Jose, the seat of Santa Clara County and Capitol of Silicon Valley. Attendance will be limited to 200, so register early!!

For more Conference details, please visit GRA's web site at <http://www.grac.org>. For information on the Santa Clara Valley Water District, point your browser to <http://www.scvwd.dst.ca.us>. This conference is presented in association with the Association of Engineering Geologists, the International Association of Hydrogeologists, the Water Education Foundation, the Professional Environmental Marketing Association, the Natural Resources Section of the California State Bar, and the Association of California Water Agencies.

President's Message

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"Managing California's Groundwater: The Challenges of Quality and Quantity: 10th Annual GRA Meeting & 23rd Biennial Groundwater Conference" - November 1st & 2nd 2001 in Sacramento. Vicki Kretsinger heads up the Annual Meeting Committee, and is also a GRA Director. Look for more information as well as calls for assistance on our Annual Meeting at our website at www.grac.org.

The Affiliates Committee, chaired by Vicki Kretsinger, continues to work on expanding our currently excellent relationships with other quality groundwater and water organizations. We are looking for ways to benefit our membership and organization as a whole through increased value by structuring strategic relationships with other groundwater organizations.

The legislative/Regulatory Committee, Chaired by Scott Slater, GRA Director, continues to provide support to keep our membership apprised on the highly fluid groundwater legislation and regulations. Scott has also enabled GRA to sponsor a bill this year (AB791), thanks to the generous lobbying support of his firm Hatch & Parent.


Your Executive Director, Kathy Snelson, continues to lead GRA into a more structured and organized way of doing

business. Kathy brings to GRA many years of experience managing and assisting other non-profit organizations, and has greatly helped us plan our program more successfully this year, and into the future. One of Kathy's responsibilities is managing the revision of GRA's California Groundwater Management handbook, to be published in the 3rd quarter this year. Kathy also has a meeting management service, which GRA is using for planning and implementing the Emerging & Recalcitrant Contaminants Groundwater Contaminants Symposium in June 2001.

Kevin Blatt, GRA's contact Webmaster, also manages our membership database. Kevin works closely with the E-Communications Committee to update the Website and provide emails services as needed. Kevin recently provided the GRA Board of Directors with a Membership Demographics Report, which included a breakdown of membership by profession and organizational affiliation.

The Executive Committee has recently provided a GRA Retreat summary and synthesis and provided a report to the GRA Board. I, Tim Parker, am the Chair, and my committee members include Vicki Kretsinger, Tony Ward, Brian Lewis, and Kathy Snelson. Our next project is to review and provide recommendations on GRA's Board of Director's handbook.

And of course, our HydroVisions Committee continues to bring quarterly issues to our membership in a high quality package packed with timely and excellent technical content. Brian Lewis, one of our Board of Directors is Chair. The committee includes David Abbott, David Von Aspern, and Editor Floyd Flood. Remember that HydroVisions is always looking for excellent technical articles and sponsors!

Best Regards to all of you and yours. I hope to see you at the upcoming seminars, annual meeting, and branch meetings. Remember to conserve not only water but electricity as well. It's liable to be a long, hot, and possibly dark summer! 

Tim.

EnviroTech
pick up previous


Managing California's Groundwater: The Challenges of Quality and Quantity

November 1-2, 2001 • Sacramento, California

Planning is underway for the 23rd Biennial Groundwater Conference, which will be held November 1-2 in Sacramento. The theme of the conference is "Managing California's Groundwater: The Challenges of Quality and Quantity." For 46 years, this conference, first sponsored by the University of California and the California Department of Water Resources (DWR), has been bringing to the attention of policy-makers the importance of the groundwater resource. Additional sponsors of the Conference are the Groundwater Resources Association of California, State Water Resources Control Board, Water Education Foundation and the US Geological Survey. Cooperating

organizations include the International Association of Hydrogeologists. Carl Hauge, Chief Hydrogeologist at DWR, and Rita Schmidt Sudman, Executive Director of the Water Education Foundation, are co-chairing the Conference Planning Committee.




Concurrent technical and policy sessions will be held during the two-day conference that will address the following areas: groundwater quality; groundwater quantity; groundwater management: new tools; watershed effects on groundwater; emerging non-conventional contaminants; development of ground water in impaired water areas; GIS and hydrologic



applications; and remediation technologies. Registration for the event is \$195 before September 30; \$250 after September 30. The student rate is \$65 for the two-day event. Registration covers printed abstracts, luncheon and evening reception as well as entry to all panels and presentations. Watch for more information on the GRA (www.grac.org) and UC (www.waterresources.ucr.edu) web sites! For further information call, Cindy DeChaine University of California Water Resources Center at 909) 787-4327. 

California's Groundwater Update 2002


The California Department of Water Resources is currently updating California's Ground Water - Bulletin 118, first published in 1975. The update is a three-year effort, with a draft report to be released by mid-October 2001 and a final report to be released by June 2002. The public review draft is expected to be available at the Biennial Groundwater Conference in Sacramento.

