WATER RESOURCES

IMPACT

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ENERGY AND WATER

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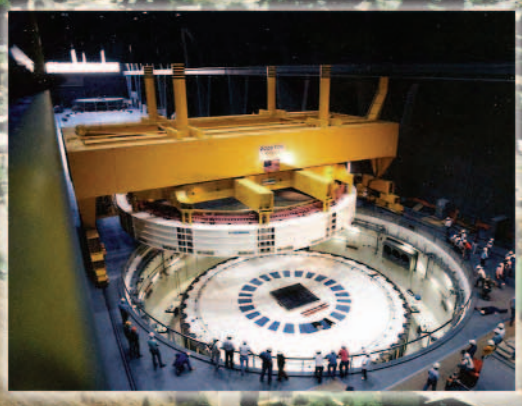

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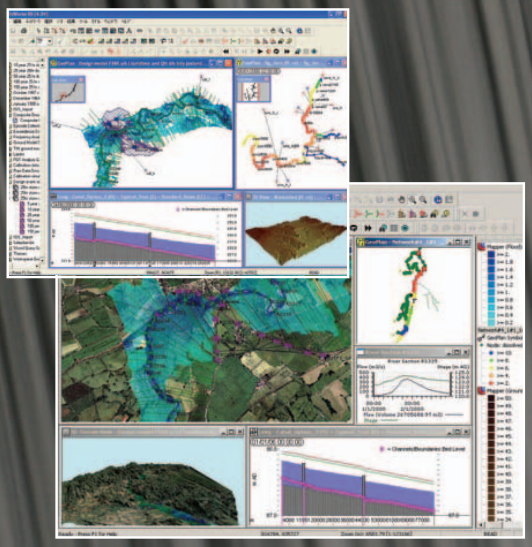

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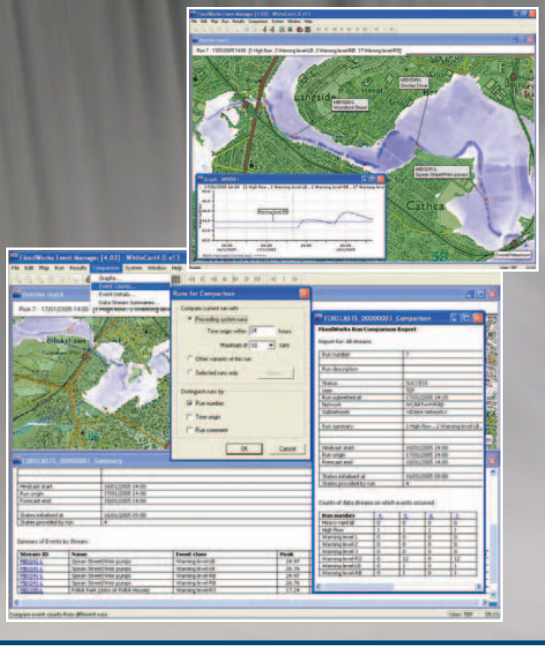

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Telephone: 888-520-2224 Email: sales@wallingfordsoftware.com

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ENERGY AND WATER

Associate Editors
ERIC J. FITCH • fitche@marietta.edu
LAUREL E. PHOENIX • phoenixl@uwgb.edu

John F. Kennedy once said "The great enemy of the truth is very often not the lie – deliberate, contrived and dishonest – but the myth – persistent, persuasive and unrealistic." Modern society is adept at ignoring our utter dependence on finite natural resources, at best only considering one resource at a time. This issue of *IMPACT* goes beyond water or energy resource scarcity to explore the gestalt of their interdependence.

(Opinions expressed by our columnists are their own and do not represent the opinion or position of the American Water Resources Association)

WATER RESOURCES
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Cover photos courtesy of the Bureau of Reclamation ... L to R from top: Grand Coulee Dam, Washington; generators in the power house at Shasta Dam, California; generator in the third power house at Grand Coulee Dam; and generators at Hungry Horse Dam, Montana.

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AMERICAN WATER RESOURCES ASSOCIATION
4 West Federal Street • P.O. Box 1626
Middleburg, VA 20118-1626
(540) 687-8390 / Fax: (540) 687-8395
E-Mail: info@awra.org • Homepage: www.awra.org

EDITOR-IN-CHIEF
N. EARL SPANGENBERG
College of Natural Resources
University of Wisconsin-Stevens Point
Stevens Point, WI 54481
(715) 346-2372 • Fax: (715) 346-3624
E-Mail: espangen@uwsp.edu
(Support for Dr. Spangenberg is provided by the College of Natural Resources University of Wisconsin-Stevens Point)

AWRA DIRECTOR OF PUBLICATIONS PRODUCTION
CHARLENE E. YOUNG
3077 Leeman Ferry Rd., Suite A3
Huntsville, AL 35801-5690
(256) 650-0701 • Fax: (256) 650-0570
E-Mail: charlene@awra.org

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ERIC J. FITCH (FITCHE@MARIETTA.EDU)

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WATER RESOURCES IMPACT

INTRODUCTION: ENERGY AND WATER

Laurel E. Phoenix

In a way, the world-view of the party imposed itself most successfully on the people incapable of understanding it. They could be made to accept the most flagrant violations of reality, because they never fully grasped the enormity of what was demanded of them, and were not sufficiently interested in public events to notice what was happening. By lack of understanding, they remained sane. ... George Orwell, 1984

According to William Catton, we have moved from the "Age of Exuberance" into an era of "overshoot," where our level of demand on natural resources is no longer sustainable. Habituated to this cornucopian plenty, but not understanding the widening gap between demand and supply, U.S. society is in for some uncomfortable surprises. Former Vice-President Al Gore might term these "inconvenient truths." Recognizing and responding to these truths in an age of overshoot is part of what James Howard Kunstler illustrates in his recent book, "The Long Emergency." How could such a rich country as the U.S. be facing a long emergency? One theory lies in the concept of out of sight and out of mind. If you replaced "the party" with "faith in technology" in the quote from George Orwell, you could be describing today's public. Confusing "technology" with "natural resources," and having little to no personal knowledge of the enormity of resource depletion, they do not concern themselves about these issues because they assume government will solve the problem with new technology. No worries.

In recent decades there have been some inroads to understanding resource degradation and depletion looking at one resource or set of resources at a time (e.g., strategic metals, energy, water). Enough of these studies have been done that the popular press has discussed them, giving the public some awareness of concern, at least about energy or water or some other particular critical resource. More recently, some professionals have started to look at the interrelationships between finite resources like energy and water, and realize that this synergistic relationship portends far more serious consequences if not addressed.

It is for this reason that our January issue introduces some foundations of the water and energy relationship, and what it means to the current comforts which are often taken for granted. Eric Fitch lists some national and international studies and where they address or fail to acknowledge these resource relationships. His article illustrates why these issues cannot be solved independently, and why ancient myths still bear lessons for us today. The article from Hightower *et al.*, gives an excellent overview of how water and energy are related in the U.S., and in what ways the needs of the Western, Central, and Eastern regions differ. They discuss data, technology, programs, and policy that are in place or that need to be developed in order to address these convergent resource problems. The article by Lon House looks at the problem from the perspective of water and wastewater utilities. How much of their costs are energy-related? How does new technology to save water or access new water perhaps require even more energy? What options exist for utilities to deal with energy issues? Finally, the article from Roluti describes what is being done to uprate hydropower facilities to coax more power from the same amount of water. It not only describes ways to improve turbine efficiency but also mentions reports that have looked at potential new hydropower sites around the country. These four articles, plus the "What's Up With Water?" column will give readers a variety of perspectives on water and power concerns, and, we hope, will engender much discussion!

AUTHOR LINK

Laurel E. Phoenix, Ph.D.
Associate Professor
Public and Environmental Affairs
MAC B310
University of Wisconsin-Green Bay
2420 Nicolet Dr.
Green Bay, WI 54311
(920) 465-2402 / Fax: (920) 465-2791

E-MAIL phoenixl@uwgb.edu

Laurel E. Phoenix is Associate Professor of Public and Environmental Affairs, University of Wisconsin, Green Bay. Her research interests are water and wastewater infrastructure, municipal water supplies, rural environmental planning, and anti-environmentalism. Laurel holds degrees in Geography and a Ph.D. in Watershed Management and Hydrology.

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WATER RESOURCES
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EXPLORING THE RELATIONSHIP BETWEEN ENERGY AND WATER

Eric J. Fitch

There is a Scandinavian legend about how the sea became salty. The story involves a miraculous mill that would grind out anything its owner commanded. The mill was acquired by a sea captain who did not test out his new possession until he was out at sea. Far from land, he took out the mill and commanded it to grind out salt for the meal. Unfortunately for him and his crew, the mill did just as he commanded and soon the ship began to fill with salt. Unbeknownst to him, the mill needed one command word to begin but a second command word to stop. The captain had no choice but to throw the mill into the sea lest his boat capsize. The stone mill sank to the bottom of the ocean and there continues to magically produce salt to this day.

Although we are dealing in the realm of science more than magic, global society treats water provision with the same lack of knowledge and sense of awe that these ancients did in explaining why God or the gods would make so much of the world's water unusable to humans and other terrestrial life. Western society looks at a faucet and sees it as the beginning and end of its considerations of the water supply. Thankfully, there are enough people with foresight to know that knowledge of the resources and systems of freshwater supply is necessary to plan for future needs. The provision of fresh water in the developed world has been irrevocably linked to the high quality, relatively cheap sources of energy that fossil fuels represent. As these sources of energy diminish and water demand continues to grow, the United States and indeed the entire world may be confronted with less easily accessible fresh water and/or water that comes with an ever increasing economic and environmental cost.

Peter Gleick, in the most recent edition of the Biennial Report on Freshwater Resources, The World's Water 2006-2007, writes about the concept of "peak oil" that has gained much currency since the publication of Hubbert's Peak, The End of Oil and other works. He reflects that society may want to consider the concept of "peak water" as well. He defines "peak water" as the world approaching a maximum level of exploitation of the water on which all human life depends. These peaks are linked in that the generation and distribution of pure water is linked inextricably with the availability of high quality energy sources that are continually accessible and affordable.

In 2004, the National Science and Technology Council published a report entitled "Science and Technology to Support Fresh Water Availability in the United States." This report highlighted the startling gaps in the data necessary for basic decision making with regard to water resources. It represented the first comprehensive examination of these national issues in a quarter century. Its conclusions were somewhat disheartening. It exposed the vast information gaps that exist with regard to the nation's water. Even for the data that is being collected, incompatible formats and different standards hamstring attempts at obtaining a true national picture of water availability. One of the key areas where data is lacking is how much energy is utilized to create fresh water (e.g., via desalination), impound water, purify water, ship/pump water and in other ways distribute water. Here is an excerpt from the report:

> *A very close linkage exists between the nation's energy future and water future – water is crucial to the production of energy; different energy sources have different water needs. Conversely, many of the technologies for withdrawing, storing, or treating water consume large amounts of energy. Thus, the science of water availability and use is crucial to the planning of our nation's energy future. The reliability of both energy and water infrastructures are linked to competition among all water users.*

The report goes on to document among other things the lack of current information in each of these key areas. This report sent forth a clarion call at the level of the federal government, as scientists across agencies and departments were tasked to develop solutions to fill data gaps and create frameworks for a national strategy.

Think of all the cities and suburbs growing in the Western, Southwestern, and Southeastern U.S., the infrastructure that has been developed to supply these areas, and the energy cost of developing, maintaining, and operating this infrastructure, and you have some idea of the conundrum facing the U.S. in upcoming decades

One of these key study groups is in the Energy Water Nexus group center out of the Sandia National Laboratories and the other national energy laboratories. Their work is ongoing (and detailed in another article in this issue of *IMPACT*). Although their studies and road maps create hope that the U.S. may soon be able to address some of these energy and water issues, larger global issues still exist.

The United States is confronting growing energy use on several key water related fronts and responding to negative dynamic impacts. To begin with, energy demand is on the increase. U.S. population as of October 2006 topped 300 million people and is growing at a net gain of one person every 14 seconds. Water demand permeates the support system for every one of these people, from domestic use to environmental support to manufacturing and supply of essential goods and services. Additionally, more and more of the U.S. population is locating in areas of water deficit. Technology fueled by relatively cheap energy has made water temporarily abundant where little

naturally exists. A prime example of this is Phoenix, which recently surpassed Philadelphia as the fifth largest U.S. city by population. The Central Arizona Project (CAP) moves a million and a half acre feet of water annually up more than 2000 feet in elevation and more than 300 miles across the desert to supply the needs of both Phoenix and Tucson. This is but one example of tremendous energy use to move water around. Think of all the cities and suburbs growing in the Western, Southwestern, and Southeastern U.S., the infrastructure that has been developed to supply these areas, and the energy cost of developing, maintaining, and operating this infrastructure, and you have some idea of the conundrum facing the U.S. in upcoming decades.

These problems of energy need and cost for water supply will be exacerbated as climate change impacts over the next 50 to 100 years make areas already in water deficit even warmer and drier. Combine these factors and it appears that an ever increasing amount of the U.S. energy budget will be used on the creation of new fresh water through desalinization, the transmission of water over greater distances and at times up great heights, and the purification of waste waters. Moreover, developing new and replacing old water infrastructure and operating that infrastructure will consume an as yet undetermined but inarguably large amount of energy. All indications confirm this energy will be scarcer and more expensive. Even with recommendations that are coming forth from the Energy-Water Nexus and other federal and state sponsored studies, it will most often in the more densely populated areas be up to local, regional, and state authorities and private vendors to implement. They may not have the economic wherewithal to implement all the recommendations of these studies. Finally on the domestic front, a source at the Bureau of Reclamation shared with me a disconcerting fact: federal agencies do a good job of tracking energy generation, but not so good a job of tracking client use. A hard set of numbers to find with regard to this issue area would be the aggregate use of energy nationally for accessing, purifying, and transporting water across the landscape. However, this activity is in so many public, private, and third sector hands that it is likely that only rough estimates can be calculated. Lacking a clear overall picture of energy use for these purposes handicaps solutions regarding reduction of energy use and cost.

This brings us to the global issues. If one were to examine the goals outlined in the U.N.'s Agenda 21: Chapter 18 on Water, one would see an ambitious litany of goals for global freshwater resources. Key program areas of this report include integrated water resources development and management; water resources assessment; protection of water resources, water quality and aquatic ecosystems; drinking-water supply and sanitation; water and sustainable urban development; water for sustainable food production and rural development; and impacts of climate change on water resources. Likewise Goal 7 of the Millennium Development Goals seeks to reduce by half the percentage of people who don't have access to safe drinking water and sanitation; an action literally encompassing the creation of new infrastructure for hundreds of millions of people at a minimum. Although Agenda 21 and the Millenium Development Goals take monetary costs into consideration to some degree, neither addresses the energy cost for the programs proposed. Ole von Uexkull in the Spring 2005 newsletter of the Rocky Mountain Institute wrote a short but compelling piece on the need to tie international aid and development spending into a realistic appraisal of the linked crisis of energy and water globally. His recommendations included advice to the United Nations Commission on Sustainable Development to link the key areas of water and energy together. If one examines the Water for Life Decade documentation, one still sees the key linkage between water and energy as one of generation as opposed to consumption.

My conclusions? As humankind in the U.S. and across the globe moves into the 21st Century, much has been made of the approach of peak energy generation from fossil fuels, the environmental impact of the continued use of these fuels, and the need to develop alternative energy sources for the sake of human and environmental needs. Similarly, much has been said about the approach to "peak water," whereby humans have tapped out most of the easily and cheaply accessible sources of fresh water. There is also the blunt reality of the ever growing need for both energy and clean water as human numbers and level of economic development increase. Often in the literature and in the practices of governments and economies, these issues are addressed as separate or at best parallel. In reality, they are inextricably linked and must be addressed as such. As the relatively inexpensive and relatively high quality sources of energy that fossil fuels offer are depleted, new sources of high quality energy must be found and substituted. This is no easy task alone. The situation is compounded by the environmental impacts of continued burning of fossil fuels, especially on climate. The best climate change models indicate that some of these key impacts will be to reduce the abundance and availability of fresh water resources. Current approaches, especially in highly developed nations such as the U.S., to augmenting fresh water supplies such as desalination and pumping water from where it is to where it is needed are all heavily dependent on cheap high quality energy. Thus a vicious circle ensues; two "crises" of peak energy and peak water that are not just Scylla and Charybdis; monstrous problems in and of themselves, where avoiding one inevitably forces you to be challenged by the other. They are more like the Lernaean Hydra; the nine-headed swamp monster whose threats must be confronted all at once lest it come back even stronger. The issues of alternative (nonfossil fuel) energy, reduction in the generation of climate change gases, and the continued production and distribution of freshwater resources for human and environmental needs are tied together in a Gordian knot that must be resolved simultaneously if they are to be resolved permanently. The beginning of this process lies in our coming to understand the current linkages between energy consumption and the provision of freshwater resources.

WATER RESOURCES
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WHAT'S UP WITH WATER?

Eric J. Fitch

"There is no such thing as water scarcity." This is one of those mind numbing statements that professionals in the water resources field know almost instinctively is simultaneously both false and true. We also know that it is the right answer to the wrong question. The question should not be "Is water scarce?" – the question should be "Is there enough high quality fresh water to support human and environmental needs where and when it is needed?" Here too, we are confronted with conditionals for answers, "No, but for these circumstances…", "Yes, but only if…", etc. Water is slippery not just physically, but materially, grammatically, and logistically. I came to reflect on this while listening to the presentation at the AWRA meeting by one of the giants of the water field, Peter Black, and contemplating the passing of another, Cliff Humphrys.

