HYDRO VISIONS

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IN-SITU HIGH-PRESSURE REMEDIATION INJECTION PROCESS

By JIM JACOBS, DAN RUSLEN, SCOTT MACLEOD and TRAVIS TAYLOR

ABSTRACT - In-situ remediation using chemical treatment can be an attractive alternative when on-site activities or structures precludes more conventional remediation methods. The key to the injection of liquids for in-situ remediation of soil and groundwater is getting thorough vertical and horizontal saturation of the treatment chemicals in the soil and groundwater, regardless of the method used. Treatment chemicals can be injected for chemical oxidation, enhanced bioremediation, soil flushing, pH adjustment or metals stabilization.

High-pressure injection points placed on close spacing, such as 2 foot to 5 foot centers, allows for complete in-situ coverage, vertically and horizontally. Pressures reaching 5,000 psi allow for the treatment liquids to be thoroughly mixed with the contaminant in the subsurface.

One such in-situ injection system, the Remediation Injection Process (RIPx) uses lance penetration to reach depths of about 20 feet. A flexible lance system is used for greater depths. Using this approach, the solutions can be accurately injected into the impacted areas to obtain direct contact with the target constituents. This precise injection of the treatment solutions/slurries can expedite the remediation process to achieve substantial reductions in contaminant concentrations in a relatively short period of time.

The hand-held injector wands can be used to remediate limited access areas such as underneath slabs, railways, and buildings, around tanks, pipelines and subsurface utilities; and into hillsides, excavation pits and stockpiles.

The RIPx has the capability to remediate a variety of constituents both in-situ or ex-situ including petroleum hydrocarbons, BTEX, MTBE, chlorinated solvents, selected metals and other contaminants.

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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.

INSIDE

The "Kevin J. Neese Memorial Award" Presented at GRA's Annual Meeting

By SCOTT SLATER, GRA Board Member

This year the GRA Board established an award in the name of Kevin J. Neese, former GRA Board member and past president of the Central Coast Branch. Kevin was a geologist first, having received both undergraduate and a masters degree before heading off to law school.

After law school he joined Hatch and Parent as a member of the California Bar and thereafter, combined his technical training as a geologist with his legal education. Besides practicing law, Kevin taught courses and seminars in educational programs regarding groundwater and groundwater management and was one of the authors of *California Groundwater Management,* first published by GRA in 1997.

Through it all, Kevin maintained a passionate pursuit of excellence. His open discourse

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PRESIDENT'S MESSAGE

BY BRIAN LEWIS

Our 1999 Annual Meeting was a success. We had over 200 hundred attendees and 13 exhibitors in San Diego. This Annual Meeting was the second time we have joined the Biennial Groundwater Conference. Secretary Mary Nicholas, Resources Agency, was the key note speaker (see pg. 3.) GRA's Annual Meeting was supported by many GRA members. Vicki Kretsinger, Carl Hauge, Susan Garcia, Harrison Phipps, Tim Parker, Tony Ward, Paul Dorey, and Scott Slater all helped with the meeting. We are also thankful to the many talented presenters for this time preparing for their talks. We also had the most number of exhibitor for an annual meeting. We had exhibitors from as far away as Florida and Canada.

David K. Todd (left) is receiving GRA's Lifetime Achievement Award from Brian Lewis.

During the business meeting, several awards were presented: David K. Todd was presented with GRA's Lifetime Achievement Award (see pg. 5). The "Kevin J. Neese Memorial Award" was presented to Governor Gray Davis for his ban on MTBE (see pg. 11). I received an award from the Board for my tenure as President. In addition, several branch members were presented with awards for their support of the Association over the years (see pg. 12).

GRA is also proud to be a member of the California Council of Geoscience Organizations. A delegation from CCGO traveled to St. Louis to provide testimony for the International Council of Building Officials regarding the need for geologists in implementing the building code. Betsy Mathieson, CCGO vice president and GRA member, was successful in having the IBCO recognize the role of the geologist for slope stability (see pg. 16). CCGO has also supported GRA on several legislative bills during this past year. CCGO has made some notable accomplishments during their first year. If possible, you should visit their web page. www.ccgo.org.

GRA is in the process of raising funds for a second edition printing of the Groundwater Management Handbook. If you or your company would like to be listed as a contributor to the publication of the handbook, please contact Harrison Phipps (see pg. 14) at (530) 435-2345 or at his email address execdir@grac.org.

Barbara Heinsh has distributed the membership directory electronically to all members with email. We are in the process of making copies on disk to our members without email. These disks should be mailed by the end of the year. Please be patience as the snail mail makes it your way. If you would like to receive the directory electronically and you are a current member, please contact Barbara at Bheinrich@jps.net. She will be happy to send you an electronic version.

I hope this newsletter finds you happy and well. As you can tell by this newsletter, your association continues to be busy. We appreciate your support and volunteerism to make this a successful association. Best wishes for the coming year and millennium.

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 e-mail:

editor@grac.org

KEYNOTE ADDRESS BY MARY NICHOLS

September 20, 1999 at the 22nd Biennial Groundwater Conference in San Diego, California

It is a pleasure to be here at this important conference, all the more so because the driving concept both here in San Diego regarding†groundwater, and now throughout the state regarding all our water resources, is certainly ïinterconnectedness.î

It is a word that the Davis administration takes very seriously. Some of you may be aware of the large-scale research program underway now known as Integrated Storage Investigation, to study the many interconnected ways the state can store water as we face the challenge of growth.

And, as we face that future of our state's water resources, there are different forces at work that will influence the way we distribute and use our water supply.

When Mulholland opened the spigot on the Los Angeles Aqueduct, he is reported to have said, "There it is, take it!" That's how it worked in those days.† It was all a question of taking water - damming and diverting rivers and then taking as much as possible for as long as possible.

Mary Nichols is flanked by Rita Sudman Schmidt, Executive Director, Water Education Foundation and Harrison Phipps, Executive Director of GRA.