The update consists of a reviewing the boundaries and compiling existing data on the approximately 525 groundwater basins and subbasins identified in the state. Key components of the update will include:

-  A summary of available groundwater balance information for each basin
-  An updated list of references for each basin
-  An Internet-based version of the update with links to supporting material

-  A downloadable GIS coverage of groundwater basin boundaries
-  A summary of groundwater management activities throughout the state

We still need your help

Much of general information for the document has been assembled, but we still need feedback on basin boundaries as well as data for individual basins. You can help by visiting our Web site at www.WaterPlan.ca.gov. Choose the groundwater link for our program. Once there, you will get program background and drafts of available information. Also included will be links to contacts at our District offices. Use these contacts to provide additional information or ask questions about a particular basin, or contact Doug Osugi, Program Manager, California's Groundwater Update 2002 at (916) 653-9493 or dosugi@water.ca.gov. 


Department of Toxic Substances Control Exams

The Department of Toxic Substances Control is offering continuous filing for the following exams (the title in parenthesis is the civil service classification):

Geologist/hydrogeologist/engineering geologist (Hazardous Substances Engineering Geologists [HSEG])

Engineer (Hazardous Substances Engineer [HSE])

Environmental Scientist (Hazardous Substances Scientist [HSS])

For more information and an application, visit DTSC's web page at www.dtsc.ca.gov. If you would like to know more information contact Brian Lewis (916) 323-3632 or via email: blewis@dtsc.ca.gov. 

Arsenic in Groundwater Hits National Center Stage!

COMMENTARY BY MARTIN G. STEINPRESS, GRA BOARD MEMBER

Early this year, California groundwater professionals enjoyed being tangentially involved in the hoopla resulting from this year's Oscar winning film "Erin Brockovich." While a "safe" level of hexavalent chromium in groundwater is still the focus of intense public, media, legislative, regulatory, and scientific attention in California, arsenic has grabbed center stage in the national spotlight. In contrast to hexavalent chromium, arsenic didn't even require a blockbuster movie to focus attention on the regulatory process of developing drinking water standards. March news headlines included: "Sipping Arsenic" and "Safe Arsenic Level is Carcinogenic." The normally methodical development of a maximum contaminant level (MCL) has again been subjected to unusual scrutiny by the media, and become fodder for political agendas and special interests from all sides, but this time on a national scale.


A naturally occurring element, arsenic is widespread in both soil and groundwater, particularly in the southwest, as documented in a recent nationwide U.S. Geological Survey study. The World Health Organization (WHO) has found that high concentrations in groundwater are a major health problem in many parts of the world, particularly in Bangladesh and India (West Bengal). But as always, the dose (concentration) makes the poison. Of course, so does one's perspective.

The brouhaha began when the new Bush administration's EPA head, Christine Todd Whitman announced her intent to delay the Clinton administration's January 17th lowering of the arsenic MCL from 50 micrograms per liter ($\mu\text{g}/\text{l}$) to 10 $\mu\text{g}/\text{l}$. She cited the lack of "clear proof" of the health risk and the need to allow for independent reviews of the science behind the studies and the estimates of implementation costs. A final EPA decision on withdrawal of the rule will come after a public comment period.

The comments have been voluminous. Environmental groups have decried the act as an outrageous yielding to corporate

interests and a delay of the much-needed health protection for many communities that depend on groundwater. On the other hand, some of the estimated 3,000 water purveyors that would have been forced to spend hundreds of millions of dollars to comply have hailed the cost-saving move, while generally supporting a standard below the current level. AWWA estimated that the cost for compliance could range up to \$2,000 per household (a figure much higher than the EPA's estimate).

The EPA's statement that "insufficient science" went into the development of the standard should be particularly unsettling to the scientific community. The Public Health Service recommended in 1962 that the standard be lowered to 10 $\mu\text{g}/\text{l}$. The EPA's health-based maximum contaminant level goal (MCLG) for arsenic is zero, and the WHO provisional guideline is 10 $\mu\text{g}/\text{l}$. A 1999 National Research Council report concluded that the 50 $\mu\text{g}/\text{l}$ cap in drinking water "does not achieve EPA's goal for public health protection and could easily" result in a total cancer risk of 1 in 100, and recommended that the current standard be lowered. Obviously, a de minimus health risk of one-in-a-million is not achievable, but the EPA considered the economic and technical feasibility and took public comment on draft standards of 5, 10, and 20 $\mu\text{g}/\text{l}$ last year before selecting 10 $\mu\text{g}/\text{l}$. How much more exhaustive a scientific and regulatory process can be imagined?

As scientists, we should admit that "safe" drinking water is relative, and standards do represent a trade-off between health risks and costs. While unfortunate, a cost-benefit approach is a necessary reality. As water resources become ever more precious and drinking water standards lower, groundwater professionals will increasingly be on the hot seat. GRA is committed to keep you informed and ready to answer the hard questions concerning groundwater with the GRA web site (www.grac.org), HydroVisions, HydroFlash, and GRA's Series on Groundwater Contaminants (including the upcoming symposia on Recalcitrant and Emerging Contaminants in June and Arsenic in the fall). So stay tuned! 