We know on a macro scale there is more than enough water on the face of the Earth to meet all human and environmental needs. We even know that there is an abundance of water in the solar system, especially among the comet belts, and in the broader universe. The presence of liquid water has just been confirmed on the surface of Mars. Visit the science fiction section of almost any good bookstore and you can find short stories and novels that in part deal with valiant humans harvesting these resources. Even some respectable planetary scientists have explored the possibility of interplanetary ice harvesting for meeting humankind's long term water needs.

Almost perversely then, we also know that water is scarce, precious, and hard to find in many key environments in the world today. Peter Black spoke about what I teach as almost a magical set of numbers to my students: 97-3-1: more than 97 percent of the world's water is salt and unusable by nonmarine life, less than 3 percent is fresh and less than 1 percent is fresh and available. He pointed out that this is not a unique conditional amongst critical resources. He spoke about how not just water, but also available carbon and other critical elements are but the smallest fraction of the totals that exist on the planet; that there is a basic asymmetry in most of nature between the total amount of any given critical resource that exists in the world and the much, much smaller fraction that is available for the use of humans and other living things.

If this was not enough of a Malthusian scenario, it becomes even more frightening when reflecting on things holistically, to consider the realities that human activities are overreaching natural availability and disrupting balances that will accelerate species loss, climate change, and perhaps hasten our species' exit from the planet. As water demand increases, so too does the demand for energy to purify and distribute water. We are in many ways locked in a tight death spiral linking money and fossil fuel consumption simultaneously with the temporary creation of usable water and atmospheric degradation. In many ways, a gloriously depressing picture of reality emerges

On the other hand, I reflected back on talks with Cliff "Doc" Humphrys, Michigan State University's long time water guru where he spoke about times of near unbridled optimism about what could be done by science and technology to bring clean, fresh water to all who needed it, even to the driest lands of the world. I recalled one conversation in particular about how in the 1970s, under the first blush of the great oil wealth that was generated from under the sands of the Arabian peninsula for the Saudi Royal family, the Saudi government had invited him and colleagues of his from all over the world to brainstorm ideas on how to bring water to their parched country. The government was trying to look down the line to times when the oil runs out. No proposal was too far out with functionally limitless funds and energy available. Some of the proposals actually made it into popular literature including the ever popular proposal of towing icebergs (e.g., see Hunter S. Fulghum's Don't Try This At Home "Tow an Iceberg to a Drought-Stricken Nation"). My favorite among the many scenarios laid out was the idea of paving a major section of the Arabian coast to increase thermal atmospheric lift on moisture coming off the gulf. This in theory would overcome the rain shadow effect of coastal mountain ranges and allow rain to reach the southeastern or Empty Quarter. Although actions were taken on many of these proposals, including a Saudi prince establishing a company with the express purpose of towing icebergs, water "creation" remains the purview of conventional technologies, first and foremost being desalinization.

The reality of world water availability floats somewhere, I believe, between these extremes. It's like the sentiment that a colleague of mine expressed the other day. She said she was both happy and lucky to live in the time after the discovery of antibiotics but before the oil runs out. We live in a time of great scientific and technological prowess. We also live in a time where human numbers and activities are in more places extending water resources past the breaking point. "New" water resources are available, but only at ever increasing costs both in terms of money and energy. Changing demands for those resources for growing and distributing food, other goods and services, and changes in climate fueled by human population and consumption growth will likely exacerbate both demand and scarcity.

Optimistic approaches to the need for ever more fresh water based on technology driven solutions are still possible, but only if we are willing to turn away from fossil fuels as our primary source of energy for water purification and distribution. We can literally take salt water and make fresh water. We do it so well in fact that deserts are blooming in part from "desal" water. This is fine if you

are able to pay the price both in money and environmental degradation. Pessimistic solutions which are Malthusian in nature are also possible. We can draw upon the images of the Four Horsemen of the Apocalypse, including death and discord, to see the possibilities that confront us if we are unable to break free of the fossil fuel/water death spiral. Peter Black reminded of the harsh reality that from a resource sustainability standpoint, we are more than a bit overextended. We have over six billion plus humans on the planet, but only long term resources that can sustainably support one billion. Keeping this caution in mind, with regard to water scarcity and supply, those of us who are in the water profession indeed are living in interesting times and must actively address both the issues of energy supply and environmental impact if we are to meet human and environmental needs for water.

AUTHOR LINK

Eric J. Fitch, Ph.D.
Director Environmental Science Program
Associate Professor of Environmental Science and Leadership
Marietta College
215 Fifth St.
Marietta, OH 45750
(740) 376-4997 / Fax: (740) 376-4753

E-MAIL

fitche@marietta.edu

Eric J. Fitch is the Director of the Environmental Science Program at Marietta College.

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WATER RESOURCES
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EMERGING ENERGY DEMANDS ON WATER RESOURCES

Mike Hightower, Chris Cameron, Ron Pate, and Wayne Einfeld

INTRODUCTION

Currently, electric power generation is one of largest water withdrawal and use sectors in the U.S. Additionally, future energy development such as biofuels, hydrogen, or synfuels production; oil shale development; carbon sequestration; and nuclear power development could significantly increase water use and consumption. On the other hand, water resource development – distribution, treatment, and transmission – is one of the largest energy use sectors. As future demands for energy and water continue to increase, competition for water between the energy, domestic, agricultural, and industrial sectors could significantly impact the reliability and security of future energy production and electric power generation.

To address these growing concerns, Congress directed the Department of Energy (DOE) to develop a Report to Congress identifying current and emerging national issues associated with the interdependencies between energy and water, and to develop an Energy-Water Research and Development Roadmap. This article provides a short overview of the emerging energy-water issues identified in the Energy-Water Report to Congress and summarizes some of the major challenges and research directions identified through the Energy-Water Roadmap process.

EMERGING CHALLENGES OF WATER AND ENERGY DEVELOPMENT

The availability of adequate water supplies has a profound impact on the availability of energy, and energy production and generation activities affect the availability and quality of water. In today's economies, energy and water are tightly linked. As illustrated in Figure 1, energy production and generation require water, and water pumping and treatment require energy. As these two resources see increasing demand and growing limitations on supply, energy and water must begin to be managed together to maintain reliable energy and water supplies and sustain future national growth and economic development.

The emerging vulnerability of energy and water supplies and infrastructures is becoming clearer. Low water levels from drought and competing uses have limited the ability of power plants to generate power (*Columbia Basin News*, 2006). Additionally, water levels in aquifers in many regions of the U.S. have declined significantly, increasing energy requirements for pumping, and, in some

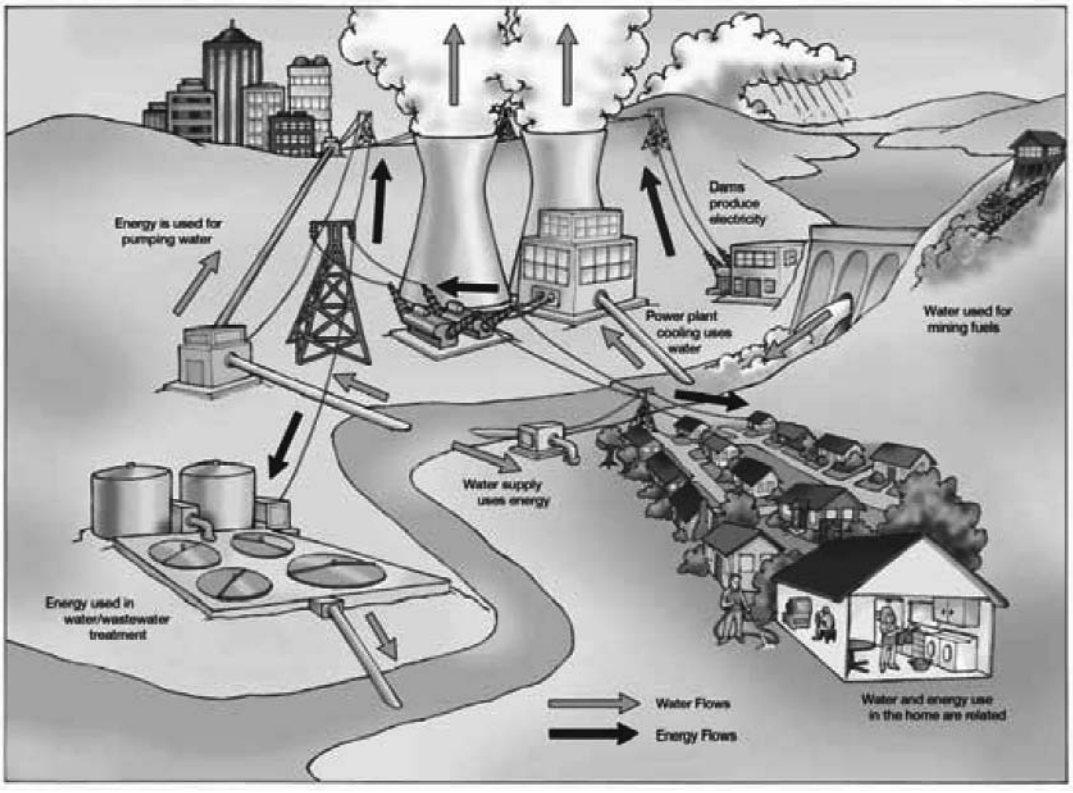

Figure 1. Examples of Interrelationships Between Water and Energy.

cases, leading to ground subsidence issues. Lack of water for thermoelectric power plant cooling and for hydropower has the potential to contribute to power shortages like those of recent years that have illustrated the vulnerability of the U.S. electrical grid to unplanned generation outages, especially in hot weather.

The information collected during the Energy Water Roadmap process suggested that most regions of the country are facing similar natural resource availability issues, needs, and concerns

At the same time, demand for energy continues to grow. In its reference case, the Energy Information Administration projects that demand for energy supplies from 2003 to 2030 will grow as follows: petroleum, 38 percent; natural gas, 20 percent; coal, 54 percent; nuclear power, 14 percent; and renewable energy, 58 percent. Demand for electricity from all sources is projected to increase by 53 percent (EIA, 2005). Providing this energy will require access to sufficient water resources.

Unfortunately, freshwater withdrawals already exceed available precipitation in many areas across the country. As shown in Figure 2 many areas of the country have water withdrawals exceeding available precipitation by up to a factor of five. The shortfalls are most dramatic in the southwest, the high plains, California, and Florida. Population growth in these regions between 2000 and 2025 is estimated to be 30 to 50 percent. This additional population will require more water and more energy. The challenges are not limited to these regions, however. For example, nearly the entire western shoreline of Lake Michigan has water demand above available precipitation, and aquifers in that region have declined as much as 900 feet (Bartolino and Cunningham, 2003), and are declining as much as 17 feet per year in some cases (Guy, 2003). In addition, many areas in the southeast are also becoming short of water.

Therefore, it is critical that water and energy resource planning and development must be integrated and coordinated across regional and local boundaries. The underlying foundation of water and energy resource data, water and energy technology, decision support tools and models, and policy directions must also be significantly improved if we expect to balance future demands for energy and water.

Congress requested that the DOE prepare a National Energy-Water Roadmap in the Energy Policy Act of 2005. The Roadmap was to assess the effectiveness of existing programs within the DOE and other Federal agencies in addressing energy and water related issues and assist the DOE in defining the direction of research, development, demonstration, and commercialization efforts to reduce water demands in energy development. Sandia National Laboratories was selected to coordinate the Energy-Water Roadmap activities, assisted by Electric Power Research Institute (EPRI), the other DOE national laboratories, and the Utton Center, a water law center at the University of New Mexico. An Executive Committee of national water and energy experts representing federal agencies and water and energy associations from around the country was also formed to help oversee all Roadmap efforts and processes.

The Energy-Water Roadmap process was designed to assess and integrate regional issues and concerns into a nationally coordinated but regionally focused energy-water science and technology research and development program. The Energy-Water Roadmap was a needs driven process and included three major elements: (1) identification and evaluation of regional and national energy-water issues and needs through three regional needs

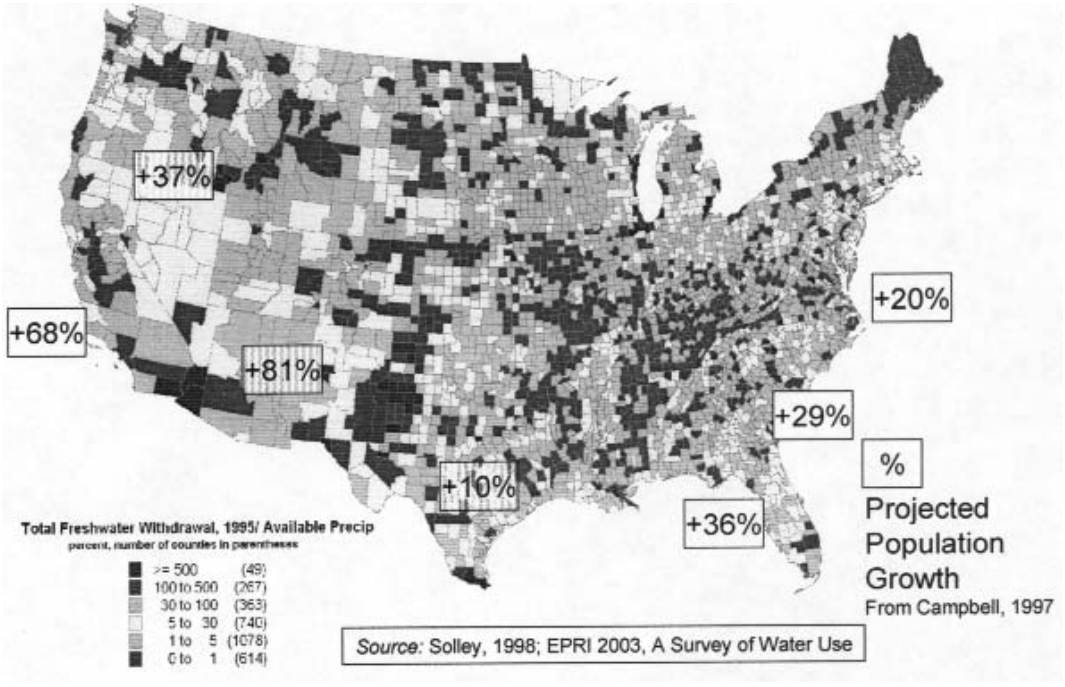

Figure 2. Water Shortages and Population Growth – Energy-Water Roadmap Process.

workshops; (2) identification and evaluation of the gaps between current programs and initiatives and future needs; and (3) identification of science and technology options to address current and emerging issues and trends and support future energy-water research strategies and priorities.

The needs assessment workshops were designed to ensure that current and emerging needs and issues and research directions were user driven. The needs assessment workshops were held November 14-16, 2005 (Kansas City, Missouri), December 13-14, 2005 (Baltimore, Maryland), and January 11-12, 2006 (Salt Lake City, Utah).

Seven categories of user/stakeholder participants were identified for invitation to the workshops including: Energy/Power/Utilities (energy mineral extraction, fossil and bio-fuels production, electric power generation); Water Utilities/Water Managers/Water Agencies Planners; Environmental/Ecological groups; Regulatory/Policy developers and agencies; Economics and Economic Development agencies and groups; other large water use sectors (agriculture, irrigation districts, mining, industrial/domestic); and special interests such as Tribal and State Government associations. Overall, about 350 individuals participated in the regional workshops. Input was obtained from participants from over 40 states. Based on these results, we were able to develop a synopsis of the national and regional level needs and issues.

Based on the regional needs workshops, a Gaps Analysis Workshop was held in Albuquerque, New Mexico, in March 2006 and included a broad mix of technical experts and researchers to assess the major gaps between existing programs and the emerging issues and needs. Based on the Gaps Analysis results, a Technology Innovations Workshop was held in San Diego, California, on May 2006 to suggest research directions and priorities necessary to meet the needs and gaps identified in the previous workshops.

SUMMARY OF NATIONAL ENERGY-WATER NEEDS AND SUGGESTED RESEARCH

The Western, Central, and Eastern Regional Energy-Water Needs Workshops possessed a variety of similarities, yet each displayed unique attributes. Eastern region participants generally had a more difficult time 'seeing' the interactions between energy and water than their Western and Central counterparts, and generally did not seem to view water availability for energy production as a significant long term problem – this may be a result of 'Eastern' water law and the relatively high precipitation rates in the region (and thus a perception that water is not now a problem).

The Central Region provided an interesting comparative look at the issues and concerns that arise when 'Western' and 'Eastern' water law collide in a region characterized by increasing water demand and energy production. The region's states display radically different approaches and levels of intensity for measuring, monitoring, and managing their water resources; this is caused by legal structures, perceptions of scarcity, and budget limitations. Participants at the Western Region meeting, not surprisingly, were heavily engaged. It is this region that faces the greatest water-energy challenges due to high population growth and scarce water resources.

Several common problem areas were identified in all three workshops that drove suggestions for major research and development needs.

