MISSOURI GROUNDWATER ASSOCIATION NEWS
Fall 2001

PRESIDENT'S CORNER

By James E. Vandike
Jim Vandike, R.G., is the Groundwater Section Chief with DNR's Geological Survey and Resource Assessment Division in Rolla, MO

They say time flies when you're having fun. If that is the case, then I must be having a ball. I find it hard to believe that eight months have passed since the 2001 MGA Annual Conference. I have no doubt that those attending found the presentations to be very informative. I certainly did. All of the speakers should be commended for their efforts.

In February of next year we will be back in Columbia for the 2002 MGA Annual Conference. The conference will be held a bit earlier in 2002. You may recall that it was difficult to find a motel room in Columbia last March due to the state high school basketball tournament. We have scheduled the 2002 conference for Friday, February 15. The conference will again be held at the Ramada Inn. Seriously think about stepping up to the plate and making a presentation. Whether you are a student or a groundwater professional, you are encouraged to become a presenter at the next conference. Water supply, waste disposal, contaminant transport, groundwater modeling, water policy, water law, and groundwater remediation are some of the possible topics for presentations.

One topic that I would like to see discussed is well interference. Every year there seems to be more and more conflicts between water users, especially between the owners of relatively shallow private domestic wells, and those having much deeper high-yield wells. In some instances, the problem is cumulative, and literally every new well drilled in a particular are exacerbates it. In other instances a new business or industry requiring large quantities of water develops in an area where previously there was very little groundwater use. Even if groundwater resources overall are adequate, there may still be enough groundwater-level decline to adversely affect shallow wells. Case histories of problems of this type, and their solutions would make excellent presentations for the 2002 MGA Annual Conference.

We hope to see an increase in MGA membership this year. Since MGA began placing the newsletter on the WEB, our costs have decreased dramatically. The conferences typically are self-supporting, so our major costs have been printing and mailing the newsletter, and billing members for their annual dues. For at least the year 2001, the Board of Directors has suspended dues because, frankly, the organization does not currently need the money.

Dues may be reinstated if the need arises, but for the time being there are none. There may be no such thing as a free lunch, but membership in the Missouri Groundwater Association is about

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Editor..... Ed Lindgren
Newsletter Committee:
Suzanne Bailey

The *Missouri Groundwater Association News* is the official publication of the Missouri Groundwater Association. MGA, a non-profit organization, was founded in 1994 to provide the membership with the opportunity to meet other groundwater professionals in and around the state, and to provide a forum for the exchange of ideas and developments in the technical and regulatory aspects of the industry. Membership is open to anyone interested in groundwater investigation, development, conservation and protection.

All correspondence relating to articles in or for the newsletter should be addressed directly to Ed Lindgren, Editor, *Missouri Groundwater Association News*, c/o Burns & McDonnell Engineering Co., 9400 Ward Parkway, Kansas City, MO 64114

as close to it as you can get.

2001 ANNUAL CONFERENCE – COLUMBIA

The 2001 Annual Conference took place on March 9 at the Ramada Inn in Columbia, Missouri. The conference was well attended by participants from industry, government, and academia. They were treated to many interesting presentations on a variety of topics, as well as a chance to network with their fellow groundwater professionals. Abstracts or brief summaries of the presentations follow.

Missouri Legislative Update
Jim Vandike
Missouri Department of Geology and Land Survey

An abstract was not provided.

MDNR's Perspective on the Proposed Risk-Based Groundwater Remediation Rule for Missouri
Steve Sturgess
Missouri Department of Geology and Land Survey