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new negative
attached

Groundwater Resources Association of California

Geostatistics for Hydrogeological and Environmental Applications

Instructor: Dr. Steven F. Carle of
Lawrence Livermore
National Laboratory

Location: San Francisco Bay Area,
California

Date: August 2001

Course Description

This two-day course will aim to teach the fundamentals of geostatistics in the context of environmental and hydrogeological applications. Geostatistics offers practical approaches to addressing the impact of spatial variability of subsurface properties such as permeability, lithology, or concentration. Specific topics will include:

- * Modeling spatial variability, with emphasis on understanding the meaning of parameters that prescribe variogram, covariance, and correlation models.

- * Use of various forms of kriging and cokriging as mapping tools and estimates of uncertainty - which form is best for specific applications.

- * Application of geostatistical simulation algorithms to stochastic simulation of continuous and categorical properties, particularly permeability and hydrofacies spatial distributions.

The course will mix theory and application by integrating working examples into the teaching of the geostatistical techniques. Theory will be presented with a goal of enhancing understanding of how to correctly apply geostatistical methods. Prior exposure to basic statistics and linear algebra is recommended, but not required. In advance of the course, students are encouraged to donate trial data sets to use as instructive example applications. The instructor will demonstrate geostatistics applications with GSLIB (public domain software). This will not be a software-training course; rather, the emphasis will be on acquiring working knowledge, conceptual understanding, and awareness of both the usefulness and limitations of geostatistical methods in environmental and hydrogeological applications.

Learning Objectives and Benefits

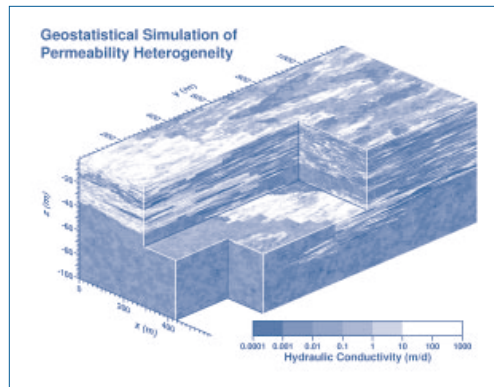
- * Awareness of types of problems that could benefit from use of geostatistics.
- * Ability to choose appropriate geostatistical methods.
- * Understanding of geostatistical models and parameters.
- * Insight needed to use geostatistical software.

Course Instructor

Dr. Steven F. Carle works in the Subsurface Flow and Transport Group at Lawrence

Livermore National Laboratory. He has B.S. and M.S. degrees in Engineering

Geoscience from the University of California Berkeley and a Ph.D. in Hydrologic Science from the University of California Davis. He has 2 years work experience in Environmental Consulting.



For the past ten years, Dr. Carle has been developing and applying geostatistical methods throughout his work on a variety of hydrogeological problems, such as subsurface characterization, interpretation of multi-well pumping tests, and risk analysis for heterogeneous aquifer systems.

Geostatistics Course Topics

Introduction

- Instructor Background
- History of Geostatistics
- Course Goals

Survey of Applications

- Quantification of Spatial Variability &

Estimation Uncertainty

- 2- and 3-D Mapping & Estimation Simulation

- Permeability, Porosity, etc.

- Categories, e.g. Hydrofacies,

Concentration Ranges

- Flow & Transport

- Hydrogeology

- Petroleum Reservoir Simulation

Basic Statistics

- Distributions, e.g. normal and log normal

- Mean, Variance, Covariance

Spatial Statistics

- Spatial Covariance

- Variogram

- Correlation

- Cross-Covariance

Estimation

- Kriging - Simple and Ordinary

- Block Kriging

- Cokriging

- Estimation Uncertainty

Simulation of Continuous Random Fields

- Sequential Gaussian Simulation (sgs)

- LU-Decomposition

- Turning Bands

Indicator Methods

- Spatial Variability

- Indicator Variograms

- Transition Probability

Estimation

- Indicator Kriging

- Indicator Cokriging

Simulation

- Sequential Indicator Simulation (sis)

- Transition Probability Approaches

Hydrogeological Applications

- Flow Simulation in Heterogeneous Aquifer Systems

- Monte Carlo/Stochastic Approaches to

- Transport Simulation

References

Geostatistics Course Dates and Location

The two-day course is planned to occur in August 2001 in the San Francisco Bay Area, California. Watch for updated information on GRA's web site www.grac.org. For more information, contact Vicki Kretsinger of Luhdorff and

Continued on page 20

Water Quality Data Elements

BART SIMMONS, PH.D.

April 2-6, 2001, US EPA held the 20th Annual National Conference on Managing Environmental Quality Systems in St. Louis. This conference for the first time included not only data quality issues, but issues in information technology. EPA has merged the two groups into the Office of Environmental Information, and the merger has forced data quality folks to talk with information technology folks in new ways. This interaction will affect the environmental community in several ways. Importantly, the standards for data collection, electronic transmission, and dissemination will likely evolve rapidly.