Improved Energy and Water Resources Planning and Management

- The **lack of long term or integrated resource planning** that effectively addresses energy-water interactions at a state, watershed, or regional level. Models and decision support tools to improve this were identified as major research needs.
- The **lack of consistent and detailed data, and the lack of models** that can be used to address current and emerging problems at the energy-water nexus. Development of better sensors and better ways to collect water data and manage the collected data were identified major research needs.
- The **lack of fundamental understanding of the nation's surface and ground water resources**, including location, quantity, quality, interactions between surface and ground water, sustainable yield, and even the current volumes extracted or returned. Improved monitoring techniques, data management, and data display were identified as major research needs.

Other problems were identified by one or two of the workshops.

- Western region participants were more **interested in climate change and its impacts on water supplies and energy production** than other groups. Research and development of validated regional climate variation models were identified as major priorities.
- Eastern region participants were **particularly concerned about the decay of water treatment and delivery infrastructures**, noting significant energy consumption and water loss from leakage. Research on ways to address infrastructure decay and degradation were identified as major needs.
- Central and Western region participants noted **significant transmission and distribution problems and constraints,** with a lack of carrying capacity for electricity and natural gas noted. They also commented on the difficulties presented by large scale integration of renewable energy technologies into the grid. Research on infrastructure improvements to reduce water use for energy production and generation were identified as having a major impact on future water efficiency in energy and electricity production.

Improved Use of Nontraditional Water for Energy Production

- Participants in all regions **expressed concern over (and see opportunities in) the volumes of produced waters** discharged from oil, coal bed methane, and

mining activities. Technology research and development to treat and utilize these waters in an energy efficient manner to supplement water supplies were identified as major research needs.

- The **utilization of brackish ground water and waste water in energy production and generation** were identified as a mechanism to reduce fresh water use. Research to develop or improve materials and processes compatible with the use of nonfresh water and assess health impacts to workers and the public from these uses are major needs.

Improved Energy and Water Conservation and Improved Water Use Efficiency in Energy Production

- Participants noted that the **water intensity of conventional electricity generating technologies is a problem. They cited the lack of water intensity considerations in current energy RD&D programs** as an indication of the division between energy and water communities, and **noted the insufficient resources devoted to developing less water intensive alternative electricity generation technologies** (solar, wind, etc.). Better science on dry or hybrid cooling issues and technologies as well as infrastructure improvements to improve the use of less water intensive technologies were seen as necessary. Hydropower research and compatibility with river ecology and overall management was an important research direction suggested.
- The **cost and value of water was also a topic of significant interest and concern** in all regions – participants noted that at present, end users do not pay the true cost of the water they consume; that water has historically been (and continues to be) undervalued in the United States; and that the legal and regulatory frameworks that bound water make it highly problematic to address this problem. Regulatory and policy studies were identified as needed to help address these issues.
- **Conservation programs were a significant focus at the Western region meeting**. They noted needs for both increased energy conservation programs and the development of national scale water conservation efforts and programs. Approaches and incentives to encourage conservation were seen as providing major improvements in energy and water efficiency.
- **Co-location of energy and water facilities** were identified as a way to improve energy and water use efficiency and resource conservation in all regions.
- The **potentially massive water demand posed by ethanol production** is a significant concern for those in the Central and Western regions. New directions in national biofuels supply and demand suggest that new research into techniques that do not require crops grown with fresh water are needed.

CONCLUSIONS

The information collected during the Energy Water Roadmap process suggested that most regions of the country are facing similar natural resource availability issues, needs, and concerns. Most communities and participants agreed that better management of critical natural resources, such as water and energy, must be integrated and coordinated across regional and local boundaries. The underlying foundation of water and energy resource data, water and energy technology, decision support tools and models, and policy directions must also be significantly improved through science and technology research, development, and demonstration in order to sustain future economic growth and development. Many of the recommendations in the Roadmap provide suggestions for resource development and management groups on how to move toward a more sustainable future that balances economic growth with natural resource conservation.

The final results of the Energy-Water Roadmap Report are expected to be published in late 2006. Additional information regarding the Energy-Water Roadmap process, including results of the Needs Workshops, Gaps Workshop, and the Technology Innovation Workshop can be found at www.sandia.gov/energy-water.

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AUTHOR LINK

Mike Hightower
Distinguished Member of the Technical Staff
Sandia National Laboratories
P.O. Box 5800, MS 0755
Albuquerque, NM 87185
(505) 844-5499

E-MAIL

mmhight@sandia.gov
cpcamer@sandia.gov
rcpate@sandia.gov
weinfel@sandia.gov

Mike Hightower is the Lead for the Energy-Water Nexus National Lab Team at Sandia National Laboratories.

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WATER RESOURCES
IMPACT

WILL WATER CAUSE THE NEXT ELECTRICITY CRISIS?

Lon W. House

Water in the U.S. is a huge energy user. Approximately 4 perecent of all electricity consumed in the U.S. is used to deliver water and treat wastewater, more than is consumed by the pulp, paper, and petroleum industries. In California water related energy use consumes 19 percent of the state's electricity, 30 percent of its natural gas, and 88 billion gallons of diesel fuel every year. And it is only going to get worse, a lot worse, as the water community struggles to find adequate supplies of water to satisfy a growing population, tries to find ways to treat water to remove ever increasingly miniscule amounts of known pollutants, and tries to cope with a bewildering array of newly identified contaminants.

Water utilities use energy to pump, treat, and deliver fresh water and collect the wastewater and treat it before disposal. While much of the agricultural water is untreated, municipal water treatment involves aeration (for taste and odor), sedimentation, filtration, and chlorination or other forms of disinfection. The primary use of electricity in the treatment process has been for pumping water during treatment and to storage before use by the customer. Urban water suppliers are moving in the direction of energy intensive and costly alternatives to conventional methods of disinfection, such as ozonation and ultraviolet radiation, for health and safety reasons. The U.S. Environmental Protection Agency is imposing new and more stringent regulatory standards for suspected carcinogens and other health risks caused by disinfection with chlorine. In addition, most conventional disinfection is ineffective against the pathogens Giardia and Cryptosporidium found in some surface water supplies. There are also contaminants, such as MTBE and Perchlorate, that require innovative and expensive new treatment facilities. These treatment technologies can increase energy consumption at a typical water treatment plant by 20 percent or more, and some plants may face even greater increases in energy use.

Water scarcity is a significant issue in much of the U.S. west of the Mississippi and becoming a more important issue throughout the U.S. as the population grows. The search for new water generally concentrates on two new sources: water reclamation and desalinization. Water reclamation is reusing treated municipal effluent. Reclaimed water use has been concentrated on purposes that do not involve human contact or consumption, such as landscape irrigation, golf course watering, and industrial cooling water. However, reclaimed water is now increasingly being considered for domestic water consumption. Even though water quality standards require complete retreatment of wastewater, there is a general public reluctance to directly use treated effluent (the "toilet to tap" controversy). A much more palatable approach, and one that uses even more electricity, is to treat the wastewater, and use the treated wastewater for recharging ground water aquifers. This water is now subject to yet another round of treatment and disinfection when it is withdrawn from the ground and before it is sent to the customers. This extra pumping and "double treatment" results in significantly higher energy requirements than for traditional water sources.

If all potential solutions to our water problems require increased energy use, how can we manage the water industry's future energy needs?

Desalinization is desalting brackish ground water, some surface water, or seawater. There are two primary desalination technologies in use today: reverse osmosis and distillation. In reverse osmosis pressure is applied to the salty water, forcing the water molecules through a semipermeable membrane. The salt molecules do not pass through the membrane, and the water that passes through becomes potable water. In distillation the salty water is heated to produce steam. The steam is then condensed to produce water with low salt concentration. Both are huge energy users. Energy constitutes about 50 percent of the cost of reverse osmosis desalination and is the majority of the cost in distillation.

The final uncertainty is what the impact of climate change will have on the water sector. One thing does seem apparent, that the timing and pattern of precipitation is becoming more erratic. Since traditional water development (i.e., dams) is both expensive and controversial, there is much interest in new storage sources for water. These generally take the form of ground water recharge or conjunctive use, in which water is stored underground during times of surplus, and used during times of need. This can require significant additional pumping use – to get the water to the storage field, and to pump it out of the ground during times of need.

If all potential solutions to our water problems require increased energy use, how can we manage the water industry's future energy needs? There are four areas of opportunity which, when used in conjunction with each other, can mitigate much of the future energy impacts: conservation, self-generation, demand reduction, and demand response.

Conservation is a mainstay of any coherent water policy. It is obvious that the less water existing customers use, the more water from established sources there is for new needs. There are significant improvements in customer water use efficiency that can yield spectacular results. For example, the population of California's cities grew by 3.5 million people in the last ten years, but overall water consumption has stayed the same. However, Pollyannas do exist who say we can save our way to the future and do not need anything other than conservation. There are limits to conservation. In areas that have been exposed to extensive conservation efforts we see a hardening of demand – there is some level of water

consumption below which it is prohibitively expensive to conserve more. Conservation also does not adequately address the need for additional storage to save water during the wet periods for use during the dry periods. Finally, many conservation programs increase energy use. Agriculture, which is the largest end user of water in the U.S., is increasingly turning from traditional flood or furrow irrigation to sprinklers or drip irrigation, with significant water savings. These new water conserving pressurized pipe systems require pumps and extra energy to supply the pressure these systems require.

Self-generation is an increasingly viable option for water utilities, as the costs of the new generation technologies has dropped in recent years and the technology improved. Water utilities typically require large open spaces around their treatment facilities, particularly wastewater treatment facilities. These open spaces can be dedicated to electricity production in the form of solar installations. Wastewater facilities generate methane in the treatment process, which can now be used to produce electricity via fuel cells or micro turbines. Many water utilities site storage facilities at the higher elevations in their service area. With sufficient elevation small, in-conduit hydroelectric generators can replace pressure reduction valves. The economics of these generators depend upon their proximity to the water utility electric loads and, in some cases, the cooperation of the local electric utilities.

Demand reduction is the ability of water utilities to shift some of their electrical demand out of the on-peak period, usually via the use of storage or by installing extra treatment capacity at its facilities. Depending upon local electric utility rate design, such programs may result in bill savings for the water utilities.

Demand response is the ability of water utilities to reduce their electrical demand when called upon by the electric utility. This can be done via the judicious use of storage, depending upon current water demand conditions. In almost all areas of the country, the electric utilities will pay for the ability to call upon this demand drop when they need it, which may make such activity attractive to water utilities.

Water sector electricity use is poised to approximately double in the next decade or so if we do not implement some of these options to mitigate that increase. Many of these options require forward thinking on the part of the water utilities, and the realization of the electricity providers that they need to work and plan with the water community on their future electricity needs.

AUTHOR LINK Lon W. House, Ph.D.
Water and Energy Consulting
4901 Flying C Rd.
Cameron Park, CA 95682
(530) 676-8947

E-MAIL lonwhouse@waterandenergyconsulting.com

Lon W. House has a Bachelors, two Masters, and a Ph.D. in Engineering and Economics from the University of California-Davis. He also has a CEM (Certified Energy Manager) certification. He taught engineering in graduate school at U.C.-Davis for a number of years. He worked for the California Energy Commission for five years as a utility planner, and he was the chief utility planner for the California Public Utilities Commission for five years. In 1990 Dr. House went into the consulting business, starting his own business (Water and Energy Consulting).

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▲ Employment Opportunity

WATER RESOURCES
IMPACT

U.S. BUREAU OF RECLAMATION IS A WORLD LEADER IN HYDROPOWER

Michael Roluti

The U.S. Bureau of Reclamation's (Reclamation) hydropower plants, a major source of clean, renewable power for the nation, are helping to reduce U.S. dependence on foreign sources of energy and ensure the long term economic and national security of the American people. Reclamation is a world leader in the generation of hydropower and the second largest producer of hydroelectric power in the United States. Reclamation's 58 powerplants produce about 45 billion kilowatt hours annually – enough to meet the residential needs of more than 9 million people – and contribute nearly $700 million a year to the U.S. Treasury from the sale of that alternative power.

Reclamation's powerplants are located throughout the western United States, providing electricity to agricultural, industrial, and residential customers. This power also bolsters the energy grid so that it is stable and can deliver electricity to those who need it.

Though the primary purpose of Reclamation projects has historically been irrigation, flood protection, and water deliveries for domestic, industrial, and municipal use, the generation of hydroelectric power is an important component of Reclamation's operations.

Interest in alternative energy sources is at the forefront of national concerns as we seek to reduce U.S. dependence on foreign sources of energy, and the use of hydropower is potentially an important response to this need.

Americans often take a stable supply of electricity for granted, but the blackout three years ago in the northeastern United States reminds us of the impacts of a major outage. Hydropower made the effects of that blackout less severe than they could have been because hydropower can respond quickly to changes in demand and provide reserve power during emergencies.

We have a strong foundation to expand our hydropower resources. Hydropower is currently the largest source of renewable power in the United States, and it can be integrated with and make the best use of other, less flexible power sources such as coal, nuclear, wind, and solar power.

The importance of reliable sources of energy came to the national attention following the first oil embargo in 1973. At that time, Reclamation undertook a review of its powerplants to determine whether the plants could be uprated to higher capacities and produce more energy – uprating is defined as the increase of at least 15 percent in power generation capability. Using current technology to maximize power generation is an area in which Reclamation has thrived.

In 1977, Reclamation generated a report, "The Western Energy Expansion Study," which identified several potential locations where Reclamation could uprate its hydroelectric units. The potential increase in generation by uprating Reclamation's generators was substantial due to the fact that many of the units were older than 30 years.

In 1978, the Power Uprating Program was established and implemented to modernize and uprate generating equipment.

Under this uprating program, a generator is considered for uprating when the turbine capability substantially exceeds the generator capability at normal operating heads. More simply stated, the mechanical components of the generator are capable of more output, but the electrical components are already at maximum output.

At present, Reclamation is conducting several uprating and rewind projects ... projects that will be completed in 2006 include Glen Canyon Powerplant, Hoover Powerplant, Grand Coulee Powerplant, and Big Thompson Powerplants.

However, in some situations this is not necessarily true. Increased rating and efficiency can be obtained by runner replacement. For turbines built before 1960, it is frequently possible to obtain output increases as high as 30 percent and efficiency increases of 1 to 3 percent by replacing existing runners with runners of an improved design.

Reclamation's Power Uprating Program has performed studies on 58 Reclamation generator units, and uprates have been completed on all of them, increasing the generator capacity by 1.78 million kilowatts.

The first uprates were two Shasta Powerplant units located at Shasta Dam in Northern California. As part of this uprating process, some generator rewinds were completed, not to gain electrical generation, but because the winding condition was poor.

The majority of the increased capacity for Reclamation powerplants has occurred at the larger facilities such as the first ones completed at Shasta Powerplant in California, Hoover Powerplant in Nevada, Grand Coulee Powerplant in Arizona, and Hungry Horse Powerplant in Montana.

At present, Reclamation is conducting several uprating and rewind projects. Projects that will be completed in 2006 include Glen Canyon Powerplant, Hoover Powerplant, Grand Coulee Powerplant, and Big Thompson

Powerplants. These projects will result in an increased generating capacity for Reclamation of approximately 500 Megawatts.

Reclamation's Power Uprating Program has created a substantial increase in our generating capacity. More increases may be possible in the future with uprates or the addition of generating units at existing plants.

The ultimate goal with this program and any future uprating program is to increase the ability to meet peak power demands and provide stability for the United States electrical power system.

In addition to uprating, Reclamation has been working on developing two reports for the Energy Policy Act of 2005. The first report, which was completed and delivered to Congress in October 2005, was in response to Section 1840 of the Act. Section 1840 asked Reclamation to identify and describe the status of potential hydropower facilities included in water surface storage studies undertaken by the Secretary of the Interior that have not been completed or authorized for construction. About 500 projects were identified in the assessment that included information on project status, the latest level of analysis, beneficiaries, amount authorized and expended, and applicable costs and benefits.

The second report is in response to Section 1834 of the Act. Section 1834 tasks the Secretary of the Interior, the Secretary of Energy, and the Secretary of the Army to conduct a joint study of the potential for increasing electric power production capability at federally owned or operated water regulation, storage, and conveyance facilities. We expect to deliver this report to Congress in February 2007.

Reclamation is also expanding our partnership activities within the industry. This past year we finalized a Memorandum of Understanding (MOU) with the Tennessee Valley Authority (TVA) that will provide for broad sharing of technical expertise in a wide range of areas, including hydropower.

The MOU also facilitates TVA's involvement in the Hydro Asset Management Partnership (HydroAMP), a means for assessing hydropower equipment conditions and a series of prioritization methods that were developed in cooperation with the U.S. Army Corps of Engineers (USACE), Department of Energy's Bonneville Power Administration, Hydro Quebec, and Reclamation. The addition of TVA to this partnership expands the breadth of technical capacity and experience in the HydroAMP program.

Reclamation also solidified a partnership agreement with the USACE this past summer. This agreement established a framework to develop support agreements on a variety of topics, including hydropower. This builds on a partnership agreement that was signed by Reclamation and the USACE in February, 2005.

The 2005 agreement enabled Reclamation and USACE to collaborate in executing each agency's responsibilities for developing, managing and protecting the nation's water and related resources. One of the areas of mutual interest is hydropower management and technical assistance in research efforts and employee training. This agreement brings together two of the leading water managers to collaborate and create a better understanding of the two water agencies.

Reclamation's Power Program has long been established as a leading power program throughout the world. Reclamation is committed to ensuring the delivery of water and the generation of power from our facilities for many years to come.