In 1999 the Missouri Legislature passed Senate Bill 334 addressing the remediation of contaminated groundwater. The Department of Natural Resources is developing procedures to implement SB 334 through a cooperative process that involves stakeholders, and the department recently released draft rules for stakeholder review. The draft rule applies to eligible new sites and sites managed under existing state statutes. It establishes eligibility criteria that allow sites to follow a risk-based approach if groundwater is not being used or is not suitable for use as a public or private water supply. Sites that meet the eligibility criteria must fully characterize the contaminant plume and perform an exposure pathway assessment. Sites that do not have a completed exposure pathway, based on poor ambient groundwater quality and/or yield, may default to project completion with little or no requirements. Other sites may request Alternative Cleanup Levels (ACLs), based on a tiered evaluation that considers site-specific information. ACLs must be met at the site-specific Point of Compliance (POC). The POC may be established on a down-gradient property as long as the plume currently underlies the property, and the property owner agree to implement institutional controls and provide access for monitoring. The minimum threshold for remedy performance for nearly all sites is monitored natural attenuation (MNA). However, the department has the ability to require additional remedial measures if warranted. All sites using MNA must have removed or controlled the source of contamination and placed institutional controls over all properties overlying the plume of contamination. Monitoring must continue until the plume attains ACLs. The department may require implementation of an alternative remedy if MNA is not effective or sufficiently protective. Public review and comment is required of all sites. Participants in the risk-based program must pay all department oversight costs.

Industry's Perspective on the Proposed Risk-Based Groundwater Remediation Rule for Missouri
Roger Walker
Armstrong-Teasdale, LLP

An abstract was not provided.

Solute-Sieving Effects at Inward Gradient Landfills
T. M. Whitworth and J. D. Cawlfield
University of Missouri – Rolla

Inward gradient landfills are very attractive because the inward flow of groundwater tends to inhibit outward diffusion of

contaminants. However, clay liners can act as semipermeable membranes and concentrate groundwater solutes in the aquifer beneath the landfill. This process is known as solute-sieving. We modeled potential steady state solute-sieving effects for arsenic and chloride. Our results indicate that it is possible for zones of increased concentration to occur in the aquifer adjacent to the bottom of the landfill liner and that these zones can be many meters wide. Maximum concentrations in this zone of increased concentration can be as high as 10 or more times that of the normal groundwater concentration. If these zones of increased concentration are detected during monitoring, the landfill may wrongly be interpreted to have failed. Our model suggests that, where arsenic is present in the groundwater, it can be concentrated from below to above regulatory standards. This might cause regulatory problems. Other natural groundwater components that may be naturally present in groundwater and might cause regulatory difficulties include radionuclides such as radon 222, nitrates, or heavy metals. The modeling results can be summarized as follows: The width of the zone of increased concentration will increase as the hydraulic conductivity of the clay liner decreases. Under favorable conditions, significantly increased concentrations may be developed as much as 15 to 20 meters or more from the clay liner. If the hydraulic conductivity is sufficiently low, the solute will be able to back-diffuse as fast or faster than the groundwater flux is able to move it toward the clay liner and no zone of increased concentration will develop. The maximum concentration will always be reached immediately adjacent to the clay liner. This maximum concentration is, in part, a function of the ability of the solute to back diffuse against the groundwater flow through the clay liner. Therefore, as hydraulic conductivity decreases, the maximum concentration will also decrease. Once the effective osmotic pressure in the zone of increased concentration adjacent to the membrane equals the hydraulic head, no advective flux will occur through the clay liner. At this point, all solute flux, both into the landfill and out of the landfill will occur by simple diffusion. Also, it is very likely that there will be a shallow no-flow zone extending from the water table to the depth where the head exceeds the effective osmotic pressure. One of the goals of the modeling is to be able to design inward gradient landfills where solute-sieving effects are minimized or eliminated.

Bioremediation of Chlorinated Solvents: An Old Process Newly Discovered for 2001

Mike Sieczkowski
Regenesis Bioremediation Products

In the environmental field, after underground storage tanks, the cleanup of chlorinated solvents is the next major remediation undertaking. Bioremediation of chlorinated solvents has been a fringe option for more than 20 years and although the concepts have been applied in the wastewater treatment industry, consistent application for environmental remediation has been illusive. Many approaches have been taken running the gamut from direct aerobic to cometabolic methanogenic degradation. Of these many options, few approaches have seen consistent implementation except for reductive dechlorination. To make this approach work, a process to control the subsurface environment while adding a carbon source is needed. To date over 130 sites have been treated with one type of carbon source, esterized lactic acid. This presentation reviews the process and discusses a sample implementation.