One example of emerging data standards is the documentation for sampling and analysis. Agencies and the public are finding secondary uses for data, which focuses on the critical steps in documenting the initial sampling and analysis.

On March 16, 2001, a notice in the Federal Register (Vol. 66, No. 52, 15273-15275) asked for comment on a set of "Data Elements for Reporting Water Quality Results." The Methods and Data Comparability Board, which has representatives from federal, state, and local agencies as well as the private sector, prepared the list. The elements were proposed to help standardize the collection of water quality data. The proposed elements can be downloaded from: <http://wi.water.usgs.gov/pmethods/elements/elements.html>

The Hierarchy of Data Elements

The major hierarchies of the proposed data elements are: Contact, Analyte Sampled, Reason for Sampling, Date and Time, Location, Sample Collection, and Sample Analysis. Some details follow.

Contact

The name of the organization which is the source of the data (the data owner), plus; the sampling entity; the laboratory; including addresses and email addresses of each.

Analyte Sampled

Include field measurements, field quality control samples, media code, sample identification code, chemical name, Chemical Abstracts Service (CAS) number, biological systematic name, and Integrated Taxonomic Information System (ITIS) number.

Reason for Sampling

Reason for sampling? It may have been obvious to the sampler, but not so obvious to a secondary data user, and may help determine the usability of the data.

Date and Time

Date and time should include sample collection start and stop times, extraction/processing, as well as analysis.

Location, Location, Location

Include not only water body/aquifer name or facility registry number, and type of sampling station, but latitude, longitude, and altitude. With the availability of GPSs, it is feasible to record location accurately, including a statement of accuracy of the measurements. Incidentally, US EPA has a Locational Data Policy (<http://www.epa.gov/irmpoli8>). It has also created a Geospatial Quality Council, which is preparing a GPS Technical Information Guidance (contact: George Brilis, Brilis.George@epa.gov). The elements include water level and water discharge rate.

Sample Collection

Include sample collection method (grab, type of pump), sample preservation, sample container, and sample volume.

Sample Analysis

Reporting standards have been established by the National Environmental Lab Accreditation Conference (NELAC) and other organizations, so labs are familiar with most of these elements, including: method number, sample size, serial dilution, composite sample, run batch, spiking amount, analytical precision, analytical accuracy/error [more on this in a future column], positive control, negative control, detection level, regulatory reporting level, and result. The statement of analytical accuracy/error and precision are being actively debated now, since it is also required by ISO 17025, the international standard for laboratory testing.

The US EPA is preparing a Data Quality Strategic Plan, which will address several issues related to environmental testing: the need for a National Information Quality Office, the need for data and metadata standards, such as those mentioned above, data transmission and storage, improving Quality Assurance Project Plans, and improving the data quality in grants and permits. Ready or not, the environmental field and lab community seem destined to integrate more information technology into their lives.

Bart Simmons can be reached at bsimmon@dtsc.ca.gov. He is Chief of the Hazardous Materials Laboratory for the Department of Toxic Substances Control.

“Santa Maria Groundwater Litigation Moves to Phase II Determination”

BY STEPHANIE OSLER HASTINGS

The collection of cases commonly referred to as the “Santa Maria Groundwater Litigation” recently concluded a “Phase I” trial and is scheduled to proceed with Phase II in October of this year. The consolidated litigation, initiated in 1997 when the Santa Maria Valley Water Conservation District filed suit against the City of Santa Maria and other water purveyors in northern Santa Barbara and southern San Luis Obispo Counties, now includes nearly 800 parties who are believed to have competing claims to pump groundwater from a common source, namely, the Santa Maria Groundwater Basin.

By order dated January 9, 2001, the Court brought Phase I to a close when it concluded that there is no disputed issue of material fact as to the “outermost” basin boundary of the Santa Maria Groundwater Basin and entered judgment on that issue. With some minor exceptions, the court

concluded that the outermost lateral and vertical boundaries of the basin lie along the divide between those geologic materials that do not readily transmit water (e.g., they are impermeable) and those that do. Thus, the “outermost” basin boundary definition is based almost entirely on geologic factors. Very generally, the “outermost” lateral boundary of the basin begins just north of the northern or Five Cities area, continues south along the Pacific coast, east along the Solomon Hills to the Sisquoc plains, and north again along the eastern border of the Santa Maria River.

In conjunction with its order adjudicating the “outermost” boundaries of the Santa Maria Groundwater Basin, the Court also issued an order designating the issues to be tried in Phase II of the litigation - specifically, the limits of the area that will be included in the remainder of the case and that which may be excluded. In other

words, the Phase II trial may result in a determination that the area that will be subject to the adjudication is something different or smaller than the undisputed geologic definition of the basin.