AUTHOR LINK Michael Roluti
Senior Advisor/Power Liaison
with USACE/TVA
P.O. Box 25007, Denver Federal Center
Denver, CO 80225-0007
(303) 445-2721 / Fax: (303) 445-6750

E-MAIL mroluti@do.usbr.gov

Michael Roluti is Reclamation's Power Liaison with the U.S. Army Corps of Engineers and the Tennessee Valley Authority.

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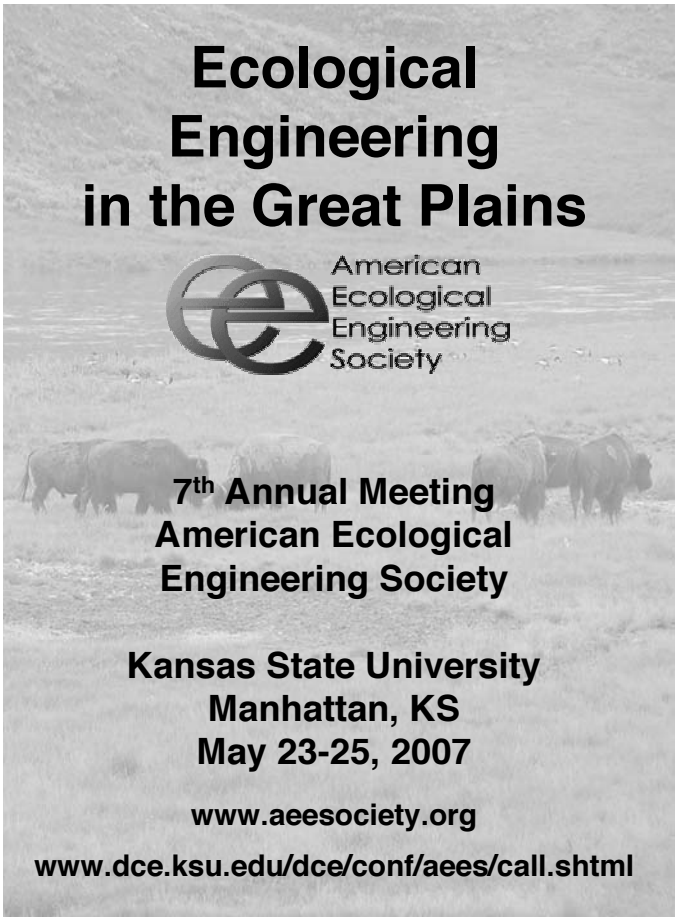

WATER RESOURCES IMPACT

THE NEW ECONOMY OF WATER

Clay J. Landry and Christina Quinn

URBAN GROWTH SPURS PIPELINE PROJECTS

The 19th Century industrial race in the West to build railroad tracks has reemerged in the form of a race to pipe water to urban centers. Both public and private parties are working to reach the populous with water through large-scale pipeline projects. The most significant private projects are in northern Texas, northern Colorado, and the Reno-Sparks area in Nevada. Other large scale projects involve municipalities and water authorities attempting to meet the needs of a growing populous. Similar to the railroads, the pipeline projects are costly and face many challenges but are drawing the attention of entrepreneurs looking for a good investment.

Private Urban Growth Water Pipelines Projects

Perhaps the most bold private water project is one to pipe 250,000 to 450,000 acre feet of water from Wyoming's Green River and Flaming Gorge Reservoir to Fort Collins and Colorado Springs. Entrepreneur Aaron Million recently told *U.S. Water News Online* that the pipeline is the way to take unutilized water in the West to benefit the cities, the farmers, and the environment on the Front Range. Million hopes to complete the project within five years. He already has private funding to finance his $4-billion pipeline and is waiting upon approval from regulatory agencies. The pipeline proposal goes along Interstate 80 to Laramie, Wyoming, then follows Highway 287 into Colorado.

Legendary entrepreneur and oilman, T. Boone Pickens, is working on his own water project to deliver 200,000 acre feet of water to Dallas or San Antonio from the Ogallala Aquifer in the Texas panhandle. The water, which was secured through Mesa Water Co., comes from beneath ranch lands owned by Pickens and his neighbors in four panhandle counties. Mesa Water Company claims to have more than 320,000 acre feet of water to sell. New York investment banker J.P. Morgan has agreed to finance the 328-mile pipeline proposal to the Dallas region for $1.8 billion provided that Mesa can secure a customer.

Private investors are also interested in the growing Reno-Sparks area where two private companies are competing to pipe water from the Pyramid Lake area south to the cities. Vidler and InterMountain Water Supply recently submitted applications for rights-a-way easements on BLM land. Vidler, wants to pump 8,000 acre feet from Fish Springs Ranch – property Vidler purchased for its 13,000 acre feet of water rights. The Vidler project requires a 28-mile pipeline. Meanwhile, Intermountain wants to withdraw 2,500 acre feet from its wells in Dry Valley and Bedell Flat. The pipeline would be 24-miles long and run parallel to Vidler's pipeline. Both projects are in an easement-approval stage.

Public Urban Growth Water Pipelines Projects

Public agencies have their own water pipeline projects. The cities of Prescott and Prescott Valley are proposing a 30-mile pipeline project to withdraw water from the Big Chino Ranch north of the towns for approximately 8,717 acre feet of water. The City of Prescott estimates the total cost at $170 million. The cities are currently working to raise funds for the project.

Water authorities also are gathering funds for large scale projects. The Southern Nevada Water Authority is proposing to build a 256-mile pipeline network to carry 200,000 acre feet of ground water from Lincoln and White Pine counties to the Las Vegas area. The Authority is applying for rights-of-way easements and preparing an Environmental Impact Statement. The Authority is reviewing financing options including municipal bonds.

In California, the San Diego County Water Authority is one of the more active urban water suppliers with pipeline projects. The Authority is spending $198 million to connect a major aqueduct west of Interstate 15 to the San Vicente Reservoir in Lakeside. The pipeline is part of a larger water project to increase water storage in case of a regional emergency such as earthquakes.

Investment Opportunities

The demand for water has created private investment opportunities for pipeline projects ranging from construction to engineering to water rights acquisition consulting. The U.S. Congressional Urban Water Infrastructure Needs Survey and Assessment estimates a $183.6-billion investment need for water transmission and distribution systems during the next 20 years.

The opportunities, however, come with risk. Each project faces the risk of delays caused by regulatory, topographical, and environmental challenges such as acquiring water rights and pipeline right-a-way easements. Gaining rights-a-way along Interstate 80, for example, may delay Million's Front Range pipeline project. The Million project is currently funded through private investment, making it more difficult to gain easements on public land. In contrast, publicly funded projects generally use eminent domain laws to obtain rights-of-way and easements.

Gaining rights to the water is another challenge. Many public and private entities purchase land in order to obtain water rights. Others purchase water rights separate from land. Regardless, both private and public project developers must show that piping the water does not affect current water rights and use. For example, the Nevada State Engineer required the Southern Nevada Water Authority run test wells for two years to see how pumping water to the Las Vegas area affects existing wells.

MAJOR PIPELINE PROJECTS BY STATE

Project/ Investor Name	Location	State Served	Size*	Pipeline Size (miles)	Cost	Public/ Private
Big Chino	Big Chino Ranch to Prescott and Prescott Valley	Arizona	8,717 AF	30	$170 million	Public
San Diego County Water Authority Lake Hodges Project	San Vicente Reservoir in Lakeside to San Diego and the Olevehain Dam, among other projects	California	90,000 AF	NA	$827 million (includes storage facility)	Water Authority
Orange County Water District	Fountain Valley to Anaheim	California	35 MGD	13	NA	Water Authority
Million Project	Green River and Flaming Gorge Reservoir to Fort Collins and Colorado Springs	Colorado	250,000-450,000 AF	400	$4 billion	Private
Fort Peck-Dry Prairie Rural Water System	Culbertson to Medicine Lake to Roosevelt County and Bainville	Montana	NA	Approx. 3,200	$250 million	Public
Rock Boy's North Central Montana Rural Water System Project	Tiber Reservoir to Rocky Boy's Reservation and surrounding communities	Montana	NA	NA	$229 million	Public
Vidler	Pyramid Lake area to Reno-Sparks area	Nevada	8,000 AF	28	NA	Private
InterMountain	Pyramid Lake area to Reno-Sparks area	Nevada	2,500 AF	24	NA	Private
Southern Nevada Water Authority	Lincoln County and White Pine County to Las Vegas area	Nevada	200,000 AF	256	NA	Water Authority
Eastern New Mexico Rural Water System	Ute Reservoir to Curry, Roosevelt, and Quay Counties	New Mexico	24,000 AF	87.5 plus 94.8 miles of lateral pipes to serve communities	NA	Water Authority
Lewis and Clark Water Project	Missouri River to South Dakota, Northwest Iowa, and Southwest Minnesota	South Dakota, Iowa, and Minesota	19.6-27.2 MGD	337	$374 to $441.5 million	Public
Mesa Water Company	Dallas or San Antonio from the Ogallala Aquifer in the Texas Panhandle	Texas	200,000 AF	328	$1.8 billion	Private
Anadarko Petroleum	Powder River Basin for brackish coalbed methane water	Wyoming	NA	48	$50 million	Private

*AF = acre feet; MGD = million gallons per day.

Moreover, rural communities where water is being exported often oppose piping projects. They raise concerns about the loss of farm land and jobs once the water is exported. The West has a long history of rural communities fighting water export projects.

Another issue these projects encounter is construction. Pipeline projects in urban areas cause concern because construction can affect commerce. The San Diego County Water Authority had to get boring machines to dig under ground as opposed to above ground because of public protest. These accommodations limit the negative effects on third parties but also add to the cost of development. Other projects in more rural areas can affect wildlife.

Nonetheless, entrepreneurs and public entities alike seem willing to take on these challenges. Piping investment proponents including Million have said that the demand for water is significant enough to offset the costs.

Million told the *U.S. Water News Online* in October that "The investment community looks at this as a slam dunk. I've already had offers to finance it [his Colorado pipeline project] purely from private sources. It's one of the more easily financed projects I've been involved with."

E-MAIL CONNECTION

Clay J. Landry (landry@waterexchange.com)
Christina Quinn (Quinn@waterexchange.com)

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▲ JAWRA Technical Papers ... December 2006 • Vol. 42 • No. 6

FEATURED COLLECTION – ENHANCING THE CAPACITY FOR SUSTAINABLE WATERSHED MANAGEMENT

- Introduction: Enhancing the Capacity for Sustainable Watershed Management
- Evaluating Interdependent Watershed Conservation and Ground Water Management Reforms
- Reducing the Risk of Fishery Resource Disasters: A Bioeconomic Approach to Sustainable Resource Management
- Water Allocation Policy Modeling for the Dong Nai River Basin: An Integrated Perspective
- The Importance of Institutional Structure in Controlling Agricultural Runoff
- Effects of Cropping Systems on NO_3-N Loses to Tile Drain
- Development of Nutrient Submodules for Use in the Gridded Surface Subsurface Hydrologic Analysis (GSSHA) Distributed Watershed Model
- Real-Time Soil Water Monitoring for Optimum Water Management
- Multicomponent Geochemical Transport Modeling Using HYDRUS-1D and HP1
- Bivariate Frequency Analysis of Floods Using Copulas

ADDITIONAL TECHNICAL PAPERS

- Watershed Level Best Management Practice Selection and Placement in the Town Brook Watershed, New York
- Economic Valuation of Riparian Buffer and Open Space in a Suburban Watershed
- Modeling the Long Term Impacts of using Rigid Structures in Stream Channel Restoration
- Flow Analysis of Landslide Dammed Lake Watersheds: A Case Study
- Turbulence in Miramichi Bay: The Burnt Church Conflict Over Native Fishing Rights
- Multitemporal Scale Hydrograph Prediction Using Artificial Neural Networks
- Multifractal Scaling of Daily Runoff Time Series in Agricultural Watersheds
- Assessment of Methods for Measuring Embeddedness: Application to Sedimentation in Flow Regulated Streams
- Lake Water Quality Assessment From Landsat Thematic Mapper Data Using Neural Network: An Approach to Optimal Band Combination Selection
- Runoff Event Impacts on a Water Supply Reservoir: Suspended Sediment Loading, Turbid Plume Behavior, and Sediment Deposition

LEGAL ISSUES

Michelle Henrie and Kyle S. Harwood

WHO BEARS THE BURDEN FOR HARM ARISING FROM COLLECTIVE PAST ACTS?

In all lawsuits, a plaintiff must prove that it was harmed. A plaintiff starts by alleging harm in its complaint. A complaint must allege facts that, if true, establish all legally required elements of the particular legal theory under which plaintiff claims it is entitled to relief. For civil wrongs (torts), there at least three required elements: (1) plaintiff was harmed, (2) defendant acted, and (3) there is a causal connection between the harm and the act.

In September, California sued six automakers for their role in contributing to global warming: General Motors, Ford, Chrysler, Honda, Nissan and Toyota. The 15-page complaint (twice amended) is interesting reading. It sets forth 19 compelling paragraphs of "Science and Consensus" related allegations about global warming, alleges in three paragraphs that defendants make cars and that cars emit over 30 percent of the carbon dioxide emissions in California (fortunately for many of us, drivers of cars are not included among the defendants), and then states 14 paragraphs of alleged harm. According to the complaint, California is entitled to relief from automakers (including attorneys fees) because it has been or is threatened with the following harm:

- **Feared Salt Water Intrusion**. "Rising sea levels will increase salt infiltration into the fresh water areas of the Bay-Delta" and California currently is "re-building levees protecting the Sacramento Bay-Delta area from salt water infiltration and other impacts of sea level rise."

- **Feared Infrastructure Inadequacy.** "[W]ater storage and delivery systems ... are being disrupted and will be disrupted as a result of global warming." For example, "Folsom Dam was designed in 1950 based on historic flow records for storing excess flow from a 500-year flood. Now, because of the increased snow melt, there have been five floods on the American River larger than the pre-1950 recorded maximum flood, and the dam is now adequate to store only a fifty-year flood under current conditions."

- **Feared Loss of Sand Beaches.** "The supply of sand to beaches in southern California is insufficient to maintain beach width in the face of sea level rise... sandy beaches will narrow and disappear, exposed shore platforms will become submerged, coastal annoring needs will increase, and catastrophic events and widespread flooding will increase."

- **Feared Drought and Heat Events.** "Dozens of other impacts have begun or are anticipated with a high level of certainty, including increased risk and intensity of wildfires, risk of prolonged heat waves, loss of moisture due to earlier snow pack melt and related impacts on forests and other ecosystems, and a change in ocean ecology as water warms."

- **Studies Relating to the Above.** "California has embarked on a massive effort to evaluate global warming impacts and threats, and to act to limit and mitigate damage. These actions have already cost California millions of dollars and will certainly cost millions more."

If California is successful in this lawsuit, this case could open the door to other lawsuits based on alleged harm, resulting from cumulative actions, for which one industry – or entity – bears the burden, even though its actions may have never violated environmental regulatory standards. No matter how a person feels about global warming, one must consider the impact of this approach.

California seeks reimbursement of future expenses incurred by California in connection with global warming. Thus, even though cars contribute to less than 1/3 of the carbon dioxide emissions in California, six (and only six) automakers could bear the entire cost of the problem. California – which arguably contributed to the problem through congested highways, lack of alternative transportation, and sprawly land use policies – would pay nothing. In addition, California seeks "joint and several liability," which means that although six automakers were named, California could pursue any one automaker for payment of the entire damage award.

Anyone who discharges into a watercourse should be nervous about this lawsuit. If this lawsuit is successful, it provides a litigation model. Even if a discharger diligently complies with its permit, even if no one realizes that specific emerging contaminants or cumulative effects would arguably cause future harm, and even though there are multiple (and identical) dischargers on the same watercourse, any one discharger could be liable for the entire resulting harm. Is this fair?

E-MAIL CONNECTION

ksharwood@ci.santa-fe.nm.us
mhenrie@bhfs.com

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WATER RESOURCES
IMPACT

TAKE CHARGE OF YOUR CAREER

Marshall Brown

The days of the mammoth corporations are coming to an end. People are going to have to create their own lives, their own careers, and their own successes. Some people may go kicking and screaming into this new world, but there is only one message there. You're now in business for yourself ... Robert Schaen, Former Controller, Ameritech

If you don't know it yet, the world of work is very different than when we were growing up. The days of retiring after 30 years with one company are over. The days of employer loyalty (and for that matter employee) no longer exist. In the past, as long as you did your job and met expectations, you were paid. According to William Bridges, author of "Creating You and Co" and "Jobshift," "Jobs were slots, boxes and pigeonholes. Jobs demanded performance in a script that was already written".

Today's work world is full of uncertainty. Every day we hear about another corporation or organization going out of business, downsizing, rightsizing, and on and on. In order to prepare ourselves for these uncertain times, we must take charge of our own career.

Another factor that is affecting today's changing world of work is that more and more individuals are looking to find meaning in their work in new ways. Especially since 9/11, people realize how short life can be and want to be doing what is important to them. They want to feel passion in their work, a commitment to their values and personal mission statements. Individuals want to make a difference. They want to know that I am good at work, that my work is important and my work fits with my values.

The hard reality is that your stake in your work satisfaction is greater than your employers. We cannot rely on our employer to provide us with satisfaction in our job. In the highly competitive global economy in which we work, you need to look out for your own best interests. You must take responsibility and manage your own career. It is no longer an option to wait for your employer to manage it for you. Whether you are in a job search now or thinking about making a career change in the near future, it's time to discover what makes work satisfying for you.