Use of Oxygen Isotopes in Determining the Source and Residence Time of Missouri Springs

Robert Criss
Washington University

Oxygen isotope ratios in meteoric precipitation are sensitive to atmospheric conditions, and accordingly vary with location and season. Practically all surface waters and shallow groundwaters are derived from precipitation, so these waters inherit the isotopic character of that source.

Across the State of Missouri, the average isotopic ratios of precipitation do not vary greatly, but major rivers import distinctive water from distant regions. This effect has been used to quantify the replacement of groundwater by Sacramento River water that was induced by overdraft, and could be applied in Missouri to the important alluvial aquifers along the Missouri and Mississippi Rivers. In addition, evaporation imparts a distinctive, heavy isotope enrichment to lakes; this effect was used to demonstrate that most of the discharge of Weldon Spring, Missouri, is now derived from a leaky artificial lake.

Other applications exploit the seasonal variations in the isotopic character of precipitation, which are large in Missouri. Groundwater systems integrate input from numerous storms, and the longer the interval of integration, the

smaller the isotopic variations. This effect provides a new means of determining the average residence time of springs. Residence times calculated by the "damped running average" model of Frederickson and Criss (1999) vary from a few months to 5 years or more for Big Spring, Missouri. Methods are under development to distinguish transient from diffuse inputs to springs affected by heavy storms.

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Hydrogeologic Design Considerations for Horizontal Collector Wells

Dave Stous
Burns & McDonnell Engineering Co, Inc.

An abstract was not provided.

Groundwater Investigation in Difficult Terrain, Joplin, Missouri

Paul Santi
University of Missouri – Rolla

Bedrock ground-water investigations in the Joplin region are difficult to perform because of the complex rock properties and because of natural and man-made modifications to the rock. While the bedrock is primarily Mississippian-aged limestone, the region has undergone an episode of karst solutioning, leading to collapse of certain layers and creation of brecciated zones. The rock still has substantial solutioned zones and natural voids. In addition, extensive ore deposits emplaced by ground-water were mined in the early and mid 20th century, creating sizeable and often interconnected mining voids. All of these features influence ground-water and contaminant flow and affect the extent of investigation of hazardous waste sites.

The bedrock characteristics and modifying factors also influence the drilling, sampling, and well installation options in the region. Four major problems may need to be addressed during site investigation: prevention of drag-down of contamination during drilling, management of water inflow into the borehole especially when drilling with air, drilling through rubble-laden mine voids, and unpredictable depths of water-bearing units and contaminated intervals. Successful approaches to managing these problems include: multiple-cased boreholes, use of drivable casing with delayed-yield grout, use of casing hammer techniques without annular sealing, grouting of fractured zones, control of type and volume of circulating fluid, and careful field screening for chemical contamination. A number of tools have been successfully used to locate water flow zones, including downhole techniques such as hydrophysics, borehole-image processing (BIPS), and standard geophysical suites; and surface techniques such as very low frequency (VLF) electromagnetic and seismic refraction surveys.

New Concepts in Water Well Maintenance

Niel Mansuy
Subsurface Technologies, Inc.

Many wells experience loss of production and water quality problems as a normal process of aging. The causes of lost capacity and water quality problems are normally categorized into physical, mineral and biological. Often the causes of

problems in wells is a combination of bacteria growing in biofilms and filtering minerals from the water as it passes over the surface. Within this biologically accumulated material, fines from the formation (clay, silt, and fine sand) can also become trapped.

The normal procedure for wells is to wait until the well has experienced a significant problem prior to performing some type of rehabilitation treatment. Often the amount of deposited material can be very extensive and complete removal of the deposits can be difficult. Rehabilitation treatments are also often performed with the pumps in place to reduce the cost of rehabilitation treatments. It is often necessary to pull a pump during rehabilitation in order to be able to deliver better energy into the well and the surrounding aquifer. The bottom parts of many wells are not effectively cleaned with the pump in place due to lack of velocity achieved in order to "flush" deposits from the well.