It's a very different water world today, however. These days, at least if you are around Sacramento very much, Mulholland would probably be saying, "There it is, market it!"

Since building new major water projects is so difficult, the new mantra of the day seems to be water marketing. But even so, that still represents a notion of taking; that somehow there's this thing that you're going to get and you're going to be able to move it around and hopefully make money at the same time. Underneath all of that is really a human sense, which is "I want more and if at all possible we'd like somebody else to give it to us or pay for it."

But the fact is that the demand for water that Mr. Mullholland and his backers so presciently recognized has not abated in the slightest. If anything, it's gotten more intense, and at least in some people's minds the focus and pressure has now turned to groundwater.

We've relied on groundwater in the past, but we've not looked at it in quite the same hungry way that people are looking at it today. That same philosophy, that somehow if we could just find better ways to extract it and move it around, we would solve our entire problem, is still, I think, at the root of many people's attitudes on this topic. But the reality is, just as we've learned in the case of surface water, we have to come up with new attitudes about water and where and when and how to appropriate and use it. The same philosophy needs to be applied to groundwater as well. It's really a philosophy that involves a different notion about the uses and ownership of water and it gets to the very heart of how we administer as a political entity within the state, how we deal with this most precious resource.

The approach that we're taking in the Davis administration is one that the word, interconnected, applies to very well because the governor has been adamant that when it comes to issues about water management, they are not going to be made in a vacuum. No one entity, no one agency, no one person even including the Governor, is going to try to be the watermaster for the state of California. The history of water wars in this state leads to the conclusion that you simply cannot make progress unless you can bring all the necessary parties to a table and get agreement on the program. That means actively seeking compromise as a way of life when you're talking about the multiplicity of different interest groups and the very challenging geography that exists in this state.

As far as groundwater is concerned, that means the first step is to define what we need and what we've got. Since Bulletin 118 with its analysis of California's groundwater is a fundamental tool, it was great news that the legislature was willing to give the Department of Water Resources money this year to begin an update of Bulletin 118. This is a very important step because it is a fundamental building block for better groundwater management in California. We obviously face a host of problems and challenges when it comes to using our groundwater and our groundwater basins e.g., uncapped wells, seawater intrusion, and plumes of various chemicals still in many of our aquifers. In the conference exhibit hall I had a chance to see some of the technology that was on display here today and we have technology that is capable of solving most of these problems. Unfortunately, there are some aquifers that may not be able to be used. The fact is that we know how to fix most of the problems. The technical aspects of remediation, storage and injection are not our major obstacles. Our major obstacles are the difficulties we have in focusing our attention on the political, institutional and legal aspects of groundwater.

I'm not here today to unveil the new program that's going to solve all of those problems. I do want to say that we do have some tools that can be used if we have the political will

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In-Situ High Pressure Remediation Injection Process

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High concentrations of liquid oxidants such as hydrogen peroxide or potassium permanganate can chemically oxidize halocarbons, petroleum hydrocarbons, and oils. The chemical oxidation process is exothermic and reaction temperatures in the subsurface can exceed 130 degrees Fahrenheit. Calcium polysulfide and other similar chemicals can precipitate selected metals as sulfates. Assuming that the pH of the groundwater remains relatively constant over time, treated metals will remain insoluble. Nutrients, biologic electron acceptors and low concentrations of oxidants to provide oxygen for microbial growth can be injected to encourage in-situ bioremediation of petroleum hydrocarbons. Other liquids used in the high pressure injection process can be acids or bases to neutralize contaminants.

Passive in-situ methods have been documented to have successfully treated chlorinated solvents and petroleum hydrocarbons into the ultimate degradation products of carbon dioxide and water. Chemical compatibility of the injection equipment components and personnel safety procedures are critical with the injection of strong acids, bases, oxidants and other chemicals at extremely high pressures.

Case example - Based on previous site investigations, the soil and groundwater beneath a petroleum storage facility in northern California was found to be impacted with free product consisting of TPH as diesel (TPH-d) and gasoline (TPH-g) range hydrocarbons. As part of a proposed pilot study, four soil borings were initially drilled using a direct push probe sampling rig. Soil samples were collected at 7 and 11 feet below ground surface (bgs) to provide pre-treatment data for the pilot scale test.

Groundwater samples were also collected as groundwater was encountered at about 7 feet bgs. The initial investigation detected free product, with concentrations of TPH-d as high as 6,500,000 micrograms per liter (ug/L) and TPH-g as high as 770,000 ug/L. The impacted soil extended to a maximum depth of approximately 15 feet bgs and generally consisted of fine sand, silts and clays.

Remediation Approach - The pilot study was designed to treat approximately 133 cubic yards or a 12-foot by 20-foot area. A grid pattern was established with 77 lance injection points spaced on 2 foot centers. After coring through the concrete and preparing the pilot study area, 495 gallons of 18% hydrogen peroxide were injected over 4.25 hours. The injection pressure at the lance tip ranged from 1,500 psi to 3,000 psi during the injection process.

Angled injection in Washington.

Chemical Oxidation Process - When chemical oxidant hydrogen peroxide (H2O2) is injected into the subsurface, it decomposes readily into reactive hydroxyl radicals (OH*) and water. The hydroxyl radical (OH*) in the subsurface can be used to rapidly mineralize hydrocarbon, solvent and other contaminants to water and carbon dioxide. This reaction is enhanced in the presence of iron. Iron is naturally occurring in soil and groundwater or can be added during the injection process, if needed. The reaction is based on the principle of Fenton's Chemistry where:

$Fe^{2+} + H_2O_2 \longrightarrow OH^* + OH^- + Fe^{3+}$

Any H2O2 not used in the oxidation process breaks-down to water and oxygen in a matter of hours. In addition, H2O2 can serve as an oxygen source for microbes in the subsurface to enhance biodegradation of contaminants.