In determining the area to be adjudicated, the Court left open the possibility that non-geologic factors such as hydrology, geography, land use and pumping patterns, and potentially other political considerations may influence its Phase II determination. While factors like these have in the past influenced basin boundary definitions for purposes of adjudication, the criteria developed through this phase of the litigation must result in a definition of the groundwater basin that provides each and every claimant to water with certainty, predictability and reliability in their water supplies, as well as finality of all adverse claims. The effort and expense of pursuing a groundwater adjudication is too great for any party to risk the potential that its water right secured by the adjudication might later be diminished should conditions change which impair the quantity or quality of water available to them. Thus, the decision to choose one boundary line over another for purposes of this adjudication could have dramatic legal consequences.

In the end, it is anticipated that Phase II of the Santa Maria Groundwater Litigation will provide the parties with a precise definition of the property at issue, and thus a better understanding of the issues in dispute. It will necessarily identify all proper claimants and provide a baseline for determining the existence and extent of overdraft, as well as the basin’s annual safe yield, upon which individual entitlements might later be quantified.

Ms. Hastings is an attorney with the law firm of Hatch and Parent in Santa Barbara, where she specializes in water law. As part of her practice, she represents two publicly regulated water purveyors and several private landowners in the Santa Maria Groundwater Litigation. Ms. Hastings is also the Vice President of the Central Coast Branch of the GRA.

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CCGO ACTIVITIES:

BY JIM JACOBS, CCGO PRESIDENT 2001 AND BETSY MATHIESON, PAST CCGO PRESIDENT

GRA is an active organizational member of the California Council of Geoscience Organizations (CCGO). We recently had an April 4th Fundraiser with over 120 attendees to hear Dr. Ken Lajoie discuss the Geology of the San Francisco Bay. In addition, CCGO's 2nd Annual Sacramento Drive-In on March 1, 2001, CCGO met with the California Division of Mines and Geology (CDMG), the State Geologist, Dr. Jim Davis of the CDMG, and Paul Sweeney, Executive Director of the Board for Geologists and Geophysicists, as well as 2 members of the Sunset Review Committee. We met with several legislators, Senator Figueroa, Assemblypersons Nation and Diaz, as well as staff members. We supported the rewrite of the Geology and Geophysicists Act, which has not been updated for 30 years. CCGO recently joined GRA to support the AB791, the "Calistoga Bill" to allow geologists to

certify springs. The California Council of Geoscience Organizations announced on March 14, 2001, that it supports California Assembly Bill 791, the "Calistoga Bill," whose title is "An act to add Section 111187 to the Health and Safety Code, relating to drinking water." See article below for the full text .

CCGO's legislative committee needs you! Help us to ensure that new laws are in the interest of public health, safety and welfare where geoscience issues are concerned. Review of bills and tracking of amendments can be done on the web, with committee communications via e-mail. Join us! Contact CCGO President Jim Jacobs at (510) 232-2728 x222 or augerpro@jps.net

LOBBYING EFFORT- Based on our Sacramento drive-in; CCGO is trying to persuade the legislature to accelerate several programs of the Department of Conservation's California Division of

Mines and Geology (CDMG). During the recent CCGO Sacramento Drive-In, our presentations to the legislators have brought CCGO to the conclusion that it would be desirable to provide them with a number of supporting letters from other CCGO members who recommend accelerating several programs that are providing basic hazards information to the consulting community, to local government and to the public. In order to achieve this, it is necessary for those who can, to prepare a letter on their own stationary. Please address the letters to Jim Jacobs and encourage CCGO to continue to support accelerating the CDMG programs related to public safety. Please state the rationales or justifications for such support, along with your recommendations. If this approach to lobbying works for CCGO, the group can try to push for groundwater and environmental programs. 💧

THE "CALISTOGA BILL"

BY BETSY MATHIESON

FLASH - CCGO SUPPORTS AB791,

The California Council of Geoscience Organizations announced on March 14, 2001 that it supports California Assembly Bill 791, the "Calistoga Bill," whose title is "An act to add Section 111187 to the Health and Safety Code, relating to drinking water." The full text of the bill is as follows (emphasis added):

THE PEOPLE OF THE STATE OF CALIFORNIA DO ENACT AS FOLLOWS:

SECTION 1. Section 111187 is added to the Health and Safety Code, to read:

111187. The department shall accept a certification report from a registered geologist as presumptive evidence of compliance with its drinking water label requirements regarding the type of water, when submitted in support of a specific water label and a license application that specifically

names, identifies, and qualifies the source of the water.

According to the Legislative Counsel's Digest, "Existing law makes the State Department of Health Services responsible for issuing licenses for water bottling plants and for ensuring that all labeling requirements for bottled water are met.

"Existing law requires the department to ensure that the information on the label or in the advertisement of bottled water, purporting to be a specific water type, for example, spring water or purified water, is what it purports to be before issuing a license and allowing the label to denote the specific water type."

The California Council of Geoscience Organizations applauds the bill's author, Assemblymember Edward Chavez of La Puente, for recognizing the importance of geologic expertise in determining groundwater sources.