There are many barrier wells or injection wells that currently are operated in an injection mode. They most often do not have pumps in the well to perform some type of pumping to backflush these wells. Even though periodically pumping an injection well will not completely remove material from surfaces and keep the surfaces clean it can extend the time between cleanings.

In order to remove deposits from surfaces, we need to deliver energy into the well and aquifer. This energy is energy of disruption, energy of detachment, energy of mobilization and energy of fluidization. Shock Chlorination of wells has been utilized for many decades in an attempt to maintain wells. Chlorine as an oxidizing agent does not have the capability of dissolving minerals that are most often associated with biological slime.

Carbon Dioxide applied during the Aqua Freed Process possesses the energy to more completely remove deposits from surfaces in the well and further into the surrounding formation. It is necessary to pull the pump in order to set a packer in the well, which can increase the cost of the rehabilitation treatment. The AQUA GARD™ procedure involves permanent placement on energy injection equipment in the well, to eliminate the need to pull the pump while achieving the energy necessary to get deposits removed from the surfaces and mobilized in the well. The AQUA GARD™ is patent pending and involves permanently installing the energy injection equipment. Once the wells are equipped with the energy injection equipment they can be more economically and more effectively cleaned. The use of gaseous and liquid carbon dioxide offers one of the best methods of delivering energy into every part of the well and the surrounding formation. With a packer and injection lines already in place it is not necessary to pull the pump in order to perform a cleaning process. This periodic cleaning of the surfaces can be performed on a scheduled interval in order to keep the surfaces clean. The cost of this periodic cleaning can be significantly reduced with the injection equipment already in place. The cleaning can often be performed with the use of carbon dioxide alone. This offers the advantage of not having to neutralize or dispose of chemicals. There are some applications that may need the addition of chemical energy in addition to the use of liquid carbon dioxide. This chemical energy may more completely remove biomass and the associated minerals.

The barrier wells and injection wells that are not equipped with pumps can also be pumped with the use of carbon dioxide to air lift the material from the well and the surrounding formation. Once the material has been detached from the surfaces it needs to be removed from the bottom part of the well and the surrounding formation. This can best be achieved with the simultaneous pumping and occasional fluidization of the sediments and deposits. This would allow more complete cleaning of surfaces and allow the original pore volume that exists around wells to be maintained more effectively. The maintenance of the pore volume and keeping surfaces clean would allow the timeframe between rehabilitation to be increased.

Risk Associated with Tossing Puzzling Data Points or Sending the Project Down the Tubes

Bill Shefchik
Burns & McDonnell Engineering Co, Inc.

When in the course of human events a hydrogeologist obtains data that does not seem to fit the pattern generated by the other data from the project, there is a natural inclination to throw the so-called bad data point out. This is nearly always a mistake. The data is trying to tell you something.

Factors that may result in apparently anomalous data points :

- Not all wells are in a common elevation plane
- Wells may be screened in different geologic strata
- Screens do not actually intersect the top of the saturated zone
- Mistakes are made or problems occur in the field
- Formation hydraulic conductivity may vary locally
- Data may be fabricated
- Subsurface features may be recharge or discharge points

Case histories that demonstrate this point:

1. Large storm drain at TWA Overhaul Base, Kansas City
   Initial data contouring was done before sewer was "discovered"
   Price tag: couple thousand bucks plus loss of face

2. Sewer at former rail yard site, San Francisco
   Fragmented data set
   Unusual project management approach: team rotation
   Litigation games: "hide the ball"
   No one sat down to think for five minutes
   Price tag: several million dollars plus serious loss of face

Tools to evaluate anomalous water level data:

Brains: **stop and think**
Trend charts
Contour maps
Permeability data
Additional rounds of water level data
Site information
Sewers
Railroads
ASTs (condensation)
Leaky water lines
Creeks, ponds
Foundation drains

Conclusions:

1. Spend a significant amount of time evaluating apparent anomalies.
2. Do not toss a data point until you understand it.