So, how do you do that? Here are a few tips to help you survive in todays' changing world of work:

1. Be Self-Managing. Think of yourself as working for yourself. You are the person in control of your own career and have to manage it. No one else can do it for you. Put a marketing plan together for YOU and just do it!

2. Know What You Have to Offer. It is imperative in today's competitive job market to know YOU. Know what you have to offer and then market yourself as the person with that information. This will help to separate you from your competition. Your marketability will depend on your ability to demonstrate, on paper and verbally, your skills (even if within the same organization). Today, whether you are working in a "for profit" or "not for profit," employers pay for results and what you can produce for them. Those that are succeeding are the ones that know what they have to offer and what they are capable of doing better than some of their competition. What do you bring to the table in the way of assets, strengths and values?

3. Keep on Learning. I would encourage you to look beyond your current skill set and look at developing additional benefits of "marketing you." By asking yourself the following questions (and discussing with your peers, friends,family and/or "board of advisors"), you should be able to come up with specific ways you might want to work on improving your product ... you, in the next six months: (a) I am known among my peers or co-workers for these projects or skills; (b) my current project is challenging and provocative to me in these ways; (c) in the past three months, I have learned the following new things that will help me to move forward; (d) three important people that I have added to my Rolodex (or Palm Pilot) in the last three months; and (e) by next year at this time, I would like to be known for these skills or projects.

4. Understand Business Trends. Read industry papers, keep track of the fast changing economic and social landscape, and understand your competition. Stay current in your field(s).

5. Prepare Yourself for Areas of Competence, Not Jobs. Focus on developing core competencies that your association or another association is likely to require in the future. Define yourself by what you do and how to get it done NOT by your job title.

6. Find a mentor. Someone that will provide honest and effective feedback to you. Someone that takes an interest in your development and will support you in your career progression.

7. Build Financial Independence. When your finances are in good shape, you can make career (and life) decisions based on what is really important to you. You won't feel like "I really have to take this job because I need the money." To manage your career effectively, you must also be able to manage your personal finances.

8. Network, Network, Network!! Even if you are not looking for a new job or career right now, develop your network. NOW is the time to do it, not when you decide to look (or have to look). Join an association, networking groups, etc., and get involved. Don't just be a checkbook member. Develop your network by meeting with people on a regular basis. Make it part of your schedule to meet with one new person every month. Get to know people that are doing what you are doing – or want to be doing. I encourage my clients to spend at least 85 percent of their job search time networking. If you can only devote

two hours a month, fine. Then spend 85 percent of the two hours meeting with "like minded people."

9. Keep Your Resume Up-to-Date. Don't wait until you get a call asking for your resume right away. That is the worst time to develop it. You will be anxious, stressed and might not be able to remember some of your significant accomplishments. Add your new expertise, skills, and memberships as you have accomplished them and do it on a regular basis.

10. Create a Vision. Picture yourself doing what you would like to be doing. Think, and verbalize it in "I am" statements. "I am association marketing professional. I am selling my services to associations." Vision what you want to be doing and put it out there! What do you have to loose?

The old ways of thinking about how and why we work are no longer useful. In order to survive in today's world of work, each of us must know what we have to offer, realize our potential and take charge of our own careers. As stated in the Talmud, "If not now, when?" Wishing you much happiness and success!!

E-MAIL CONNECTION

marshall@mbrownassociates.com or visit
www.mbrownassociates.com

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▲ Student Opportunities

DOCTORAL OPPORTUNITIES IN ENVIRONMENTAL MANAGEMENT

Montclair State University now offers a Doctoral degree in Environmental Management. Our program focuses on three inter-locking themes, (1) Water-Land Systems; (2) Sustainability, Vulnerability, and Equity; and (3) Environmental Modeling and Visualization. Graduate Assistantships are available to qualified full-time students which include full fee waivers and a 10 month stipend of $15,000. Applications for spring semester admission will be considered starting 15 February 2007.

Information about our program can be found at our website at http://www.csam.montclair.edu/degrees.html.

Inquiries should be directed to Patti McNicholas at (973) 655-5423.

▲ Graduate Research and Teaching Assistantships

Graduate Research and Teaching Assistantships
Hydrologic Sciences Graduate Program
University of Nevada, Reno

The Hydrologic Sciences Program at the University of Nevada, Reno is seeking to fill up to six graduate research and teaching assistantships starting in July/August, 2007.

We are seeking applicants for three teaching assistantships for the introductory graduate courses in groundwater, fluid mechanics and aqueous geochemistry. The remainder will be research assistantships in the same general subject areas. The annual salary is $17,000 for M.S. students and $18,000 for Ph.D. students and includes medical benefits and tuition, for a total package worth up to $31,000/year. Additional research assistantships may be available from the Desert Research Institute (www.dri.edu) and from the U.S.G.S. Water Resources Division in Carson City (nevada.usgs.gov). All applications shall be made to the UNR Hydrologic Sciences Program, regardless of the funding source.

The Hydrologic Sciences Program has nearly 70 graduate students (30% Ph.D. and 70% M.S.) and more than 40 core faculty who teach courses, advise students and conduct research in the hydrologic sciences. The program is consistently rated nationally among the top ten by the U.S. News and World Report Guide to Graduate Schools. General areas of research in the program include groundwater, surface water, aqueous geochemistry, contaminant transport, soil physics and chemistry, aquatic ecology and fire science ecology. Approaches to research range from applied to theoretical. Students and faculty are very active in international water issues (www.saiwi.org).

Instructions for application to the program can be found on our website: www.hydro.unr.edu and on the Graduate School's website: www.vpr.unr.edu/grad2. Additional information can be obtained by contacting our program office at 775-784-6469 or by email: hydro@unr.edu.

River Terrace & Floodplain Hydrology
Connecting surface water and ground water along the Rio Grande and other large rivers

The symposium will evaluate implications of existing research and chart future directions for needed work, as well as provide a better understanding of river valley hydrology and related management strategies.

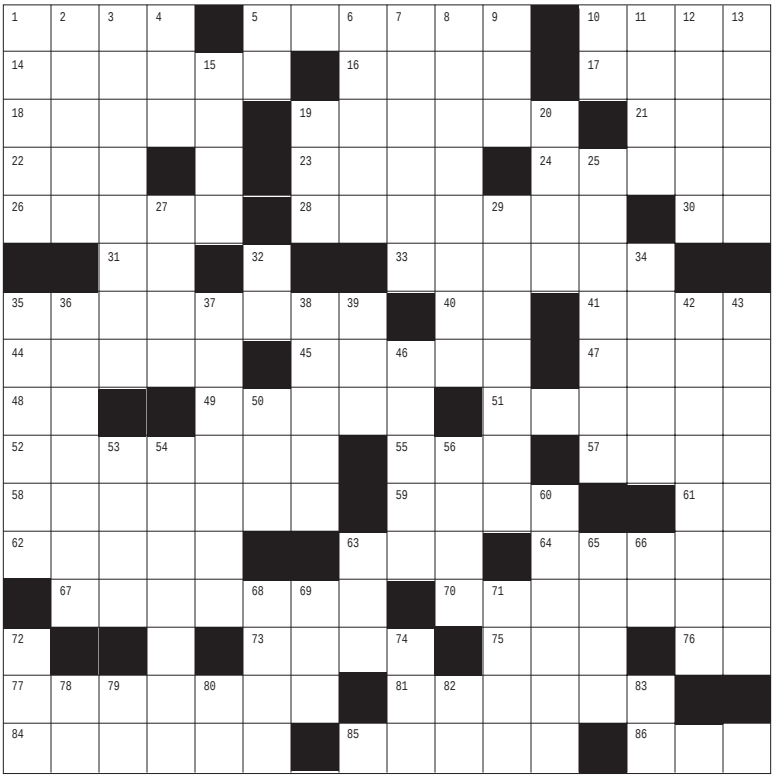
Invited speakers and contributed posters will:

1. Explore connections between surface water and groundwater in river terraces and floodplains.
2. Examine integrative measurement and modeling methods to identify primary system components.
3. Share information among researchers in the area of connections between surface water and ground water, and share experiences from throughout the Rio Grande basin and other large river systems.
4. Identify knowledge gaps and future research directions to improve scientific understanding.

CALL FOR POSTERS

Hotel Encanto
Las Cruces, NM
February 28 & March 1, 2007
http://nmwater.nmsu.edu
Melissa Alarcon
Symposium Coordinator
Phone: (505)202-1427
melalarc@nmsu.edu

▲ Water Resources Puzzler (answers on pg. 36)



ACROSS

1 atomic or screen
5 building blocks
10 "_____ the night before ..."
14 sun god
16 tide type
17 Holliman or Monroe
18 setter or coffee
19 short snooze
21 S.A. beach
22 small bite
23 fabric tear
24 camel stops
26 painting surface
28 renters
30 library sound
31 informal greeting
33 removed
35 naval groups
40 switch position
41 _____ and proper
44 weighed down
45 tear jerker?
47 Tennille or Braxton
48 atomic no. 77
49 bullring moves
51 blackheads
52 blockheads
55 one of the Stooges
57 musical symbol
58 lofts
59 sea or striped
61 fatique wearer
62 building material
63 bat wood
64 charge or girl
67 old tars
70 not in the know
73 "The Yellow _____ of Texas"
75 bar order
76 site of Mt. Rushmore
77 near or far
81 wanderers
84 genetic materials
85 cow's baglike organ
86 "You lucky _____!"

DOWN

1 an inanimate object
2 weird
3 poorly made
4 "_____ the season..."
5 undergraduate deg.
6 lacking sense
7 C16H34
8 type of court
9 place to relax
10 atomic no. 52
11 Hundred Years and Thirty Years
12 Zodiac ram
13 to splash through a puddle
15 birthplace of 7 U.S. Presidents
19 between EST and MST?
20 cooking and flower
25 lacking emotion
27 place of an event
29 female goats
32 Rosen or Kaline
34 slobber
35 trysts
36 ropes
37 _____ fly
38 soil type
39 Miller or Jillian
42 7 and 11
43 failed to explode
46 metrical feet
50 envelope abbr.
53 line or surgeon
54 ring of flowers
56 site of Honolulu
60 anagram of rascal
63 horse or zebra kin
65 due
66 loc. of James R.
68 minerals
69 Zeus or Apollo
71 Elvis or Jesus
72 small cobra
74 note or zone
78 loc. of Big Muddy R.
79 loc. of Flint R.
80 atomic no. 69
82 fatigue color (abbr.)
83 loc. of Cheyenne R.

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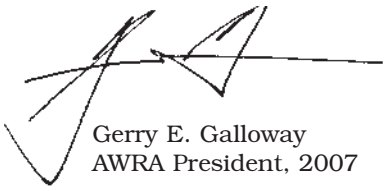
▲ President's Message ... Gerry E. Galloway, AWRA President, 2007

2007 is going to be a challenging year for water resources in the United States and abroad and for AWRA as an organization that represents so many aspects of these water resources. It is a distinct privilege for me to be part of the AWRA leadership team as we face these challenges and work to ensure that important decisions are informed by sound science and the knowledge base of the AWRA family.

The 110th Congress reported for duty in early January and brings new faces to the critical committees and to the staffs of these committees. The 109th Congress left many water-related issues on the table. There is yet to be a resolution on what will be done about the protection and restoration of coastal Louisiana and Mississippi. The post-mortems on Katrina pointed out the challenges in ensuring that levees serve the purposes for which they were designed and that levees are a national as well as a New Orleans problem. There has been no Water Resource Development Act since 2000 and action on many water problems are tied to the passage of such an act. The Congress is still wrestling with U.S. clean water issues and has yet to take a stand on what support we will provide to other nations to deal with the absence of sanitation and clean water in so many parts of the world. This issue of *IMPACT* highlights the nexus between water and energy and what energy technologies can offer to the water community. The Congress also will be dealing with many of these topics during its current session.

The year ahead for AWRA will be busy. The January AWRA National Water Policy Dialogue will enable AWRA to bring together water experts from around the nation to examine what steps should be taken now to move ahead with the policy issues identified in the two earlier AWRA Dialogues. Following the Dialogue, this information will be presented to the President, the Congress, and the governors and, with a push from many of the other organizations that are co-sponsoring the Dialogue, we hope will be given full consideration. The June AWRA specialty meeting in Vail will bring together professionals to deal with the growing threat of emerging contaminants and to identify what steps we in the water community should be taking. This is another case where AWRA members are at the cutting edge in dealing with issues that must be faced during this decade. In the fall, AWRA will sponsor another in our series of meetings dealing with ecological restoration. As was pointed out during the September 2006 meeting in Fort Lauderdale these restoration projects are very expensive and are growing in number even though we have not reached consensus within the community as to how best to carry them out. Finally, I look forward to seeing many of you at out annual meeting in Albuquerque in November where we will once again deal with the broad spectrum of issues that has made these meeting so useful for water professionals.

The great attendance and the diversity of the program at the Baltimore meeting in November clearly illustrates the strength of AWRA. I look forward to working with each and every one of you in the year ahead and I thank you in advance for your contributions to the efforts of the Association and its programs.



Gerry E. Galloway
AWRA President, 2007

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HAVE SOME COMMENTS ABOUT THIS ISSUE OF IMPACT?

(COMMENTS ON PREVIOUS ISSUES ARE ALSO WELCOME)

SEND US YOUR FEEDBACK

Water Resources IMPACT is in its ninth year of publication and we have explored a lot of ideas. We hope we've raised some questions for you to contemplate. "Feedback" is your opportunity to reflect and respond. We want to give you an opportunity to let your colleagues know your opinions ... we want to moderate a debate ... we want to know how we are doing.

For this issue send your letters by land-mail or e-mail to

Eric J. Fitch (fitche@marietta.edu) or

Laurel E. Phoenix (phoenixl@uwgb.edu)

Comments may also be sent to

Earl Spangenberg (Editor-In-Chief)
(espangen@ uwsp.edu)

Either way, please share your opinions and ideas. Please limit your comments to approximately 350 to 400 words. Your comments may be edited for length or space requirements.

▲ Inconsistent Water and Land-Use Law at the State and Local Level ...

Lisa McGuire, Deanne Kloepfer, Walter Lyon, Robert Moresi, Jr., and Winfield Wright – AWRA Policy Technical Committee Members

Water laws and institutions are authorized for many goals: water quality protection, public water supply, irrigation, and flood control, to name a few. However, disconnects between these laws and the laws, policies, and practices governing land-use decisions can hamper sound management of both. These disconnects can also lead to inefficient use of resources, legal conflicts, infrastructure design flaws, and inadequate resources to meet the needs of future growth.

At the 2006 AWRA annual meeting in Baltimore, Maryland, several members of the AWRA Policy Technical Committee convened a panel session to discuss this issue at the state/local scale. The following are summaries of case studies the panelists presented on this topic.

CALIFORNIA: FLOODPLAIN WATER MANAGEMENT VS. LOCAL LAND USE

From north to south in central California, comprehensive floodplain management increasingly conflicts with local land-use actions. A massive system of floodplain levees was originally built to provide reliable water supplies for the state's huge agricultural industry and protect agricultural lands against seasonal flooding. But the system is not built to flood proof the increasing number of residential and commercial developments springing up in the midst of the levee system and sanctioned by local land-use authorities.

In 1986, flooding on the Yuba River opened a 150-foot gap in the levee, allowing approximately 20,000 acre-feet of water to flood 7,000 acres in the Yuba County communities of Linda and Olivehurst. Hundreds of homes and a shopping center were impacted, and approximately 2,600 parties filed suit against the local reclamation district and the state. Even though the levee was originally built to manage water for agriculture and protect agricultural lands and even though the state had transferred maintenance and operation to the local authorities, in 2003 the California Court of Appeals ruled that the state was liable and the local reclamation district was not. The California Supreme Court refused to hear the state's appeal, and the state and the plaintiffs agreed to a settle for approximately $500 million.

In effect, this lawsuit, known as the Paterno case, puts cohesive, long term, strategic management of California's floodplains in an inferior position to local land-use decisions and requires the state to "fix" the levees. In the wake of damages to levees since the Paterno case, the state is spending millions on spot-by-spot repairs, while little effort is being made to achieve consensus on a comprehensive solution to the conflict between floodplain management and local land-use actions.

PENNSYLVANIA: REGULATORY COMPLEXITY IN STATE LAND AND WATER LAW

The early history of land and water management included a small number of federal laws that recognized and addressed the natural linkages between land and water. The overwhelming number of more recent laws that address land and water do not recognize the reality that land and water management are interdependent and must be managed in a unified manner.

In Pennsylvania, for example, more than 30 laws and thousands of pages of regulations govern land and water use. They can obstruct sound management by both government and developers because they have different objectives, are administered by various programs and agencies, and do not recognize the close connection between land and water use. As a result administration of these laws lacks a common purpose and generates much confusion, unnecessary cost, and red tape. The group 10,000 Friends of Pennsylvania and the Brookings Institution recently studied two of these laws – the Pennsylvania Municipalities Planning Code and the Sewage Facilities Act, which govern state and municipal actions for sewage facilities planning and permitting and land use planning and regulation – and concluded that these laws "are in conflict and can undermine a municipality's ability to manage growth" (10,000 Friends of Pennsylvania, 2005).

A process of developing a "model State land and water code" is needed to examine goals and content in existing state water and land laws and produce a model code encompassing the goals and interests of all stakeholders. Such a code could serve legislators, governors, environmental organizations, and development interests. Precedents for such efforts exist, including the American Society of Civil Engineers' (ASCE's) model statutory provisions that are intended for adoption by state governments to allocate water rights among competing interests and resolve quantitative conflicts over water (ASCE, 2004).