Hundreds of bills have been introduced in the new legislative session. Tens of those include references to such key topics as contaminated soil, seismic safety, landslides, oil and gas development, and mine reclamation. To learn how to get information on any bill, and how to subscribe to an e-mail update service for bills that interest you or your business, visit the CCGO web site's legislative alert page at <http://www.ccco.org>.

CCGO's legislative committee needs you! Help us to ensure that new laws are in the interest of public health, safety and welfare where geoscience issues are concerned. Review of bills and tracking of amendments can be done on the web, with committee communications via e-mail. Join us! Contact CCGO President Jim Jacobs at (510) 232-2728 x222 or augerpro@jps.net

GRA Web Site Adds Legislative Updates, Discussion Forum, and More

BY MARTIN G. STEINPRESS,
GRA ELECTRONIC COMMUNICATIONS COMMITTEE CHAIR

The GRA web site (www.grac.org) has increased its usefulness for members in the last few months with the following improvements:

- A legislative and regulatory update page with summaries of new bills, regulatory actions, and links to the complete text of bills
- A discussion forum that gives members the opportunity to comment on new legislation and regulations that may affect the groundwater industry
- Online addition of employment listings by corporations

- Online sales of the Proceedings of GRA's January Hexavalent Chromium in Groundwater Symposium, and announcements of upcoming seminars

- Online membership applications with secure payment by credit card

Thanks to our ace webmaster, Kevin Blatt, for these enhancements! GRA is dedicated to providing you with the services you need at your desktop, so let us know what else we can do to serve you better.

GRA's Electronic Newsletter Premieres!

BY MARTIN G. STEINPRESS,
HYDROFLASH EDITOR

The first and second issues of GRA's new electronic newsletter were sent in March and April with more to come every month or so. HydroFlash provides members with brief updates on important issues, and is intended to take no more than a minute of your time to scan. The short summaries of each topic have web links to more detail on GRA's web site (www.grac.org) and other sites. HydroFlash provides updates on fast-changing legislative and regulatory issues, meeting and symposia announcements, and other news on GRA web site additions. While HydroFlash will be free of advertising, contact the editor if your organization would like to sponsor an issue. And watch your E-mail inbox for future issues.

Aerial Photography Interpretation Workshop

The GRA Sacramento Chapter will hold an Aerial Photography Interpretation Workshop Saturday, November 10, 2001 at the Red Lion Hotel in Sacramento. Brian Hausback, the chair of the CSUS Geology Department will be the lead instructor. Cartwright Aerial Surveys, Inc. will provide the aerial photos as well as demonstrate the use of digital aerial photos. The class is still in the planning stages but is anticipated to be an all day class. Costs are still not firm but are anticipated to be approximately \$80 with lunch provided. More information will be posted on the GRA web page at www.grac.org in the near future. To be added to the list for interest in this class or for more information contact Barbara Heinsch at bheinsch@jps.net or call 530-666-8858.

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Governor Davis Names Tepel to State Mining and Geology Board

Governor Gray Davis has just named several members and the chair to the California State Mining and Geology Board. Among the new members is California Council of Geosciences Organizations (CCGO) founder Robert E. Tepel. The State Mining and Geology Board is composed of nine members appointed by the Governor and confirmed by the senate, for four-year terms.

The Board operates within the Department of Conservation and is granted certain autonomous responsibilities and obligations under several statutes.

The Board serves as a regulatory, policy and appeals body representing the State's interests in geology, geologic and seismologic hazards, conservation of mineral resources, and reclamation of lands following surface mining activities. For more information about the Board, visit its web site at <http://www.consrv.ca.gov/smgb/>.

Mr. Tepel has had a long and productive career at the Santa Clara Valley Water District in San Jose, California. He recently retired from the agency.

He is a past president of the Association of Engineering Geologists (AEG) and recently was the chief organizer for the very successful Fall 2000 AEG-GRA Annual Meeting in San Jose, California. He has written many articles and even a book on professional licensure, one of his areas of interest. He has also been involved with the Association of State Boards of Geology (ASBOG).

Under Mr. Tepel's leadership, CCGO was founded and grew. He helped with the mission, vision, incorporation, and strategic plan that have led CCGO to its current status as California's largest association of geoscientists. Mr. Tepel initially led the charge during the State legislature's sunset review of the Board of Registration for Geologists and Geophysicists about 5 years ago, and CCGO participated actively in the Board's sunset review last year.

Mr. Tepel has remained supportive of CCGO over the years and we are proud of his appointment to the State Mining and Geology Board.

For more information about the California Council of Geoscience

Organizations, visit its web site at <http://www.ccco.org> or contact CCGO

President Jim Jacobs at AugerPro@jps.net or (510) 232-2728.

Distributed by Betsy Mathieson, Past President, California Council of Geoscience Organizations.

Update on the Technical Committee For the April 7th Board Meeting

BY PAUL PARMENTIER, CHAIR OF THE TECHNICAL ADVISORY COMMITTEE

MEMBERS: The committee members include Paul Parmentier (Chair), Terry Foreman and Martin Steinpress and Jim Jacobs (GRA Board Liaison).