Results - Significant reductions of diesel range hydrocarbons were found to occur in the groundwater. TPH-d was reduced in the groundwater from a maximum concentration of 6,500,000 ug/L prior to the injection treatment down to a maximum detected concentration of 4,700 ug/L following the oxidation process. No free product was detected after treatment. With only 4.25 hours of treatment, the overall average diesel concentration in the groundwater was reduced by greater than 99% and gasoline by greater than 50%.

Discussion - The concentrations of the lighter-end hydrocarbons such as TPH-g did not exhibit the same reductions and chromatograms from the laboratory analysis of pre-and post-treatment samples were distinctly different. Based on the chemistry of oxidation processes, longer chain aliphatics (C-12 to C-24) such as diesel tend to oxidize before lighter-end hydrocarbons, such as gasoline. Therefore, upon injecting a strong oxidizing agent, such as hydrogen peroxide, into the subsurface where the soil is impacted with petroleum hydrocarbons, larger decreases to existing total organic carbon (TOC) and any oil or diesel range organics should initially be exhibited as these constituents are preferentially oxidized.

During the oxidation process, shorter-chain hydrocarbons are produced from the oxidation of the long-chain hydrocarbons, such as diesel. Some of these may appear as gasoline-range compounds and could explain the difference in chromatograms before and after treatment. It is also likely that various straight-chain acids, such as acetic acid, would be created during the chemical oxidation process; however, these mild acids are not a threat to groundwater. Both the gasoline range compounds and mild acids would ultimately break down to carbon dioxide and water with further exposure to hydrogen peroxide.

The significant reduction of diesel concentrations in the groundwater indicate the heavier-end diesel chains are being broken apart during the injection of the hydrogen peroxide. The likely by-products of the oxidation of diesel are gasoline-range petroleum hydrocarbons and straight-chain acids. With continued exposure to hydrogen peroxide, the diesel will be preferentially destroyed and the gasoline will start to be consumed at a faster rate.

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GRA' 1999 Lifetime Achievement Award Presented to David Keith Todd

By BRIAN LEWIS

The Groundwater Resources Association's Lifetime Achievement Award is presented annually to an individual that has made significant contributions to the field of groundwater. At GRA's 1999 Annual Meeting September 20-21 in San Diego, David K. Todd, Ph.D., received GRA's Lifetime Achievement Award.

Brian Lewis (center) along with Governor Gray Davis' representative (left) stands with the GRA's Lifetime Achievement Award recipient David Keith Todd.

Todd received his Bachelors of Science in civil engineering from Purdue University in 1948. He then went to New York University to receive a Masters of Science in Meteorology in 1949 and in 1953 he received his Ph.D. from the University of California, Berkeley. He is the oldest of four children (three boys and a girl). He is the son of a professor of civil engineering at Purdue University in Layette, Indiana. His two brothers are also engineers and his sister married an engineer.

Todd started in Civil Engineering at Purdue, but his studies were put on hold when he joined the Air Corp as a weather forecaster. After finishing his undergraduate studies, he pursued his Master of Science in Meteorology. During the war, he mastered his contouring technique. He was given one data point for the Atlantic Ocean and had to create a map of iso bars for the entire ocean. Using limited data would help him later as a groundwater hydrologist contouring groundwater basins.

Todd started his career at the University of California, Berkeley in 1950. At Berkeley, he taught all of the hydrology courses and was in charge of the graduate program in Water Resources Engineering. He has held the position of Instructor, Lecturer, Assistant Professor, Associate Professors and currently is Professor Emeritus.

Todd decided to pursue the study of groundwater hydrology when he attended in 1956 the Darcy Centennial Symposia in Dijon, France. This conference helped to focus his studies on groundwater. He thought the study of groundwater hydrology was a natural combination of his engineering and meteorology studies. He would try to quantify the natural movement of groundwater.

In 1959, he published his text book, Ground Water Hydrology. This text book is used by over 52 American universities and is translated into six foreign languages (Hindi, Malaysian, Persian, Portuguese, Spanish, and Turkish.) Chances are, if you studied groundwater hydrology in college, you used Todd's book. Todd has published six other books and over 120 technical papers. A review of his publications has a number of titles dealing with conjunctive uses and sea water intrusion. A few titles made us wonder if we were giving the award to a mad scientist. A few of the papers were titled, *Economics of Ground Water Recharge by Nuclear and Conventional Methods,* 1964. *Nuclear Crater for Ground Water Recharge,* 1965, and *Nuclear Craters for Water Resources Development and Management,* 1965. Thank goodness no one put his research to uses. Todd was questioned on this research. He explained that J. Robert Oppenheimer (scientific leader for the Manhattan Project) asked him to think of peaceful uses for nuclear bombs. It was part of the "Plowshare" program to find peacetime application of our military arsenal.

His 1959 text book has only one or two sentences on water quality. Most issues of water quality in the 1950' dealt with Total Dissolved Solids (TDS) or salinity. His revised text book has chapters on water quality and groundwater contamination. Todd has seen significant changes in the field of groundwater in the last forty years.

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EnviroTech Pick up

Job Announcement

Water Resources Professional
(compensation dependent on qualifications)

Saracino-Kirby, Inc., Water Planning & Management in Sacramento, CA seeks a talented professional to help develop and implement water resources projects and studies. Minimum qualifications include a BS in geology, engineering, or hydrologic sciences, three years experience in water resources planning or management, and excellent communication skills. Position entails gathering and analysis of hydrologic and other scientific data, computer modeling, and preparation of written materials. Send resume and references via e-mail to: apps@saracino-kirby.com

The next HydroVisions due date for articles is December 10, 1999. We welcome your articles and photos. Articles may be emailed to:

editor@grac.org

Letter to the Editor

Hi:

I thought the subsidence article in this issue was terrific. I'd like to use it in a course I'm teaching at M.I.T. in Jan 2000. Can I get my hands on a couple of dozen copies of the newsletter? I'll try to reciprocate with a short article if you're interested.