BOOK REVIEW

The Hidden Sea: Ground Water, Springs, and Wells
Francis H. Chapelle

Francis Chapelle, a research scientist with the U.S. Geological Survey, has written this delightful overview of the myth and science of ground water. *The Hidden Sea* is written for the lay reader, who might not have a scientific background, but is curious about ground water and its importance in our everyday life. However, a ground water professional (geologist, engineer, water well contractor, etc) will also get much return on the time invested reading this book.

The book is divided into three sections:

In Part 1, Myths and Models, the author introduces ground water with two examples of ground water contamination, one from New England and the other from Maryland. He goes on to discuss subjects related to the myths and legends surrounding ground water, the medicinal uses of spring water, references to ground water from the Bible, and water witching as a method for locating wells. He wraps up this part of the book with a discussion of Darcy's Law and ground water management problems from the area around Savannah and Hilton Head on the Altlantic Coast.

Part 2, Bays of the Sea, is a nice overview of regional ground water systems, with a focus on the hydrogeological environments. The section begins with a description of what an aquifer is, with examples. The author moves on in subsequent chapters to discuss several hydrogeological regions of the United States, to include the Atlantic Coastal Plain, the Mississippi River Alluvial Valley, the Basin and Range province of the Southwest, the aquifer underlying California's San Joaquin Valley, and the Ogallala Aquifer of the High Plains. Other topics woven into these chapters include hydrogeochemistry, ground subsidence related to ground water with-drawl, and heavy metals contamination. Part 2 ends with a brief discussion of drilling technology and well construction methods.

Part 3, Evil and the Wells, covers material of interest to many of us; that is, ground water contamination and remediation. Chapters discuss various topics, including landfill design, chlorinated solvent contamination, radionuclide contamination at the Idaho National Engineering Laboratory, and BTEX contamination at a jet fuel tank farm. Of special interest to MGA members will be the two chapters which discuss aspects of the TNT contamination present at the former ordnance works at Weldon Springs, outside of St. Louis.

I found little to criticize in *The Hidden Sea*, especially considering its intended audience. The material and examples are somewhat heavily drawn from the southeastern portion of the United States, but this is to be expected since Francis Chappelle works for the USGS out of Columbia, South Carolina. The book is a lucid introduction to many aspects of our business. If you have a spouse, children, relatives, or friends who wonder what ground water is all about, I can't recommend a better introduction.

The Hidden Sea is available from the National Ground Water Association.

Review by Ed Lindgren, MGA News editor.

LEGISLATIVE AND REGULATORY UPDATE

By J. Ronald Sides, Ph.D., R.G.

Missouri Legislation

The proposed Comprehensive Groundwater Remediation Rule (Rule) may be of interest to MGA members. This is a proposed rule which was mandated by Missouri Revised Statutes, Section 644.143, which states that the Clean Water Commission shall establish procedures for determining whether remediation of groundwater, based on risk to human health and the environment, is appropriate for any particular site.

MDNR's historical approach to groundwater, most recently expressed in the CALM document, was

- All groundwater is a potential source of potable water,
- The MCLs apply everywhere, and
- Natural attenuation is generally not an acceptable remedy for groundwater impact.

However, the proposed Rule provides for risk-based groundwater remediation. This is a brief summary of some of the components of the proposed Rule. It should be noted that the proposed Rule is being developed as of this printing. Therefore, anything in this summary is subject to possible change. The "word on the street" is that it may be finalized some time in early 2002.

The Rule currently provides for a risk-based approach to groundwater remediation and provides for MDNR oversight of remediation projects. In the absence of direct MDNR oversight, parties must entirely into a site-specific groundwater remediation agreement.

Subsequent to the agreement, parties must perform site characterization. The site characterization must evaluate a considerable amount of chemical and hydrologic data including hydraulic conductivities, hydrologic boundaries, the presence of all karst features within one mile, and the locations of nearby wells. These data will be submitted in a Site Characterization Report, which must be approved by MDNR.