COLORADO: DEVELOPMENT OF PUBLIC WATER SUPPLIES

There are numerous water related and land related regulatory requirements to develop a public water supply in the State of Colorado. The Lightner Creek Project, near Durango, Colorado, illustrates this point. Of the 12 federal, state, and county regulatory requirements to construct a water supply project, water related regulations comprised five, and land related regulations comprised seven. To withdraw water from Lightner Creek and pump water to the reservoir, the water related requirements included: (1) application for water rights and defense

against objectors in water court, (2) safe yield analysis of the water source, (3) stormwater runoff permit, (4) change in use from agricultural to domestic for the water right, and (5) technical consultations to determine whether project withdrawals could impact endangered fish species. The land related requirements included: (1) change in point of diversion of water right, (2) engineering and route determination, (3) access and rights-of-way, (4) location and construction of the diversion structure, (5) wetland crossings for the pipeline, (6) clearance for endangered plants and animals, and (7) commercial land-use application with the county. All of the regulatory requirements were intertwined and inseparable because all must be met prior to approval by the county, which has the power to grant or deny the project. Parties were allowed to legally intervene for or against the project, which makes the process intractable, and ultimately resulted in the project being denied. Since the approval power resides at the county level, this panelist concluded that all regulatory requirements should be vested at the county level. In addition, he raised the question of whether during a time of devolving government a process could be established where local governments could be authorized to process every part of a water development permit, similar to water quality plans for Indian reservations.

FLORIDA: WATER VS. GROWTH

In 1972 Florida enacted legislation to create five regional agencies to regulate the use of water, but not to use the agencies' authority as a tool to manage growth. This unique agency concept, where five similar agencies are based on nongovernmental boundaries, covers the entire state for the purpose of regulating the use of both surface and ground water. Florida's regulatory arena has intentionally separated the management of the water resources from growth issues or growth control. However, floods, drought, and significant increases in demand have placed water resource management at the top of the growth issue. Extreme increases in the demand for water have resulted in water shortage, environmental harm, and resource use conflicts. Growth management plans have long been written in a vacuum of the availability of a sufficient water supply. Now, every municipality must update its Comprehensive Land Use Plan every five years, and also its Regional Water Supply Plan to show that growth will occur in conjunction with sufficient water resource availability. The five agencies also prepare a regional water availability plan to support the municipalities' efforts.

Water resources availability to support growth was never provided with certainty until recently. Now growth and planned development must include provisions for water supply. Permitting of supplies includes equitable processes, availability assurances, long term sustainability, and the implementation of alternative supplies.

DISCUSSION

The discussion following the case studies was moderated by Maxine Woelfling from the Harrisburg, Pennsylvania, office of the international law firm Morgan, Lewis & Bockius, based in Philadelphia, Pennsylvania. Guided by the moderator, the panelists and audience examined characteristics of the legislation, legal decisions, and authorities leading to the outcomes in each case study. Participants also considered such questions as whether projects of high public importance might warrant an overarching decision making institution. As noted by the moderator, others have examined causes of disconnects between water and land-use management, identifying factors such as jurisdictional gaps and conflicts, separation between planning and implementation, and inconsistency between state plans and development decisions and budget expenditures (Tarlock and Lucero, 2002). And as highlighted elsewhere and in our session, various measures and mechanisms could help resolve these disconnects.

Members of the Policy Technical Committee may further explore possible tools to address these disconnects, including the development of a model integrated water and land use code. We welcome readers' thoughts and suggestions.

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E-MAIL CONNECTION

Lisa McGuire (mcguire.lisa@epa.gov)
Walter Lyon (walter.lyon@comcast.net)

(The views and comments expressed in this article are those of the authors and do not necessarily represent those of the U.S. Environmental Protection Agency or other organizations.)

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▲ Positioning Water at the Center of the Political Debate ...

Loïc Fauchon, President, World Water Council, Marseille, France (AWRA Honorary Member) – Presentation at the AWRA Awards Luncheon

I would like to thank you, dear friends of AWRA for this invitation to be with you today. To speak before your very experienced organization with such a great reputation is a great honor. It is an honor for me, personally, for those that are accompanying me, for the Marseilles Water Company of which I am the President, and especially for the World Water Council.

I would like to briefly speak to you about the World Water Council, and to express my point of view on the problems that humanity will have to face in the coming years and decades. I also wish to supply some concrete and sustainable answers for these crucial questions for the world's future.

Water is today a strategic issue, essential to the future security of our planet. To speak of that is first of all to recall a fact too often forgotten ... in today's world, an insufficient supply of potable water kills ten times more people than all armed conflicts combined. Water-related disease has been by far the *principal cause of mortality in the world* for a long time and will be for many more years to come.

The battle for sufficient disease-free water is not very spectacular, because it is a battle against poverty, and misery. Not enough politicians are involved because the fight concerns the weakest, those that are far from the cameras and who have no voice.

There is no human development without water. This is evident for us, as professionals, but we need to share the reasons for this fact with politicians and decision-makers so that more can understand the scope of the battle.

The first piece of evidence relating development to water problems is the reality of an increase in global population by one billion in 12 years. There is no certainty that beyond 2050 the rate will truly slow, mainly because of the progress of health policies.

Population increase alone is complicated by three factors: the first is the problem of rural areas, where overcommitted water resources cause supplies to diminish or disappear for millions and millions of farmers and herders.

The second factor is the anarchic growth of megacities that are thirsty and that, here or there, can no longer be easily supplied. These large cities, probably 50 or so with more than ten million inhabitants, are a true explosion waiting to happen, with an ever more dangerous factor of instability and potential disorder.

The third complicating factor is great migrations that throw and will continue to throw tens of millions of people who have access neither to water nor to essential services, on the roads and beyond the seas.

After population, the second piece of evidence relating human development to water problems is the very important question of pollution. Pollution is one of the most important sources of tension over water resources. Because pollution is unforeseen, because it is sometimes dangerous, and because fighting pollution is very expensive, we often refuse to see it.

The final piece of evidence, after population and pollution, relating human development to water problems, is climate. In order to prepare ourselves to counter the effect of slow or abrupt changes, many countries devote considerable sums of money on overcalibrating infrastructures and equipment. To prevent flooding, we will raise dikes; to avoid drought, we will dig deeper wells or build more dams.

It is the role of the World Water Council to consider the tensions that arise from the impact of water problems on human development, and to propose different answers that can, together, bring society to place a high priority on addressing water problems.

We see tensions over the availability of the resource in four ways: first is the location of water, next is sustainability of water, third the quality of water, and finally, the quantity of water. To guarantee access to water, to bring security in supply, and to ensure stability is to be able to supply answers to the tensions arising out of these considerations.

These answers translate to concrete and sustainable actions. The Council groups the answers in terms of specific themes. The first answer can be found within a simple principle, but with progressive implementation: **consume less**. The need for this answer is a reality in our developed countries, and it is true in poor countries when water is free or nearly free. It is an answer requiring changing behavior, an answer of a way of life that needs the force of public action, united with the will of the citizen.

The second is to **manage better** – to manage better technically, to know how to reduce all types of water losses, but also to improve water management, be it public or private – to manage water like a rare resource, like a resource that has a high turnaround cost that cannot be wasted. To manage better is to noticeably improve water governance by decentralizing administrative competencies, by bringing them closer to the ground and to the citizen, but also by fighting against corruption more intensely through reinforced monitoring policies.

The third answer is linked to **risk management**. Establish a true international cooperation to improve the prevention of catastrophes related to water, sometimes overabundant, sometimes lacking, and to coordinate measures to take when catastrophes happen.

The fourth answer is purely **technological**. It is one that consists of using man's ingenuity better in the future, as a friend of water. Let's take a few simple examples for increasing available resources across time and in

different areas. Using desalinization of seawater or brackish water, which, due to the reduced costs, today represents hope for an increasing number of countries. But also technology holds the capacity to dig deeper, the capacity to transfer water over great distances to make water highways, and the capacity to recycle water and to reuse it in agriculture and industry. In order to do this, policies for transfer of know how are strongly needed, in addition to new types of research and development programs led in the countries that need them, in order to take into account the specificities of each country and region.

The fifth answer is **financial** and is obviously essential as only five percent of development aid today is devoted to water. It is a major economic mistake. More money is needed for water, not only to aid investments in the poorest countries, but also to guarantee the operation of infrastructures.

The sixth answer is a **moral** answer. In their dialect, the nomads of the Sahara say "Aman Iman." That means "water is life." It is simply an element that is indispensable to human dignity. This must be said with simplicity. Access to water is a right, as is access to health care or education. It is a personal right, an individual right. We wish to put forth the idea that in a modern and democratic state, every individual has the right to a vital minimum, to a sort of allocation that lets him or her live in a dignified way.

The seventh answer, if I may put it this way, is **energy** related. The instability of the price of oil and gas terribly weakens access to water for the poorest. The questions of access to water and control over energy will be indissoluble in the future. I would like to insist that today there is the opportunity and the necessity for a strong and organized push for the use of renewable energy in the poorest countries.

All these answers are interconnected. We must bring them forth with conviction, for the role of each of us is not only to study and to progress, it is also to *convince*. Together, we must give to the world the conviction that placing a high priority on solving water resource problems is not as much a necessity as a duty, not only because it is a moral obligation, but above all because security in supply of fresh water has become a strategic imperative that no State, no community of women and men can spare in the long run.

Water, dear friends, needs to endure, but it also needs equity. Everyone understands this today because the situation is critical in many places in the world. Today, we have, and tomorrow we will have enough water if we cooperate. And to do that, we must find common superior values. This is what the World Water council has endeavoured to do since its creation in 1996. It attempts to make the debate public, because the conviction will assert itself if it goes beyond the awareness of decision makers at every level. The public at large, citizens here and there, will bear the message, thanks, in particular, to the amplification power of the media.

A simple and universal message: the future of our planet is conditioned by a mastering of water resources. Each man, each woman, each child, should be able to live, to work, to die where he or she is born. And for that, water and energy are needed first. Failing that, we will continue to throw millions of human beings on roads and over seas, people who will end up running into walls and fences built up hastily by the rich.

Yes, it is without question better to contribute to building walls of water rather than walls of indifference. This is an essential element of a global strategy, consisting of fairer development and of pacific coexistence.

(*Editor's Note:* I have edited the text of Mr. Fauchon's speech for length. Any errors are mine, and not those of Mr. Fauchon ... Earl Spangenberg, Editor-in-Chief.)

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▲ Book Reviews (JAWRA)
December 2006 • Vol. 42 • No. 6

The following books are reviewed in the December 2006 issue of *JAWRA*, pgs. 1717-1722.

The Great Lakes Water Wars – Peter Annin – ISBN 1-55963-087-6

Water Management in Arid and Semi-Arid Regions – P. Koundouri *et al.* (Editors) – ISBN 1-84542-423-9

Tribal Water Rights: Essays in Contemporary Law, Policy, and Economics – T.E. Thorson, S. Britton, and B.G. Colby (Editors) – ISBN 0-8165-2482-3

The Atlas of Climate Change – K. Dow and T.E. Downing – ISBN 0-520-25023-0

Integrated Transboundary Water Management in Theory and Practice – G.D. Gooch and P. Stalnachke (Editors) – ISBN 1-843390-84-1

Water Gas Treatment for Resource Recovery – P.N.L. Lens *et al.* (Editors). – ISBN 1-843391-27-9

Water Resources in Jordan: Evolving Policies for Development, the Environment, and Conflict Resolution – M.J. Haddadin (Editor) – ISBN 1-933115-32-7

Groundwater Hydraulics and Pollutant Transport – R.J. Charbeneau – ISBN 978-1-57766-479-6

▲ USEPA's Priorities for America's Water Resources ...

Benjamin H. Grumbles, Assistant Administrator, USEPA, Washington, D.C.

Presentation at the AWRA Awards Luncheon

INTRODUCTION

I'm Ben Grumbles and I approve this message ... But seriously, whether you're a Republican or a Democrat, there's good news after yesterday. You won't be hearing "I'm ... and I approve this message..." for a couple of years – at least not with the same intensity.

I greatly appreciate the opportunity to share with you the U.S. Environmental Protection Agency's (EPA) priorities for America's water resources.

1. CHESAPEAKE BAY RESTORATION

First of all, welcome to the Chesapeake Bay Watershed. EPA continues to place a priority on working with our partners to restore and protect America's largest and one of the world's greatest estuaries

The Chesapeake Bay ecosystem is unique, playing a vital role in the commerce of six states and Washington, D.C. The area around the bay is home to some 16 million people and provides millions more a place to enjoy its splendor and allows them to participate in recreational activities along the many miles of shoreline.

Restoring the Bay is a long-term task, because the nature of the watershed and the shallowness of the Bay make it extremely vulnerable to what happens on land.

The population in this 64,000 square mile watershed grows by more than 100,000 annually. Development patterns take an estimated 100 acres of forest daily. The increase in impervious surface, through which rainwater cannot penetrate, has accelerated rapidly, thus reducing the capacity of the watershed to absorb pollutants.

During the 1990s, population grew by about 8 percent and impervious surface increased about 41 percent. As population and impervious surface grow, ever-greater levels of effort are required to achieve the same relative pollution reductions.

Despite these pressures, the Chesapeake Bay program efforts have arrested the decline of the Bay, and achieved net, measurable reduction of nutrient concentrations in the rivers that feed the Bay. Reducing the nutrient and sediment loads into the Chesapeake is the major focus of the Bay program, but it is not the only work underway.

Working with many partners, EPA's Chesapeake Bay program has achieved tremendous results and successes in protecting and restoring the Bay.

We have seen significant restoration successes vital to the health of the Bay's ecosystem, such as the 4,000 miles of stream – and Bay-side forest buffers planted in the last decade. We have also seen nearly 1,800 miles of rivers and streams reopened to the passage of migratory fish. And the amount of underwater Bay grasses has more than doubled since its low point in the early 1980s.

In the last few years, the Chesapeake Bay has also been supporting the use of regulatory tools to promote restoration activities. In December 2004, EPA issued a Chesapeake Bay basin-wide "permitting approach" for municipal and industrial wastewater National Pollutant Discharge Elimination System (NPDES) point sources.

More than 450 wastewater facilities across all jurisdictions are covered by this approach, and the net nitrogen reduction load to the Bay is estimated at over 17 million pounds annually when all the permits are implemented over the next few years. This innovative approach shows that watershed partnerships can yield impressive environmental results.

These new regulatory and nutrient trading programs hold great promise to accelerate the restoration of the Chesapeake Bay.

2. WATER QUALITY TRADING

Water quality trading is an innovative, market-based approach to advancing environmental and economic goals through efficient and effective collaborations to use credit trading for water quality upgrading.

Last month, EPA's Office of Water and the U.S. Department of Agriculture's (USDA) Natural Resources and Environment signed an unprecedented partnership agreement to promote clean water and healthy watersheds through water quality trading. Through a pilot project in the Chesapeake Bay basin, this agreement will apply market-based approaches to develop water quality trading standards and establish methods to ensure credible water quality results.

"Flexibility with accountability" is the key. We believe better guidance at the federal level will accelerate water quality trading policy development at the local level and increase the probability of success. Ultimately, a successful trading program will occur when stakeholders take advantage of potential cost savings, economic growth, asset management, and planning as a result of buying and selling pollutant reduction credits.

Water quality credit trading utilizes individual NPDES permits under the Clean Water Act to foster increased compliance through flexible, market-based approaches.

For example, a wastewater permit facility can purchase pollutant reduction credits as an alternative compliance path or trade pollutant credits under an overall pollutant cap through watershed-based permits involving multiple permit holders.

Nationwide, there are 94 NPDES permits that allow for trading, encompassing 236 facilities. Of these facilities, 121 have participated in trades.

In the past five years, interest in credit trading has been growing among various stakeholders ranging from water and wastewater associations, capital markets, permit writers, the environmental community, to the consulting sector and construction industry.

EPA's 2003 Water Quality Trading Policy encourages flexible policies that meet water quality goals. In 2004, we released the Water Quality Trading Assessment Handbook, which outlines four elements to determine the feasibility of trading within watersheds. Currently, we are also developing three guidance documents to support watershed-based permitting including: (1) a framework for applying the watershed based permitting approach; (2) a guide for developing a watershed-based permit; and (3) a series of case study examples.

3. FOUR PILLARS OF SUSTAINABLE INFRASTRUCTURE

The Sustainable Infrastructure Initiative is an effort to help ensure that our nation's water infrastructure is sustained into the future by fundamentally changing the way the nation views and manages its water infrastructure. It is, first and foremost, a collaborative effort involving drinking water and wastewater utility managers, trade associations, local watershed protection organizations, and federal, state, and local officials.

To focus these efforts, we have identified what we term the four "pillars" of sustainable water infrastructure. These "pillars" include: (A) Better Management, (B) Full-Cost Pricing, (C) Efficiency Water Use, and (D) Watershed Approaches to Protection.

(A) Better Management – The Better Management "pillar" involves changing the paradigm from managing for compliance to managing for sustainability. In May, EPA, the Water Environment Federation (WEF), and five other organizations signed a Statement of Intent under which we are developing a list of attributes of sustainably managed systems, identifying existing training and tools available to help utilities adopt and implement improved utility management systems (including advanced asset management, environmental management systems, and others), and developing a strategy to fill the gaps in training and tools and to encourage broader adoption of sustainable management practices.