Action Items Planned:

1. White Paper on Cr VI:

The Technical Committee plans to summarize the Chromium VI seminar information into a "White Paper" similar to the document prepared last year for MTBE.

Format: "Just the Facts" -not taking sides on controversial health risk issues.

Technical supporters lined up in So Cal from Komex/H2O and Geomatrix to help write the document.

Schedule: Draft due to Jim Jacobs for review April 30, 2001

2. Review the MTBE "White Paper" and update if necessary-

3. Follow up on making MTBE paper accessible on the web site.

Submitted April 3, 2001 from Paul Parmentier to Jim Jacobs on behalf of the Technical Committee.

Fast-TEK
negative you have

Southern California Highlights

BY PAUL PARMENTIER, PRESIDENT

Spring 2001 Update

The Southern Branch successfully supported the January Chromium VI Seminar, and after that effort, our typical activities resumed with our first bi-monthly dinner meeting, held in February. Alice Campbell of SCS Engineers presented an interesting talk on groundwater VOC contamination from landfills (see summary of her talk below).

Source Mechanisms and Conceptual Models for VOC Transfer to Groundwater Near Landfills.

Alice M Campbell, Hydrogeologist
SCS Engineers

In order to explain patterns of volatile organic compound (VOC) concentration changes in groundwater monitoring wells near landfills in arid and semiarid environments, the entire chain of events that is involved in moving VOCs to groundwater must be understood. The main factors to be investigated and understood include:

Recognition of the nature of groundwater recharge at the site, both in time and in space.

Recognition of the nature of landfill gas (LFG) migration at the site, and of the location in time and space of LFG origin, fate, and transport.

Recognition of the several different ways that LFG may transfer to groundwater via the vadose zone, including saturated and unsaturated flow mechanisms.

Alice presented conceptual models illustrating several mechanisms believed to be operating at typical arid sites. For example, groundwater in semiarid environments originates from episodic recharge events, often separated by long intervals of no recharge. In desert regions, direct precipitation on outcrops of

fractured bedrock without significant soil development may recharge alluvial materials derived from and adjacent to the bedrock outcrop. During the dry periods between recharge events, LFG originating from unlined landfills that occupy canyons or quarries in bedrock may occupy portions of the nearby vadose zone, and when recharge events occur, VOCs may enter groundwater a number of different ways. This episodic character of VOC contamination is often apparent in time-history plots of VOC concentrations from groundwater monitoring programs. Several time-history curves were presented that showed differences between several VOC transfer mechanisms.

Similarities and differences between several different leachate-to-water and LFG-to-water transport mechanisms were also discussed. In arid and semiarid climates, saturation of waste only occurs under rare or local conditions. Leachate transfer mechanisms include downward migration of fluid from saturated waste, upward excursions of groundwater into waste, and lateral incursions of water to waste in the form of springs that daylight into a refuse mass. LFG transfer mechanisms include diffusion of a relatively static gas cloud in contact with a groundwater surface; washdown of a relatively static gas cloud in the vadose zone; sweepup of volatiles condensed onto soil out of LFG by rising groundwater; and a variant of washdown, the entrainment of VOCs when gas is trapped beneath a saturated soil layer and moves along coarse stream deposits for long distances, and recharge water subsequently sweeps up the gas. Generally, large areas of gas contact occur in relatively uniform alluvial materials. In these environments VOC concentrations are commonly low but the problem is widespread.

Another geologic setting that favors VOC transfer is fractured bedrock and derived high-conductivity linear features such as stream channel deposits. In these environments, LFG and groundwater share the same pathway, so VOCs are more readily incorporated by recharge events. VOC concentrations are generally higher and occur in pulses, often separated by long intervals of low levels. Subtleties in

geologic factors may have significant effects on how VOCs move, and two sites with superficial similarities may have rather different VOC transfer mechanisms. Although LFG and leachate effects on VOC concentrations in groundwater are superficially similar, small differences may be used to infer differences in source of VOC transport at arid sites.

In summary, Alice pointed out forcefully the importance of a good hydrogeologic characterization and monitoring of groundwater conditions at landfill sites, and their potential complexities.

San Francisco Branch Highlights

LINDA SPENCER, PRESIDENT AND
BILL MOTZER, MEMBERSHIP CHAIR,
HYDRO-ENVIRONMENTAL
TECHNOLOGIES, INC.

We are having a great spring filled with lots of interesting meetings. On May 16th, Martin Steinpress will present "Hexavalent Chromium In Groundwater: Natural Occurrences Versus The Erin Brockovich Effect". The talk will be at the Old Spaghetti Factory in Oakland. Fliers and registration information will be sent via mail, and we should have the information on the GRA website.