Cheers, Dick Meehan, Member

http://www.stanford.edu/~meehan/

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Thank You

Chemist's Corner

Leaching Tests in the New Millennium

BY BART SIMMONS

Y2K and the TCLP

Waste management and site mitigation depend on predicting the leaching of contaminants to groundwater or surface water. The U.S. EPA depends on the Toxicity Characteristic Leaching Procedure (TCLP) to identify wastes that must be managed as hazardous due to their potential for groundwater contamination, but the TCLP has come under fire recently for its failures, particularly with oily wastes and wastes containing arsenic and other elements that form anions in solution. This year the EPA Science Advisory Board sent a letter to EPA Administrator Carol Browner, pointing out several problems with the TCLP and calling for changes. The EPA held a public workshop this summer to discuss the issues. The consensus was that the TCLP has problems, and that a new system should be used, probably a tiered system. Tier 1 would be a conservative "availability" test, and Tier 2 would be a test which included site specific data to estimate actual leaching concentrations.

Whither the WET?

The Waste Extraction Test (WET), the test used in California for non-RCRA hazardous waste identification, has also been under review. The Wilson administration had proposed eliminating the WET for the TCLP. In reaction to this and other proposals for revisions to waste management regulations, a scientific peer review law was adopted for proposed regulations coming from Cal-EPA. The proposed regulations for hazardous waste classification were sent to a committee of the National Academy of Sciences, which issued its report earlier this year. Regarding extraction tests, the NRC report contained three options: 1) work with U.S. EPA to develop a new extraction test which overcomes the limitations of the WET and the TCLP; 2) use available data on extraction using the WET or TCLP in a probabilistic model for predicting potential for groundwater contamination. The NAS committee points out that no test can perfectly simulate field conditions, but the bias of the tests can be used in modeling. For example, the WET is known to overestimate the amount of lead and zinc that is extracted by municipal solid waste leachate, while the TCLP underestimates the amount of arsenic and other anion-forming elements. 3) incorporate a groundwater pathway into Caltox, the multimedia model which was used in the waste classification proposal. The new administration is now reviewing the report and the options for implementing the NRC recommendations.

Meanwhile, on the site

Meanwhile, another extraction test, the Synthetic Precipitation Leaching Procedure (SPLP), has gained popularity for deciding whether contaminated soil should be left in place, treated, or removed. The SPLP does not have a specific regulatory application like the TCLP or WET, but is widely used across the country in site mitigation. It is designed to simulate extraction withpercolating rainwater, and uses different solutions for samples from east of the Mississippi to simulate "acid rain." A "deionized WET" has also been used for the same purpose. Since the major feature of the WET is the use of a citrate buffer, the name is misleading, but is still used for some site assessments.

The Future

The U.S. EPA is clearly under more pressure to revise its hazardous waste identification procedures, but its schedule is less certain. Researchers who are active in the field, like David Posson, from Vanderbilt University, favor a two-tiered system. The first tier would use a conservative extraction system for availability, perhaps similar the Dutch Availability test or the WET to estimate the availability of contaminants. The second tier would use multiple extractions over a range of pH and solid:liquid ratios to understand leaching as a function of pH. This tier would also use site-specific data to estimate potential leaching.

A group of modelers are advocating the elimination of extraction tests in preference for better modeling. The notion is that we can predict groundwater contamination knowing the total concentration of a contaminant in a waste or soil, and the application of the right models. Some researchers on leaching behavior recoil at that notion, and feel that there is still a future for extraction tests. The debate between modelers and experimenters will continue until a compromise is found in the next generation of tests for the new millennium.

EXHIBITORS

GRA's Annual Meeting
22nd Biennial Groundwater Conference

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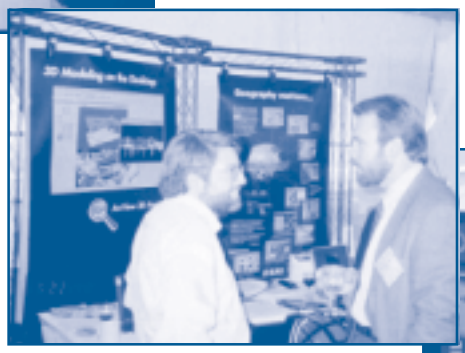
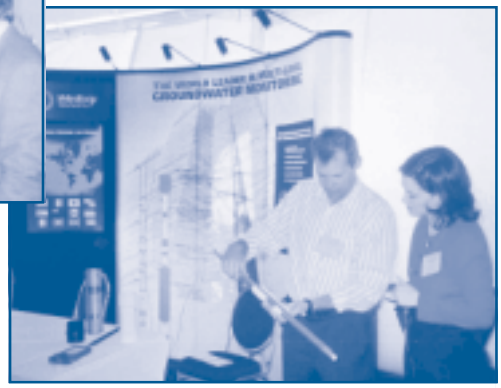
Groundwater Resources Association of California
Harrison Phipps, executive director
601 Villanova Drive
Davis, CA 95616
530758-3656
Non-profit organization dedicated to resource management that protects and improves groundwater through education and technical leadership.

Water Education Foundation
Rita Schmidt-Sudman, executive director
717 K Street Suite 317
Sacramento, CA 95814
916444-6240
Non-profit organization whose mission is to develop and implement education programs leading to a broader understanding of water issues and to resolution of water problems.

State Water Resources Control Board
Janis Lee
901 P Street
Sacramento, CA 95814
916653-0424
Regulates all water quality and water rights issues in California

California Department of Water Resources
Carl Hauge, Chief Hydrogeologist
1020 9th Street
Sacramento, CA 95814
To manage the water resources of California in cooperation with other agencies, to benefit the state's people, and to protect, restore, and enhance the natural and human environments.





AWARDS AND EVENTS

GRA's Annual Meeting
22nd Biennial Groundwater Conference

September 20 & 21 • San Diego, California

Look Who's Getting Awards

Kevin J. Neese 1960 -1999

Kevin Neese, GRA Board Member, partner with the Santa Barbara law firm of Hatch & Parent, and co-author of California Groundwater Management, died after a short illness at the age of 39.