(B) Full-Cost Pricing – Water and wastewater services in this country do not consistently recover the full cost of service, nor do they accurately reflect the true value of the service provided. In fact, the average American family spends more each year for soft drinks and other beverages than they do for water and wastewater services combined.

Under this "pillar", EPA is developing tools and techniques to assist utilities interested in recognizing and recovering the long-term, full cost of providing service. Our goal under this "pillar" is to help utilities correct market signals that have been distorted by years of subsidies, and to help communities find appropriate options for cost allocation and rate design.

Last week, EPA convened an expert panel in Lansing, Michigan, to define an approach to full-cost pricing that makes sense and can be followed by practitioners across the country.

(C) Efficient Water Use – WaterSense Voluntary Program – The Water Efficiency "pillar" involves reducing per capita demand on our water infrastructure. Through water efficiency, utilities can delay expansions to deal with population growth and make better use of existing resources. This "pillar" is about providing consumers and communities with information and choices, establishing pricing policies to encourage efficiency, identifying technologies and promoting programs to detect and repair leaks, and encouraging water reuse.

In June, EPA announced the development of a new water efficiency market enhancement program. This program, called *WaterSense*, will educate American consumers on making smart water choices that save money and maintain high environmental standards without compromising performance.

WaterSense specifications will be established to recognize products and services that perform at least 20 percent more efficiently than their less efficient counterparts. These products and service providers will be able to display the *WaterSense* label.

In addition to seeking manufacturers, retailers, and distributors as partners in this program, EPA is actively encouraging utilities and nongovernment organizations to sign up as partners. More information on this program is available at http://www.epa.gov/watersense/.

Last month, the *WaterSense* Program announced its first set of technical requirements (or specifications) for professional certification programs. Organizations can now earn the *WaterSense* label for their certification programs for landscape irrigation system designers, auditors, and installation/maintenance professionals.

Individuals who receive these certifications will be better equipped to service their customers' irrigation needs. Soon, consumers will be able to identify the most knowledgeable industry professionals by looking for *WaterSense* partners.

In the near future, EPA will also partner with certified irrigation professionals and manufacturers, distributors, and retailers of high-efficiency plumbing fixtures.

(D) Watershed Approaches to Protection – The basic goal of this "pillar" is to promote integrated planning in programs affecting local water resources in order to achieve the watershed's water resource goals in an optimal way. Using a watershed approach, multiple stakeholders integrate regional and locally-led activities with local, State, Tribal, and Federal environmental management programs.

For many of us, the watershed-based approaches are more of a "cross-beam" than a "pillar." It's about thinking outside the fence-line, beyond the pipes and traditional partnerships to identify the full range of options to achieve water quality and human health protection goals. It involves integration of community planning and development to reduce life-cycle cost and optimize investments. It involves finding solutions that meet the community's needs and sustains community values.

A grassroots, locally-driven watershed approach hinges on watershed awareness. We all know our zip code; we should know our "drip code" too. EPA continues to advance watershed awareness through voluntary assistance and outreach and program guidance.

This "pillar" will become increasingly necessary for communities as population growth, growth patterns, and

development affect the quantity and quality of available water: • Water shortages require a more holistic look at all water resources on a watershed basis: (1) watershed-based approaches that include source water protection will become critical, and (2) water reuse will become a much more common component of water resource management on a watershed-basis. • Increased loadings from our additional population and the industrial and agricultural base that supports it will require more efficient technologies, including those that prevent or treat at or nearer the source. • Some of these technologies may need to be integrated into community plans to be feasible. • Some of these technologies will create new opportunities for fuller use of the water within the watershed. • Water quality trading will be seen as the most economic solution for more communities trying to balance point source and nonpoint source loading reductions.

Increased development will increase storm water runoff and expand flood zones, requiring us to re-think our planning and development paradigms and to develop more efficient storm water control and flood management on a watershed basis.

4. WATER SECURITY

The area of water security continues to be a strong priority for EPA's Office of Water. States and utilities have accomplished much over the past several years and we are now engaged in working with our stakeholders to consider how security should be considered over the next several years.

The initial focus, as demonstrated by the vulnerability assessments, was to identify what risks made utilities vulnerable. Although we always need to consider new types of threats, this job is largely done. However, the more difficult work begins after you have identified threats – because now utilities have to determine what actions they will take to reduce risks.

As utilities consider what actions to take, they are doing it within a voluntary, or "inspired" mode, rather than a regulatory "required" mode. To make the argument that changes to laws and/or regulations are not needed, utilities will need to be able to demonstrate how their actions are ensuring the security of their facilities.

As we move forward, we need to work as a community – to ensure that all utilities are engaged in efforts to ensure security and to ensure that we are all resilient enough to resist any hazard that may face us – whether a terrorist attack or major weather event.

At EPA, we have a number of activities on which we will be placing a specific focus over the next year that support these broad themes.

We are working with utility organizations to **promote mutual aid agreements** among drinking water utilities. These agreements will expedite the rapid deployment of emergency support, including equipment and personnel, to restore critical operations as quickly as possible.

On a related note, we are continuing to develop tools and training for **emergency response planning**. This year, we focused our training on the Incident Command System to promote the integration of water utilities into the response structure.

We are implementing our **WaterSentinel program**, the goal of which is to design, deploy, and test contamination warning systems at pilot utilities. EPA has identified a series of potentially useful documents from this project, such as consequence management guidance, which we intend to disseminate to the water sector on an aggressive schedule – that is, we will not wait for the project's conclusion.

Finally, we are continuing efforts to define and disseminate best security practices that are reflective of **active and effective security programs**. As you may know, last year the National Drinking Water Advisory Council recommended 14 features which constitute an effective security program.

We are presently assessing whether available tools and training address each of these features. To help meet requirements of the National Infrastructure Protection Plan, we are also working with utilities and other key stakeholders to develop aggregate measures so that we can begin to gauge the sector's progress in improving security.

5. U.S. EPA'S INTERNATIONAL WATER PROJECTS

Now turning to international water efforts, the U.S. Government and the USEPA have been very active in its support of the UN Millennium Development Goals target to halve the proportion of people world-wide without access to clean water and adequate sanitation by 2015.

By way of example, in 2005, the U.S. Congress passed the Paul Simon Water for the Poor Act. This legislation established for the first time the approach that "access to clean water" was a U.S. foreign policy goal.

The EPA Office of Water has been working with several countries, including Uganda, Australia, New Zealand, and Jamaica, among others to develop and implement Water Safety Plans, with the objective to provide a holistic risk managed approach to water management.

Currently, we are evaluating an Organization for Economic Cooperation and Development (OECD) Water initiative intended to provide water financing options to countries and regions that lack the financial resources to construct a water management infrastructure.

Recently, the Office of Water has engaged with China on a variety of issues intended to support the millennium development of goals by assisting China in their water needs, especially in rural areas.

I also wanted to bring to your attention an international EPA Conference on sustainable water infrastructure called: "Paying for Sustainable Water Infrastructure; Innovations for the 21st Century."

CONCLUSION

In conclusion, my advice is to "Think globally and drink locally." This isn't a call to patronize your local drinking establishments but to focus on protecting source waters and restoring watersheds, including wetlands. It's also a reminder of the value of infrastructure that delivers clean drinking water to the drinking taps of millions of Americans.

Thank you, AWRA, and thank you all for your leadership on water resources, locally and globally.

▲ AWRA's 2006 Annual Conference Student Presenter Competition

Congratulations to the two winners of AWRA's 2006 Annual Conference Student Presenter Competition which was held during the conference in Baltimore, Maryland, November 6-9. Twenty-six students participated and were scheduled throughout the 68 sessions and the poster session. Conference attendees were given the opportunity to judge the students during their scheduled session. The following criteria was used for both oral and poster competitors:

- Efficient use of allotted presentation time or poster space.
- Quality of responses to audience questions in oral or at poster sessions.
- Effective integration of audio-visual materials.
- Perceived preparedness.
- Logic and understandability of material (problem, methods, results, conclusions).
- Adequate description of context for material – conveyed purpose of paper, identified relevant literatures, etc.
- Overall style and presence; effective communicator – enthusiasm or persuasiveness.
- Suitability for AWRA/professional audience.
- Significance and originality of the material presented.

Everyone did a terrific job and made the decision difficult. However Adam Freihoefer and Eden Feirstein were selected as the outstanding winners (see below).

Again, our congratulations on a job well done to all those students who were in the competition and we wish them all the best in their future endeavors. We look forward to hearing more from everyone at future AWRA conferences!

Oral Presentations – ADAM FREIHOEFER, Session 25, Water Quality Modeling and TMDLs III, Improving SWAT Model Calibration for Phosphorus Export With Field-Scale Monitoring (co-author: Paul M. McGinley)

Adam is a graduate assistant currently pursuing a Master's degree in the College of Natural Resources at the University of Wisconsin-Stevens Point (UWSP). Prior to graduate school, Adam received a B.S. in hydrogeology from UWSP in 2002 and then worked for an international environmental engineering consulting firm. As a consultant, Adam completed hydrogeologic investigations and integrated GIS into databases for federal clients throughout the Midwest U.S. and the Pacific Rim. He is an active member in the UWSP student chapter of AWRA. In his Masters thesis research, Adam improves approaches to calibrate watershed-scale process models for simulating hydrology, sediment, and nutrient transport with field-scale monitoring data. Adam is coupling a calibrated watershed model to reservoir water quality response as part of TMDL projects in Wisconsin. His research interests include the use of spatial analysis tools, web-based GIS design, and computer modeling of contaminants. When he completes his M.S, Adam hopes to continue working to model nutrient and contaminant transport using spatial models.

Poster Presentations – EDEN FEIRSTEIN, Poster Session, Groundwater Flow Dynamics in the Colorado River Delta; An Investigation to Support Riparian Habitat Restoration in Northern Mexico (co-authors: K.J. Baird, T. Maddock III)

Eden is a MS Student in the Department of Hydrology and Water Resources at the University of Arizona (UA). Her research focus is the development of a ground water model to describe the subsurface flow dynamics in the Colorado River Delta in Mexico. Through her thesis work she is supporting the environmental efforts of several nonprofit organizations by concentrating on stream-aquifer interactions and the corresponding relationship to sustainable riparian restoration based on vegetation groundwater requirements.

Eden received her BS in Geology and Geophysics from the University of Hawaii (UH). As an undergraduate she worked for three years as a research assistant in the Coastal Geology Group where she wrote extensively about the coastal geology of the Hawaiian Islands and conducted field work including coastal surveying and coral reef drill coring. She also worked as a Hydrologic Technician for the Water Resources Division of the USGS in Honolulu and as an Image Analyst at the Hawaii Institute of Geophysics and Planetology.

In pursuit of her interests in environmental sustainability and social development Eden has been a leader in the UH ECO-club and the UA Student Chapter of Water for People, working to develop a comprehensive recycling program at UH and to coordinate infrastructure improvements in rural Mexico.

▲ Recipients of AWRA's Annual Awards for 2006

The following awards were presented at AWRA's Annual Water Resources Conference in Baltimore, Maryland.

William R. Boggess Award

"Using Geology to Improve Flood Hazard Management on Alluvial Fans – An Example From Laughlin, Nevada"

Journal of the American Water Resources Association (JAWRA) ~ Vol. 41 ~ No. 6 ~ Pgs. 1431-1447

P. KYLE HOUSE
Nevada Bureau of Mines and Geology
Univesity of Nevada ~ Reno, Nevada

Dr. Kyle House is a Research Geologist at the Nevada Bureau of Mines and Geology, University of Nevada, Reno. He specializes in interpretation and mapping of Late Cenozoic alluvial and lacustrine deposits with emphasis on the geological evolution of fluvial systems and the paleohydrology of large floods. Dr. House has BS and BA degrees from Western Washington University in Geology and Geography, respectively, and MS and PhD degrees in Geosciences from the University of Arizona. Kyle has 17 years of experience mapping and analyzing late Cenozoic sedimentary deposits in the Southwest and, during this time, has been a persistent advocate of incorporating geological information into flood hazard assessment and flood frequency analysis.

Icko Iben Award

ROBERT C. WARD
Colorado State University (retired)
Fort Collins, Colorado

At the beginning of 2006, Robert Ward retired from Colorado State University (CSU) after a 35-year career on the CSU Engineering faculty, teaching courses in systems analysis methods, water quality monitoring and management, and engineering design. His research focus was, and continues to be, on improving the design of water quality monitoring systems to enhance their ability to produce consistent and comparable data and information in support of water quality management decision making. He has authored two books on water quality monitoring design and, in 2005, completed an eight-year term on the National Water Quality Monitoring Council. During a sabbatical in New Zealand in 1983-1984, he assisted New Zealand scientists in organizing the design of a New Zealand national water quality monitoring program that continues to this day to produce consistent water quality data and information on New Zealand streams. Since 1994, he served on the Scientific Organizing Committee for four European Monitoring Tailor-made Conferences held in The Netherlands.

In 2005, he completed 14 years as Director of the Colorado Water Resources Research Institute, located on the Colorado State University campus. In his research administration role, he served terms as President of the National Institutes for Water Resources and the Universities Council on Water Resources (UCOWR) as well as serving a term as a member of the AWRA Board of Directors in the 1990s. He received the Warren Hall Medal at the 2006 annual UCOWR meeting in Santa Fe, New Mexico, recognizing his work in research administration, both in Colorado and nationally. In January 2006, Robert also was awarded Honorary Life Membership in the Colorado Water Congress, recognizing his work in connecting university-based water research to the solution of practical day-to-day water management problems.

Besides consulting and professional society activities, retirement for Robert includes hiking, biking, reading, gardening, raising funds for the CSU Water Archives, and serving as a Commissioner for the Poudre Heritage Alliance, a group that seeks to inform the general public about the development of western water law and technology, using the Poudre River as a classic example.

Robert obtained his undergraduate engineering degree from Mississippi State University and graduate degrees from North Carolina State University.

A. Ivan Johnson Outstanding Young Professional Award

RAFAEL E. FRIAS III
Black & Veatch ~ Tampa, Florida

Since joining Black & Veatch in 1998, Rafael "Rafa" Frias has been involved in many civil and environmental engineering projects. A project engineer based in Tampa, Florida, Frias has worked in water supply study and design projects and has performed hydrologic and hydraulic computer modeling projects for stormwater master plans, surface water quality and ground water modeling for environmental projects. He has most recently worked with the City of Ocala, Florida, the Everglades Agricultural Area (EAA) Reservoir A-1, the Tampa Bay Seawater Desalination Facility Modifications, and the City of Lakeland, Florida. Before moving to B&V's Tampa office, Frias

dealt with several projects in the Midwest U.S., particularly in the Kansas City area. A member of the American Water Resources Association, American Society of Civil Engineers, and Water Environment Federation, Frias, who has experience in international assignments for water supply, water distribution, and drainage systems design projects, earned a bachelor's degree in 1997 from Louisiana State University and a master's degree in 2002 from the University of Kansas. He is a licensed professional engineer in the states of Florida and Kansas.

(Editor's Note: This Award was established in 2006 by the American Water Resources Association and was named in honor of ***A. Ivan Johnson*** *who throughout his life has contributed untiring support and help for young water resources professionals in the United States and world wide.)*

William C. Ackerman Medal for Excellence in Water Management

ROBERT M. HIRSCH

U.S. Geological Survey ~ Reston, Virginia

Robert M. Hirsch is Associate Director for Water, of the U.S. Geological Survey (USGS). He has served in this capacity since 1994 and is responsible for all USGS water science which encompasses research and monitoring of the nation's ground water and surface water resources including issues of water quantity as well as quality. He began his USGS career in 1976 as a hydrologist and has conducted research on water supply, drought, water quality, pollutant transport, and flood risk. He has been a member of the federal Senior Executive Service since 1989.

Bob received the PhD. in Geography and Environmental Engineering from Johns Hopkins University in 1976 and holds a B.A. in geology from Earlham College. He is co-author of the textbook "Statistical Methods in Water Resources" and has published over 25 papers or book chapters and 14 official publications of the USGS. A long time member and supporter of AWRA, he is a Fellow of the American Association for the advancement of Science and a member of the American Geophysical Union. He is a member of the Editorial Advisory Board of the Journal Environmental Science and Technology. He chairs the Advisory Committee on Water Information, a Federal and non-Federal committee, and is co-chair of the Subcommittee on Water Availability and Quality. This Subcommittee reports to the Committee on Environment and Natural Resources, under the National Science and Technology Council, which coordinates water-related research and development across the Federal Government. He frequently provides Congressional testimony on national water issues related to surface water, ground water, floods, droughts, and water quality. Bob received the Department of the Interior's Superior Service Award in 1985, Meritorious Service Award in 1988, and Distinguished Service Award in 1994, and has twice been honored as a Presidential Rank Award Member of the Senior Executive Service, in 1994 and 2004.

During his career, Bob developed and published a suite of methods for analysis of long term trends in water quality and atmospheric deposition, and related methods for estimating the transport of dissolved and suspended constituents in rivers. These techniques are now widely used to evaluate water resource issues and policies. He also developed and published a variety of methods for the analysis of water supply drought risk, using historical streamflow data, operational water resource models, and principles of statistics. He served as a member of the design group for the USGS National Water Quality Assessment Program and was the principal author of the design document, and was principal spokesman for the program in its formative years. He developed the conceptual design for the USGS National Streamflow Information Program, used by the USGS to provide a stable, reliable and modern multi purpose streamgaging network. Bob set the goals for the USGS NWISWeb system that serves the needs for hydrologic data of emergency managers, water and wastewater system operators, recreational water users, and water resources planners, engineers and scientists.