Our up and coming South Bay Section met at March 21, 2001 at the Keton Restaurant in San Jose. Approximately 40 people (more nonmembers than members) and Tim Parker, President of GRA attended. Attendees dined on a choice of grilled pork medallions, teriyaki chicken, pan fried tofu and veggies, crispy Shitake mushroom dinner salad, or nut-crusted shrimp salad, and desert and coffee. Randy T. Hanson of the U.S. Geological Survey Water Resources Division (San Diego) gave an excellent presentation entitled: An Update on Current U.S. Geological Survey Studies of Sedimentary Stratigraphy and Groundwater Hydrology of the Santa Clara Valley Groundwater Basin. This is the second year of a four-year project conducted in cooperation with the USGS

Continued on page 21

San Francisco Branch Highlights

Continued from page 20

Geologic Division and Santa Clara Valley Water District. Randy gave us an overview of the on-going investigations using a very sophisticated regional ground water model, deep well logs, mixing of basin water by stable isotope analysis, geochemical surveying and 3D-geologic mapping. All of this is vitally important to those of us conducting investigations in the Santa Clara water Basin and we thank him for his outstanding work.

The food in the Old Spaghetti factory does not quite measure up to this Japanese cuisine in San Jose. Our South Bay Coordinator, Mark Wheeler is just trying to one-up the North Bay venue. Nonetheless, we had a good turnout for a meeting in Oakland featuring Thomas L. Hicks of Martell Water Systems, Inc. His topic was "Zone Sampling - A Step In The Exploratory Phase Of Well Drilling To Aid The Geologist, Engineer, Drilling Contractor In The Design Of Production Water Wells. Zone sampling is used in conjunction with other traditional tools in the design of the production well; to provide an indication of potential for production; and to allow water samples to be obtained from a specific location within the borehole. As with all sampling techniques, the samples obtained are only as good as the crew and equipment working over the borehole. In mud rotary the drill rig, crew, and mud system is paramount in not only obtaining accurate samples, but also in constructing a "sand free" production well. Therefore, it is important to understand the benefits and limitations of the testing involved. Water samples obtained by this method can be tested on site, or forwarded to a laboratory; and the degree of ease in which samples are obtained, and volume produced, provides a greater degree of confidence in the results. 💧

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Job Announcement

ENSR, an international environmental consulting firm, has multiple opportunities available in our growing Sacramento office. We are looking to fill the following positions:

Senior Geologists

Field coordinator and project manager for site investigation/remediation program at a major state Superfund site. Responsibilities include subcontractor scheduling; permit acquisition; general administrative financial review and approval; field support; preparation of work plans for soil, soil vapor, and groundwater investigations; and preparation of RI/FS reports. Also assist in preparation of RAPS, RAWs, and environmental permits. BS or higher degree in Geology or Hydrogeology required. Minimum of 5 years experience managing large multi-task field programs, including experience working with public agencies and municipalities.

Remediation Engineers

Manager/technical lead for soil vapor extraction and groundwater remediation projects at a large state Superfund site. Experience in planning, permitting, design, construction and operation of soil vapor extraction, groundwater pump and treat, and in situ groundwater remediation systems. Experience with preparation of RI/FS, RAWs and RAPS. BS or higher degree in Environmental, Civil, Mechanical, or Chemical Engineering required. Minimum of 5 years experience required.

ENSR offers competitive benefits and compensation package including a comp time program. Please visit our website at www.ensr.com for more details on our current openings. All qualified candidates should email their resumes to HRwest@ensr.com, fax to (916-362-8100) or mail to:

ENSR
10324 Placer Lane, Suite 200
Sacramento, CA 95827
An Equal Opportunity Employer M/F/

Dates & Details

CALL FOR NOMINATIONS - GRA DIRECTORS

Continued from page 1

GRA would greatly appreciate your thoughtful consideration and nomination of groundwater industry representatives you believe will bring appropriate expertise, energy and dedication to achieving the mission and goals of GRA.

Should you have any questions about the Call for Nominations, please contact Kathy Snelson, Executive Director, at 916/446-3626 or execdir@grac.org.

Geostatistics Course

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Scalmanini, Consulting Engineers (530) 661-0109.

Cooperating Organizations

The Groundwater Resources Association Geostatistics course is being conducted in cooperation with the International Association of Hydrogeologists and the Association of Engineering Geologists.

2001 BOARD OF DIRECTORS' MEETING DATE AND OTHER KEY DATES

ALL MEMBERS WELCOME

Conference	June 14-15, 2001 Characterization & Remediation of Emerging & Recalcitrant Contaminants Wyndham Garden Hotel, San Jose
Symposium	June 14-15, 2001 Santa Clara Valley Water District, San Jose
Board Meeting	August 11, 2001 FAST-TEK, Point Richmond
Board Meeting	November 3, 2001 Wallace-Kuhl, Sacramento
Seminars	Spring or Summer 2001 Environmental Statistics, Location to be determined Fall 2001 Groundwater Modeling, Location to be determined
Annual Meeting	November 1 & 2 2001 Joint with Biennial Groundwater Conference, Sacramento



GROUNDWATER RESOURCES ASSOCIATION
OF CALIFORNIA

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