The Kevin J. Neese Memorial Trust has been established by Hatch & Parent to assist Kevin's family. He is survived by his mother & brother, his wife Fariba and two children, Tasha, five, and Patrick, eight.

Contributions may be sent to:

Kevin J. Neese Memorial Trust
Hatch & Parent
21 East Carrillo Street
Santa Barbara, CA 93101

David Keith Todd

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In 1978, Todd formed his own consulting firm, Todd Engineers, in Emeryville, California. He has consulted in over 25 countries and provided consulting services to over 207 companies. People who have worked with Todd know his professional ethics. He has been known to base his decisions on technical merit, even if it hurts his client. In one court case where Todd was hired to be an expert witness, the opposing attorney found an error in one of Todd's exhibits. When this was brought to Todd's attention, he rose from the witness chair and walked over to the exhibit to correct the mistake. This act left the attorney deflated and unarmed to make his point.

When asked to reflect on his career in the groundwater field, Todd thinks of his students as one of the lasting legacies he has in the groundwater industry. He has some notable students, John Cherry, Allen Freeze, Jacob Bear, Slovo Neuman, and Iris Priestaf. Considering that most of us used Todds book in College, he has directly or indirectly taught many of us the importance of groundwater as a vital resource.

GRA is proud to have David K. Todd as their 1999 Lifetime Achievement recipient.

David Abbott, Iris Prestaff, and David Todd contributed material for this article.

Kevin J. Neese Award

Continued from page 1

of technical and legal issues lead to a better understanding of the problem and a higher likelihood of problem resolution. The GRA felt that his conduct coupled with his deep concern and interest in furthering the understanding, development, protection and management of groundwater resources merited the annual award.

The Kevin J. Neese Award was not intended to be a replacement for the life time achievement award. Rather the intent of the GRA Board was to recognize a significant accomplishment by a person or entity within the most recent twelve month period that fosters the understanding, development, protection and management of groundwater.

After considering the various contributions made by individuals in a variety of contexts, the Board decided to honor Governor Davis for his leadership in proposing the ban on MtBE. The action was particularly courageous given threatened litigation under the North American Free Trade Agreement (NAFTA) and by the oil companies. His decision has made it easier for State and local agencies to deal with clean-up efforts, obtain public support for their programs and to negotiate directly with the oil companies. In the long run, his leadership may save California billions of dollars in the form of avoided future treatment, clean-up, contamination and health costs. Thus, the Board felt that the Governor's action had a profound impact on groundwater and the entire State of California, in 1999. The Governor was honored at GRA's Annual Meeting September 21st.

Scott Slater(left) presents the "Kevin J. Neese Memorial Award" to Governor Davis' representative, Tim Ryan.

Of course, MtBE was particularly important to Kevin. As the general counsel to the South Lake Tahoe Public Utility District he ardently opposed MtBE use in the South Lake Tahoe. No doubt he would have been pleased with the Governor's leadership and the GRA's decision to honor the Governor in this instance.

GRA Seeks to Reprint "California Groundwater Management" Manual

In 1997 the Groundwater Resources Association (GRA) supported the publication of "California Groundwater Management" authored by Steve Bachman, Carl Hauge, Anthony Saracino, and the late Kevin Neese. The handbook was provided to the public by the GRA free of charge and has been so successful that it is now out of print. However, the need and demand for more copies of the handbook continues.

Over the past twelve we have continued to receive requests for a second printing. To accommodate these requests and to foster public and professional education regarding groundwater and groundwater management, we are now requesting you, one of the initial sponsors of the handbook to contribute at least $500 dollars to GRA to offset the cost of printing and distributing a second edition.

All sponsors who contribute will be acknowledged on the inside cover of the second printing. Your support for this project would be greatly appreciated.

Please make your check payable to the Groundwater Resources Association.

NEW MEMBERS

Welcome! New members that joined GRA during September and October, 1999

James Cullen	Einarson, Fowler & Watson	SFB
Robert Dougherty	Covington & Crowe, LLP	SC
Rick Dreessen	Tait & Associates	SFB
Tula Economou	Tetra Tech, Inc.	SFB
Terry Foreman	CH2M Hill	SC
Joshua Graber	OGDEN Env. and Energy Services	SFB
Mark Henderson	CH2M Hill	SC
Eric Hendrix	Mission Geoscience, Inc.	SC
Kris Johnson	Einarson, Fowler & Watson	SFB
Bruce LeClerque	Santa Cruz County Planning Dept./Flood Control	CC
Leah Matheson	MSE Technology Applications, Inc.	SAC
Dr. Gene Pearson	Univ. of Pacific, Dept. of Geosciences	SAC
Christopher Sharpe	GRA Student Member	SC
David Springer	ARCADIS Geraghty & Miller, Inc.	CC
Ben Swann	Camp Dresser & McKee, Inc.	SFB
Mark Wuttig	CH2M Hill	SC

Keynote Address

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to use them. I believe that although we're still in the process of doing the environmental impact reporting on the program, that the CALFED process can be looked to as a good model for what we need to do; that is to bring together agencies and private groups that need to be involved and approach the problem in a holistic way. Now you've all heard the expression that it takes an entire village to raise a single child and so it takes thirteen state and federal agencies and about thirty different organizations plus a cast of thousands to begin to address the problems in the Sacramento Bay-Delta. What makes the program important is not just that we have all these people spending time together trying to develop solutions to a set of problems, it's the fact that we are using this forum as a way to develop an integrated approach to the problems of water quality, water supply and flood protection and work on them in a way that tries to optimize all of the solutions. It makes it tremendously complicated because there's never a single solution that cuts across every single set of problems. If you look at where the population is, the needs of agriculture, where the water supplies are, and the tools for getting water to where the people are, you come up with ideas for a set of solutions. You can then model these solutions and look at them from an economic cost perspective and hopefully develop solutions that will be politically viable. As a result of having had so many different groups involved at least you stand a chance of getting the necessary legislation. We know that we have a long history in California of not being able to solve water problems through legislation. We do small incremental steps from time to time, but most of the time when we have a big issue on water, it gets solved in the courts or it doesn't really get solved at all because it is so difficult to forge political consensus in this area.