The Rule provides for (1) remediation by source control, (2) exposure pathway assessment, (3) risk characterization and determination of cleanup, (4) risk characterization and determination of cleanup levels, which may be other than MCLs, (5) a tiered site evaluation (6) and an ecological risk management plan. Alternative Cleanup Levels (ACLs) are risk based, and can replace MCLs or other MDNR-approved criteria.

After characterization is complete, a Risk-Based Groundwater Remediation Plan is submitted. Monitored natural attenuation can be a viable remedial alternative. However, this is possible only after it is demonstrated that there is no significant source of groundwater impact. Groundwater monitoring will be conducted and an estimated time for remediation will be supplied. After conditional approval, there will be a public comment period.

Under some circumstances, the point of compliance (POC) for the remediation can be the property boundary as opposed to the source area. For off-site plumes, the POC may be located on downgradient properties, assuming (1) institutional controls, (2) proper right of entry is established, (3) monitoring can be conducted, (4) proper notification of downgradient property owners occurs, and (6) several other criteria.

There is discussion about the potential use of an "urban groundwater zone designation" (UGZ). This may be used, for

example, in St. Louis, where it is not legal to drill wells for potable water so this exposure pathway is legally incomplete. (I understand that wells can be drilled in St. Louis for cooling water.) The proposed provision includes a number of requirements. One proposed requirement is that the UGZ is applicable only to cities with a population of at least

200,000, and may only extend into adjacent areas for a distance of three miles. As proposed, a UGZ would encompass only areas of known contamination, with a small buffer zone. As presently stated, these provisions appear to imply that (1) instead of one large UGZ (such as the St. Louis City boundary), there could be many within a city and (2) smaller suburban areas would be excluded.

The proposed Rule is still in the formation process and some of the summary material discussed above may have been changed. For additional information, you may want to contact the Missouri Clean Water Commission.

New CALM Guidance Numbers

As of September 1, 2001, many of the soil numbers in the MDNR CALM guidance document have changed. These correspond to the Tier 1 "lookup" table (Table B1) soil target concentrations (STARCs). These can be downloaded from the MDNR web site at:

http://www.dnr.state.mo.us/deq/hwp/hwpvcp.htm

Just for fun, here is an "old vs. new" comparison for a few of the more commonly observed constituents of concern. These are leaching to groundwater STARCs in mg/kg:

- trichloroethylene rises from 0.097 to 0.1 (essentially unchanged).
- tetrachloroethylene drops from 0.42 to 0.1.
- 1,1,1-trichloroethane drops from 4.67 to 3.5.
- 1,1-dichloroethylene drops from 0.10 to 0.09.

In this brief example, 75 % of the new STARCs are more conservative.

A Word from your Web Site Manager

Many of you have noticed that our web site was down for about three months this summer. In order to have a web site, you must have a domain name; which in our case is "missourigroundwater.org." In addition, the web site files must be supported by some kind of host. This can be an individual computer, or more commonly, a commercial hosting company with a large modem and storage capacity.

You must register for a domain name and this registration must be renewed annually or every two years. It is my job to renew our domain name. However, the notices that this name was to expire went to the address of my former employer, which had become an invalid address. As a result, they were not forwarded and I did not catch this until it was too late and the domain name expired. Unfortunately, once a domain name expires, it is unavailable for a three-month period of time.

I offer apologies to the MGA and have taken steps to ensure that this does not happen again. I feel it is important to state that the fault for this oversight is entirely my own and does not involve any of the other MGA officers.

Ron Sides

TENTATIVE CALENDAR OF EVENTS

Date:	**Event/Deadline:**
February 15, 2002	MGA Annual Conference, Columbia, Missouri

Missouri Groundwater Association
c/o Ed Lindgren
Burns & McDonnell
9400 Ward Parkway
Kansas City, Missouri 64114

www.missourigroundwater.org