Honorary Member

LOÏC FAUCHON

Marseille Water Supply Company – Marseille, France

Loïc Fauchon, who has held positions in both the public and private sectors, assumed the position as President of the Groupe des Eaux de Marseille, on July 1, 1997.

Groupe des Eaux de Marseille (GEM), the fourth largest French group in the water sector, is a private corporation of 19 companies with a total of 2,540 employees and a consolidated turnover of 415 million euros (2005), specialized in water supply, sanitation, solid waste management, street lighting, and urban service management software.

For over 35 years, the Groupe has developed international activities, particularly in Latin America and in the Mediterranean Region with a subsidiary company of the Groupe locally incorporated in Morocco, with contracts in Fès, Marrakech, Casablanca, and with another subsidiary company incorporated in Tunisia. In Algeria, GEM is involved in the rehabilitation of Algiers water supply and is starting a management contract in Constantine.

From 1991 to 1997, Mr. Fauchon, was Director General of Société des Eaux de Marseille (SEM), the main company of the Groupe des Eaux de Marseille, which has been managing for over 50 years the treatment and supply of drinking water to two million inhabitants in Marseilles and 70 districts in Provence, with about 845 employees and an annual turnover of 290 million euros (2004).

A graduate of the Political Science Institute and Economic School of Aix-en-Provence University, Loïc Fauchon had a long career in the public sector before joining SEM in 1991. From 1972 to 1974, he was Secretary of "Tourism and Leisure" for the Provence-Alpes-Côte d'Azur regional authority; from 1974 to 1979, Secretary General for the Verdon Development; from 1979 to 1980, Advisor to the President of the Region Council; from 1980 to 1983, Director of the Bouches du Rhône Council and from 1983 to 1991, Deputy Director of the Office of the Mayor of Marseilles and later Secretary General for International Relations of the City of Marseilles.

Mr. Fauchon has been Vice-President of the Mediterranean Water Institute, with headquarters in Marseilles. From October 2000 to January 2005, he has been Governor and Special Advisor to the President of the World Water Council (WWC) with headquarters in Marseilles, then Vice-President of WWC from October 2003 to December 2004. He organized and participated in international forum in Marrakech in 1997, in The Hague in 2000, in Kyoto in 2003, and in Mexico City in 2006. Mr. Fauchon assumed the position of WWC President on January 7, 2005, and has been recently re-elected in March 2006 at this position for a new mandate.

From 1983 to 1997, Mr. Fauchon was elected city council member and later mayor of Trets, a city of 9,000 inhabitants in Provence.

In 2003, Mr. Fauchon was decorated with the Chevalier of Legion of Honour. Since 1977, Loïc Fauchon is the President of "TransSahara – Caravanes sans frontières," an ONG of 80 volunteers that he established for humanitarian missions in Sub-Sahara Africa, particularly in the Adrar district and in Mali and which also intervened in Bosnia, Armenia, and Albania after cataclysms or civil wars.

Fellow Member

JANET L. BOWERS
Chester County Water Resources Authority
West Chester, Pennsylvania

Janet (Jan) Bowers is the Executive Director of the Chester County (Pennsylvania) Water Resources Authority. She oversees management and operation of the Authority's four regional flood control facilities and water supply reservoir. She also directs the County's long term partnership of cooperative programs with the U.S. Geological Survey, including County-wide flow management and water quality monitoring networks. She directs projects in wetlands mitigation, water quality restoration, and watershed management, as well as stormwater management studies and engineering reviews for the County.

Ms. Bowers led the development of "Watersheds – An Integrated Water Resources Management Plan for Chester County and Its Watersheds" that was adopted by Chester County Commissioners in 2002 as the water resources component of the County's comprehensive plan. The "Watersheds" plan is now being used to help integrate local land use and water management decisions. As part of the "Watersheds" implementation projects, she led the development of a county-wide stormwater management model ordinance that is being used by several of the 73 municipalities within Chester County.

Ms. Bowers is a member of the Pennsylvania Statewide Water Resources Committee, which is working to develop a new water resources management plan for Pennsylvania. She currently serves on the Delaware River Basin Commission's Water Management Advisory Committee. She previously served on the Watershed Advisory Council to assist DRBC in developing the "Water Resources Plan for the Delaware River Basin". She also serves as co-coordinator of the interstate/interagency Christina Basin Clean Water Partnership. This Partnership has been working for over a decade to install BMPs, develop TMDLs, and implement numerous interstate strategies to improve water quality and water management in the Brandywine, Red Clay, White Clay, and Christina River watersheds in Pennsylvania, Maryland, and Delaware.

Ms. Bowers served as National President of the American Water Resources Association in 2000, and on the Board of Directors as AWRA Treasurer for two terms. She previously served as President of the National Capitol Section AWRA, co-founder of the Maryland Section AWRA, and Vice President of the Pennsylvania Section AWRA. She served as Chairman for the 2002 AWRA Annual Conference and as a member of the 2006 AWRA Annual Conference Planning Committee.

Prior to joining the Authority, she worked in environmental consulting conducting flood mitigation, contaminated site remediation, water resources engineering, and watershed planning projects throughout the U.S. Ms. Bowers received her M.S. degree in Geology/Hydrogeology from West Virginia University and is a registered professional geologist in three states. In her "home watershed," she volunteers as the environmental activities coordinator for East Fallowfield Township, is a member of the Township's Park and Recreation Commission, and represents the Township on the Buck and Doe Run Watershed Partnership.

Richard A. Herbert Memorial Scholarships

Graduate Student Winner
JOSHUA ALLEN JOSEPH, JR.
Virginia Polytechnic Institute and State University
Blacksburg, Virginia

Joshua Allen Joseph, Jr., completed his undergraduate studies at Southern University and A& M College in Baton Rouge, Louisiana, where he majored in Civil Engineering. He began his graduate studies at the Massachusetts Institute of Technology where he received a MS in Civil and

Environmental Engineering studying Groundwater Hydrology and Contaminant Transportation Theory. Joshua then attended the John F. Kennedy School of Government at Harvard University where his policy analysis research addressed Models of Cooperative Research and Development for Environmental Technologies. He received a Masters of Public Policy in 1996. Additionally in 2000, Joshua was awarded a Post-Masters Advanced Certification in Environmental Engineering and Science from Johns Hopkins University.

At the Virginia Polytechnic Institute and State University where Joshua is currently pursuing a doctoral degree in Civil and Environmental Engineering, his research is interdisciplinary and related to monitored natural attenuation and natural resources economics. Chief among his many extracurricular activities is his involvement in the Virginia Tech Chapter of AWRA. Since 2005, he has served as an officer of the chapter and is the current president.

In his own words, "I aspire to conduct groundbreaking research, educating students inside and outside the classroom, and having that research and education expand to communities across our nation and throughout the world. Whether as an engineering faculty major or national laboratory researcher, I am interested in interdisciplinary applications that permeate beyond traditional science, policy, and engineering."

Undergraduate Student Winner
ANN MARIE LARQUIER
Southern Oregon University
Ashland, Oregon

Ann Marie Larquier is an honors student at Southern Oregon University pursuing her undergraduate degree, majoring in Environ-mental Studies Geology. Her minor is in Land Use Planning. Ann followed her interests in geology and water resources to the University of Alaska-Fairbanks last fall, and spent this past summer in Russia with a team of exchange students at the Tahoe-Baikal Institute, which is committed to enhancing sustainable economic development, cultural understanding, and the protection of unique watersheds throughout the world.

Ann's extracurricular activities highlight her desire to restore natural lands with community interests in mind. She has been involved in the Lake Tahoe Environmental Education Coalition where she helped with water quality assessment efforts. Influenced early on by her experience in the High Sierra Resources Workshop and the National Youth Watershed Summit, Ann has been passionate about conserving and protecting water resources since early in her high school career.

In her own words, "Growing up in the high desert of Nevada, water scarcity issues were a part of every day conversation, and living in a subsistence agriculture/ranching community fueled my desire to be a part of things. I hope to pursue a career which integrates natural resources management with ecology and real world environmental issues. I am especially interested in hydrogeology as well as watershed protection and restoration."

Outstanding Student Chapter Award
UNIVERSITY OF WASHINGTON STUDENT CHAPTER

Outstanding State Section Award
NEW JERSEY STATE SECTION

President's Award For Outstanding Service
JOHN J. WARWICK & LAUREL HELSEL
Reno, Nevada

Aquarius Club Member
MICHAEL E. CAMPANA
Corvallis, Oregon

WATER POLICY ANNOUNCEMENT
Guatemala will be the venue for the SIXTH WATER DIALOGUE

Organized by the Government of Guatemala and the Inter-American Water Resources Network (IWRN), the Sixth Dialogue will take place in Guatemala City, on August 12-17, 2007.

The Sixth Inter-American Dialogue on Water Management is the most prominent regional event that gathers a wide array of stakeholders and practitioners in the theme of water management in the Americas. Organized by the Inter-American Water Resources Network and the Government of Guatemala, with the collaboration of many international agencies, civil society organizations, academic institutions, and the private sector, the Sixth Dialogue will take on the need to evolve "From Dialogue to action – Strengthening partnerships and building the basis for meeting the Millennium Development Goals." The Dialogue is built around the foundation of wide participation to come up with a set of recommendations that will be sent to the decision-makers and opinion drivers in water issues in the region – regardless of the sector in which they act. Building such a partnership means more than just agreeing in how to split chores to work together for an objective, like water and sustainable development. It also means making a call to everyone to be part of the crusade to manage responsibly the most precious resources that our countries have: water and their people.

For additional information, please visit the webpage http://www.iwrn.net.

Solution to Puzzle on pg. 22

▲ Water Resources Continuing Education Opportunities

FEBRUARY 2007

6-8/Understandig Agriculture's Effects on Amphibians and Reptiles in a Changing World Workshop. St. Louis, MO. **Contact** http://www.umesc.usgs.gov/ag_effects_workshop/workshop.html

20-21/USEPA SWMM and PCSWMM 2006 Stormwater Modeling Workshops. Toronto, Ontario, Canada. **Contact** Bill James (info@computationalhydraulics.com; 519-767-0197; fax: 519-489-0695; www.computationalhydraulics.com)

22-23/International Conference on Stormwater and Urban Water Systems Modeling. Toronto, Ontario. Canada. **Contact** Same as above. **Deadline for Abstracts – January 30, 2007**

MARCH 2007

1-2/Annual Meeting of the Wisconsin Section of AWRA – The Future of Wisconsin's Water Resources: Science and Policy. Wisconsin Dells, WI. **Contact** Sue Swanson, Chapter President (608-363-2132; e: swansons@beloit.edu; w: http://www.awra.org/state/wisconsin/)

▲ AWRA Future Meetings

2007 MEETINGS

JUNE 25-27, 2007

AWRA'S SUMMER SPECIALTY CONFERENCE ~ VAIL, COLORADO ~ VAIL CASCADE RESORT

"EMERGING CONTAMINANTS IN WATER RESOURCES"

NOVEMBER 12-15, 2007

AWRA'S ANNUAL WATER RESOURCES CONFERENCE

EMBASSY SUITES HOTEL ALBUQUERQUE ~ ALBUQUERQUE, NEW MEXICO

ADDITIONAL INFO – www.awra.org

AMERICAN WATER RESOURCES ASSOCIATION MEMBERSHIP APPLICATION – 2007

MAIL THIS FORM TO . . . AWRA • 4 West Federal St. • P.O. Box 1626 • Middleburg, VA 20118-1626
FOR FASTEST SERVICE . . . FAX this form (credit card or P.O. orders only) to (540) 687-8395
QUESTIONS? . . . CALL AWRA HQ at (540) 687-8390 or E-MAIL at info@awra.org

➤ Complete All Sections (please print)

LAST NAME _____ FIRST _____ MIDDLE INITIAL _____

TITLE _____

COMPANY NAME _____

MAILING ADDRESS _____

CITY _____ STATE _____ ZIP+4 _____ COUNTRY _____

IS THIS YOUR ❑ HOME OR ❑ BUSINESS ADDRESS?

PHONE NUMBER _____ FAX NUMBER _____

E-MAIL ADDRESS _____

RECOMMENDED BY (NAME) _____ AWRA MEMBERSHIP # _____

➤ Student Members Must Be Full-Time And The Application Must Be Endorsed By A Faculty Member.

PRINT NAME _____ SIGNATURE _____

ANTICIPATED GRADUATION DATE (MONTH/YEAR): _____

➤ Key For Membership Categories:

JAWRA – Journal of the AWRA (bi-monthly journal)
IMPACT – IMPACT (bi-monthly magazine)
PROC. – 1 copy of AWRA's annual symposium proceedings

ENCLOSED IS PAYMENT FOR MEMBERSHIP (PLEASE CHECK ONE)
❑ FULL YEAR ❑ HALF YEAR

- ❑ Regular Member (JAWRA & IMPACT).....$150.00
- ❑ Student Member (IMPACT) FULL YEAR ONLY $30.00
- ❑ Institutional Member (JAWRA, IMPACT, & PROC.) $325.00
- ❑ Corporate Member (JAWRA, IMPACT, & PROC.) $425.00
- ❑ AWRA Membership Certificate.....$11.00

➤ Foreign Airmail Options: Contact AWRA for pricing.

➤ Please Note

* Membership is based on a calendar-year; after July 1st regular, institutional, or corporate members may elect a 6-month membership for one-half of the annual dues.
* Students do not qualify for half-year membership.
* Remittance must be made in U.S. dollars drawn on a U.S. bank.

➤ Payment Must Accompany Application

PAYMENT MUST BE MADE BY CHECK OR ONE OF THE FOLLOWING CREDIT CARDS:
❑ VISA ❑ MASTERCARD ❑ DINERS CLUB ❑ AMEX ❑ DISCOVER

CARDHOLDER'S NAME _____

CARD NUMBER _____ EXPIRATION DATE _____

SIGNATURE (REQUIRED) _____

➤ Your Primary Reason For Joining? (check one)

- ❑ To Receive Information Through JAWRA and IMPACT
- ❑ Networking Opportunities
- ❑ Technical Committee Interactions
- ❑ Conference Discount
- ❑ Employment Opportunities
- ❑ Other: _____

➤ How Did You Learn Of AWRA? (check one)

- ❑ Promotional Mailing
- ❑ Internet Search
- ❑ Journal (JAWRA)
- ❑ IMPACT
- ❑ Boss/Friend/Colleague
- ❑ Email Received
- ❑ Other: _____

AWRA
Community, Conversation, Connections

DEMOGRAPHIC CODES

(PLEASE LIMIT YOUR CHOICE TO ONE IN EACH CATEGORY)

JOB TITLE CODES

JT1	Management (Pres., VP, Div. Head, Section Head, Manager, Chief Engineer)
JT2	Engineering (non-mgmt.; i.e., civil, mechanical, planning, systems designer)
JT3	Scientific (non-mgmt.; i.e., chemist, biologist, hydrologist, analyst, geologist, hydrogeologist)
JT4	Marketing/Sales (non-mgmt.)
JT5	Faculty
JT6	Student
JT7	Attorney
JT8	Retired
JT9	Computer Scientist (GIS, modeling, data mgmt., etc.)
JT10	Elected/Appointed Official
JT11	Volunteer/Interested Citizen
JT12	Non-Profit
JT13	Other

EMPLOYER CODES

CF	Consulting Firm
EI	Educational Institution (faculty/staff)
ES	Educational Institution (student)
LR	Local/Regional Gov't. Agency
SI	State/Interstate Gov't. Agency
IN	Industry
LF	Law Firm
FG	Federal Government
RE	Retired
NP	Non-Profit Organization
TG	Tribal Government
OT	Other _____

EDUCATION CODES

HS	High School
AA	Associates
BA	Bachelor of Arts
BS	Bachelor of Science
MA	Master of Arts
MS	Master of Science
JD	Juris Doctor
PhD	Doctorate
OT	Other _____

WATER RESOURCES DISCIPLINE CODES

AG	Agronomy	GI	Geographic Information Systems
BI	Biology	HY	Hydrology
CH	Chemistry	LA	Law
EY	Ecology	LM	Limnology
EC	Economics	OE	Oceanography
ED	Education	PS	Political Science
EG	Engineering	OT	Other
FO	Forestry		
GR	Geography		
GE	Geology		

_____

PLEASE NOTE YOUR SELECTED CODE NUMBERS FROM ABOVE

JOB TITLE CODE .....
EMPLOYER CODE .....
WATER RESOURCES DISCIPLINE CODE.....
EDUCATION CODE .....

AWRA 2007 Board of Directors

AWRA
Community, Conversation, Connections
American Water Resources Association

Mission To advance multidisciplinary water resources education, management, and research.

Objectives • The advancement of water resources research, planning, development, management, and education; • The establishment of a common meeting ground for physical, biological, and social scientists, engineers, and other persons concerned with water resources; and • The collection, organization, and dissemination of ideas and information in the field of water resources science and technology.

Promise AWRA promises a balanced, professional approach to solving water resources challenges in a friendly and comfortable atmosphere.

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The Mission, Objectives, and Promise give direction, meaning, and purpose to the American Water Resources Association. Our Board of Directors is here to serve you and our community.

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Community, Conversation, Connections

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American Water Resources Association
4 West Federal St., P.O. Box 1626
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Telephone: (540) 687-8390

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