I'm heartened by the first really tangible effort that the legislature has made in the area of water quality in this administration; the water bond. The legislature has passed at the governor's request and he will soon be signing legislation, which will place on the ballot this March a bond asking the people of the state of California to vote to spend close to $2 billion in a precedent-setting effort to apply a multi-faceted approach to dealing with water in California. In this single bond legislation, which goes by the wonderful name the ëSafe Drinking Water, Clean Water, Watershed Protection and Flood Protection Act of 1999,í what we have is the following: about $70 million for safe drinking water programs, $292 million in flood protection including $70 million specifically earmarked for non-structural approaches to flood management and $25 million for urban stream restoration programs. There is $468 million for public agencies and non-profit organizations to implement watershed plans including $8 million for education, $235 million earmarked for a Southern California watershed program to improve the Santa Ana River watershed, a very seriously impaired watershed area, and $25 million earmarked for salmon habitat restoration work. Under Clean Water and Water Recycling we have $355 million including money for groundwater remediation and $100 million for non-point source pollution prevention and cleanup, and $90 million designated for coastal non-point source pollution. We also have $155 million for water conservation programs and in the area of water supply infrastructure $630 million which includes storage, including $200 million for groundwater and $250 million that goes to projects that will be implemented by CALFED. Those are huge numbers, although they're not huge in terms of what actually needs to be done in California, but a down payment, if your will, over the next four years or so of close to $2 billion. I think is a very good gesture in the direction of showing that we can approach these problems in a holistic and interconnected way for these are amazingly "green" water projects, which will also expand our supply and the security of our water supply. I'm just delighted at the opportunity to not only help go out and try to talk to the voters about what these bonds will do for us, but also to have the opportunity to participate if we're successful in actually carrying out those programs.

Obviously we're going to have to make sure that the money is spent well, spent in ways that achieve positive results, and that people understand the money is being spent not just on a project here and a project there, but towards realizing an interconnected vision of California's water future. As we've all learned within the last couple of years, our long-term future water supplies and our ability to use the water are dependent on things like what we burn in our automobiles. There's an incredible need to understand that groundwater isn't something obscure, that only water engineers have to worry about, but the public as a whole needs to care about. It's going to be a tough sell, I think. It's not an easy thing to educate people about unless they happen to have grown up or live in an area with a well. The concept of living in a watershed or in a groundwater basin and understanding why a basin plan is related to anything else you might be doing in your community is a difficult concept. This is something that is going to take a lot of integrating in the way that we go about it.

I am committed and I know that the governor is committed as we move forward in the next few years to developing environmental solutions to all of our environmental management and resource management programs which display this same kind of interconnectedness. Whether it's the watershed management programs that the Department of Forestry and Fire Protection is working out on the north coast, or whether it's the farthest southern portions of the state where we are dealing with recharge and flood control. These are going to be programs where we will be bringing together large groups of disparate organizations, local governments, businesses, and the private sector using the best science and the best technology available, to ultimately forge new political consensus.

For all of these resource issues, the principle thing we have to deal with is instilling that sense of interconnection and being interconnected. I want to applaud you for having chosen that as the title of your conference and for the work that you're all doing and to thank you for what I know is going to be a very productive relationship in the next few years as we move forward to try to remove the obstacles and do the kind of interconnected work we'd all like.

Fifteen foot lance injections in San.....????

In-Situ High Pressure Remediation Injection Process

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For another case outside of Olympia, Washington, a manufacturing facility had soil contaminated with volatile organic compounds, including perchloroethylene (PCE), trichloroethylene (TCE), dichloroethylene (DCE) and toluene. The contaminants were reduced in the soil using high concentrations of hydrogen peroxide. The TCE, DCE and toluene were destroyed after one treatment event. Approximately 70 percent of the PCE was destroyed after two treatment events, enough to allow for site closure. The actual remediation cost was a fraction of the alternative which was a dig and haul project with shoring. Regulatory objectives were met and site closure, property transfer and redevelopment was accomplished.

NOTES: The authors thank Ragnar Stefansson and Eric Janzen of FAST-TEK and Marcus Ashcroft of PRO-TECH for their help with this RIPx project. RIPx is a trademark of FAST-TEK Engineering Support Services.

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San Francisco Branch Activities

September 1999

Submitted by JIM ULRICK, Branch Secretary

Our September meeting was a special event honoring the lengthy and distinguished career of Tom Iwamura. After working for more for than 40 years in the groundwater industry, Tom Iwamura recently retired from the Santa Clara Valley Water District. At the Water District, Tom worked on many groundwater basin management issues, including groundwater recharge, land subsidence, salt water intrusion, and, since the early 1980s, environmental issues. He tirelessly mentored and guided many of us practicing in the groundwater industry.

Tom gave a presentation that reflected on his career and shared his perspective about the future of the groundwater industry in California. In the early days, hydrogeology was concerned with water supply; the environmental and water quality aspects were not significant until after the early 1980s. Even today, with such great emphasis on water quality, the fundamental principals of hydrogeology still apply. In his review of hydrogeologic reports, Tom found the following fundamental elements to be commonly missing:

A consideration of topography, Geomorphology, The effects of long-term climate cycles, The use of sedimentology to interpret drilling logs, and Groundwater/surface-water interactions (Some agencies are even divided into separate groundwater and surface-water divisions).

The long-term opportunities in the field of groundwater are enormous. We face a constantly increasing demand for a finite resource ñ both in California and globally. Non-point-source pollution, such as pesticides in Bay Area creeks and metals in the Bay, is just beginning to be addressed. Solutions to these types of water-quality problems will require a regional watershed approach.

We need to become our own advocates in behalf of groundwater. Because groundwater cannot be directly observed, it has historically been the subject of occult practices, such as dowsing and water witching. Each of us has to counter misconceptions and prejudices about groundwater. We need to use plain language, simple analogies, and expressive graphics to do this. Try to understand the people you are talking to, and speak their language. Much of the general public do not even realize that groundwater is amenable to scientific methods. Reach out and talk to the public. If each of us were to make ourselves more understandable it would go a long way toward advancing the practice.

Check the GRA Internet home page: www.grac.org for upcoming San Francisco Bay Branch meetings.

Sacramento Branch Highlights, 1999

By BARBARA HEINSCH and RICHARD SHATZ, with contributions by DAVID VON ASPERN

The Sacramento Branch has been rewarded with a great year for interesting and informative presentations at our regular meetings as well a super field trip to Penn Mine.

Our January speaker, Edd Schofield, District Manager, Water Well and Environmental Screens, US Filter gave a very well attended presentation, Groundwater Well Rehabilitation: Evolution of Science and Current Practice. This presentation included practical solutions for resolving the difficult problem of well rehabilitation. His presentation focused on the current advances in rehabilitation methods, materials, and new well development chemistry. There are numerous claims within the water well industry about the effectiveness of various cleaning techniques and chemistry for well rehabilitation. Edd discussed a new development within the water well industry to use the scientific approach to well cleaning chemistry. This new approach emphasizes well rehabilitation based on laboratory analysis as the most efficient treatment of mineral scale and biofilm blockage.

Impacts of MTBE on California Groundwater and a Perspective on Groundwater Quality Sustainability was the topic presented by Dr. Graham E. Fogg, UC Davis Professor of Hydrogeology, in February. The results of the SB 521 University of California study on MTBE were discussed with respect to identified groundwater impacts and potential future impacts. A statewide survey of LUFT sites and public supply well data provides ample evidence of relatively rapidly spreading MTBE plumes. Furthermore, risk-based modeling of statewide impacts suggests the potential for substantial increases in numbers of contaminated wells in the coming decades. Such impacts were discussed in the context of other contaminant threats and recent research on natural attenuation (physical processes), long-term plume behavior, and pump-and-treat remediation experiments. New advances in characterization of hydrostratigraphy and aquifer vulnerability on the east side of the San Joaquin Valley were also presented.

Kenneth Ehman Ph.D., Groundworks Environmental Inc., El Dorado Hills was our March speaker. His presentation, Sequence Stratigraphic Analysis Applied to Groundwater Investigations, discussed how geology controls the movement of groundwater as well as contaminants. A large percentage of groundwater impacted sites lie on complex, interstratified sediments. Sequence Stratigraphic Analysis is a state-of-the-art method for delineating continuity of sediments in complex settings. Using concepts of stratigraphic facies analysis and sequence stratigraphy, the geometry and distribution of aquifer and aquitard sediments are linked to the original depositional processes that formed the sediments. Applying sequence stratigraphic techniques to this data may be one of the best means to understand the subsurface and to develop solutions to groundwater problems.

Groundwater Modeling was the topic of our April meeting. Linda D. Bond, of L.D. Bond & Associates, is an independent consulting hydrogeologist and co-author of FEMFLOW3D. Ms. Bond provided an overview of FEMFLOW3D (1997, Durbin and Bond), the new 3D Finite-Element Groundwater Model, recently published by the U.S. Geological Survey. Her presentation included useful subroutines for calibration and land-surface water-use. The use and implementation of the model and utility programs that can be used to construct input files and plot output data were described. Ms. Bond also compared FEMFLOW3D to other groundwater models including MODFLOW and IGSM, and illustrated some concepts of regional groundwater dynamics that can be analyzed and quantified from the results of this model.

For a change of pace, our May meeting was held in Davis instead of Sacramento. Our speaker

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was Dr. Charles R. Goldman, UC Davis Professor of Limnology. Dr. Goldman's presentation, Four Decades of Change at Lake Tahoe, was entertaining as well as informative. His presentation was filled with wonderful anecdotes, great color slides, and spiced with humor (maybe Barbara is biased since Dr. Goldman was her limnology professor at UCD). As Lake Tahoe lies within the Sierra Nevada Mountains, it has been necessary to consider the health of the lake in the context of the entire watershed and blend science with political action. This includes the contributing tributaries, as well as atmospheric and groundwater effects. A multidisciplinary approach is essential for developing effective water management strategies for increasingly complex environmental problems. So much damage has already been done that restoration-oriented research is of expanding importance. Strong environmental science must be at the forefront in developing better management practices as we face the ever-mounting demands for water, a most-essential and limited resource.

Our June meeting required a last minute speaker change but the switch was positively received. Jonas Minton, executive director of the Sacramento City/County Office of Metropolitan Water Planning, was originally scheduled to speak. Mr. Minton's office is more commonly known as the Sacramento "Water Forum." Instead, Ed Schnable, CEO of the Sacramento North Area Groundwater Management Authority and general manager of the Sacramento Metropolitan Water Authority, made the presentation. Mr. Schnable's talk covered the issues of surface and groundwater uses, conservation measures, fishery improvements, politics and "herding cats." The discussion was lively and contained a number of intriguing anecdotes.

In the beginning of the year, our branch conducted a membership survey. Among other things, the survey revealed that a majority of participants preferred meeting every other month instead of monthly. Mostly, members wanted to at least have fewer meetings in the summer. As a result, for the rest of the year, the Branch Officers scheduled bimonthly meetings.

Our August presentation, Appropriate TMDLs Development and Implementation, was given by G. Fred Lee, PhD, PE, DEE, and president of G. Fred Lee and Associates. Total Maximum Daily Loadings (TMDLs) are mandated by the Clean Water Act, which requires all states to evaluate compliance with Water Quality Standards. The TMDLs must consider both specific numeric standards as well as narrative standards, i.e. copper, zinc, dissolved oxygen and excessive algae, etc. Waterbodies that do not comply with standards must be listed as "impaired" and placed on 303(d) lists where the cause of impairment is identified (constituent of concern). The regulations now stipulate that if the Water Quality Standard (the Water Quality Objective in California) is exceeded by any amount more than once every three years, this exceedance is considered a violation. The 303(d)-listed waterbody must develop a TMDL and a schedule to achieve the TMDL for the constituent causing impairment. Dr. Lee described the TMDL process and explained the problems with how it is currently being implemented. He provided examples of the TMDL process and recommendations to better implement this process.

Our October meeting was presented by Dr. Charles Alpers, U.S. Geological Survey: Geochemistry and Hydrogeology of Groundwater Affected by Acidic Drainage at the Penn Mine. Dr. Alpers gave a comprehensive discussion detailing how the acid drainage from the Penn Mine, in Calaveras County, California, has produced a zone of contamination in ground water between the former Mine Run Dam and Camanche Reservoir. A groundwater investigation was conducted by the U.S. Geological Survey (USGS) during 1991 to 1995 to evaluate subsurface transport of metals and acidity between Penn Mine and Camanche Reservoir and the hydrologic interactions between flooded mine workings and other ground water and surface water in the S¶icinity. Downhole geophysical methods used in the fractured-rock setting included acoustic televiewer and heat-pulse flowmeter. Geochemical methods that were useful in determining metal sources included trace element ratios and stable isotopes of S, O, and H in water and minerals. The results of the USGS investigation were discussed in the context of the ongoing remediation at the site that is being conducted by the East Bay Municipal Utility District and the Regional Water Quality Control Board, Central Valley Region. At the meeting, Dr. Alpers made available original documents to which he contributed, which included USGS Water Resources Investigations, Report Nos. 96-4257 and 96-4287. Purchase and/or other arrangements to obtain those publications can be made by contacting Dr. Alpers via email at: cnalpers@usgs.gov.

On the weekend following Dr. Alpers' dinner/evening presentation, the Sacramento Branch hosted a field trip to the Penn Mine site with Dr. Alpers as the lead guide with assistance from Greg Vaughn of the State Water Resources Control Board. Eileen Fanelli, RG with the East Bay Municipal Utility District (EBMUD), was sched-

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Sacramento Branch Highlights, 1999

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uled to attend but was unable to make it due to a traffic mishap in the Bay Area. Ms. Fanelli had attended the Branch's evening presentation earlier in the week and had contributed to that program. The Sacramento Branch is grateful to Ms. Fanelli for helping to arrange site access for the field trip, and for being willing to devote her own time in the evening and on a Saturday to help with these special events. GRA's Sacramento Branch also wishes to publicly thank the East Bay Municipal Utility District for granting site access to our group of modern-day Penn Mine "prospectors." Because she unexpectedly could not make it on Saturday, Ms. Fanelli has indicated that she would be willing to arrange a second Penn Mine field trip; Ms. Fanelli may be contacted via email at: efanelli@ebmud.com. What a trooper she is - a geologist to the core!

The Penn Mine is an abandoned facility in the Sierra Nevada Foothills copper-zinc belt in northwestern Calaveras County, California. This belt consists of massive-sulfide ore bodies composed primarily of pyrite, chalcopyrite and sphalerite that are associated with metavolcanic rocks of Jurassic age. The Penn Mine area has 20 or more shafts, several adits and a number of open pits and cuts. Two smelters and several mills were historically operated at the site. The mine has approximately 10.5 miles of underground workings that were excavated at their deepest depth to 3300 feet below the surface. Several acres of mill tailings and unmilled waste rock from these mine workings were exposed on the surface, as well as smelter slag averaging more than six weight-percent zinc. EBMUD's recent remedial activities included siting a nearby landfill and burying most of the tailings and waste rock. Historically, contaminated surface run-off from the mine area flowed directly to the Mokelumne River (now Camanche Reservoir - the dam was constructed in 1963).

In 1978, diversions and impoundments were constructed in an attempt to control discharge of contaminated surface water. Use of sulfidic waste rock and mine tailings to construct dams, dikes and basins, coupled with recirculation of contaminated water between impoundments, may have unintentionally enhanced formation of acidic, metal-rich water. The former Mine Run Reservoir was treated with lime to raise pH and immobolize contaminants, for a brief time period in 1993 as part of EBMUD's remedial efforts. Although the impoundment system reduced but did not eliminate surface discharges from the mine, the results of Dr. Alpers' study indicated that contamination of ground water downgradient from the former Mine Run Dam occurred through fractures in bedrock under the former surface impoundment. Another of EBMUD's recent remedial activities included the removal of Mine Run Dam and the other surface run-off impoundments. Ground water contamination by the surface impoundments was distinguishable from contamination potentially stemming from flooded underground mine workings by marked differences in water chemistry. Part of Dr. Alpers' study involved drilling into and sampling a flooded mine workings such that that water could be analyzed and compared to groundwater chemistry downgradient from the former Mine Run Dam. By the time of GRA's field trip, the tailings/waste rock relocation and landfilling had been completed, the former locations of the surface impoundments had been regraded, and drainageway restoration was underway, including fresh hydroseeding activities.

The Penn Mine field trip was attended by a total of 16 participants, comprised of Sacramento Branch members and their guests, regulatory personnel and several college students. The Sacramento Branch arranged carpooling from Sacramento, and provided cold beverages. Participants brought their own lunches and the group dined in the shade along the picturesque shore of Camanche Reservoir. Dr. Alpers' dinner/meeting presentation was informative and the field trip was fabulous, including ideal fall weather. Sacramento Valley residents were relieved to escape the smoke from wildfires that was lingering in Valley air on the weekend of the field trip, October 16th.

HYDRO VISIONS
Groundwater Resources Association of California

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