

WATER RESOURCES IMPACT

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Development of the
Watershed Toolkit

WATER RESOURCES IMPACT

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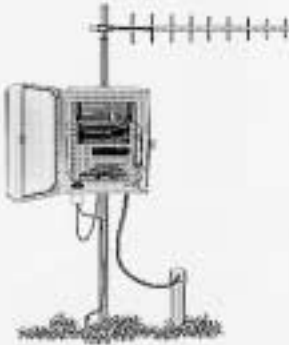
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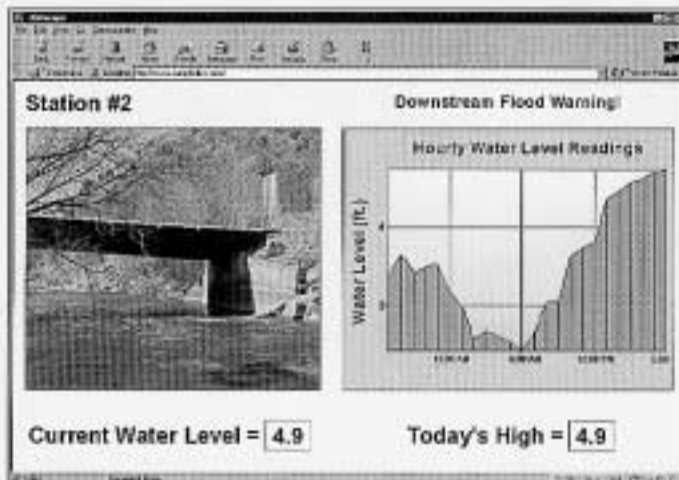
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DIRECTIONS IN THE DEVELOPMENT OF THE WATERSHED TOOLKIT

Jefferson G. Edgens, Associate Editor
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Science is at the heart of sound public policy and, thus, part of the watershed toolkit. Lack of sound science has created water quality problems rather than solving them. Some of the authors - MTBE and the application of sewage sludge are two cases in point. News stories and feature articles in this issue cite examples of why it is important to follow scientific principles before embarking on aggressive and costly water quality regulations.

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NEW DIRECTIONS IN THE DEVELOPMENT OF THE WATERSHED TOOLKIT: BETTER SCIENCE MAKES BETTER POLICY

Jefferson G. Edgens

Never has putting together an issue of IMPACT been so fraught with problems yet so diverse in article topics. John Herring and I were slated to put this issue together almost a year ago. But as with the best of plans things develop that throws everything into a cocked hat, and this issue of IMPACT is no exception.

The title of November's issue, "Directions in the Development of the Watershed Toolkit," is a mystery. At the time of our Board meeting we conjured topics and this one came about. But John and I wracked our brains, as did too the Editor-in-Chief, to clarify what "Directions in the Development of the Watershed Toolkit" meant. No one knew.

Moreover as time went by and John pursued his Fulbright Scholarship, we declared the title dead and pursued our own authors. Time sped by and John quickly turned over the entire issue to *moi*. With a full plate and a limited window to find writers, I made a command decision to assemble the magazine around a host of hot topics, with a common theme - *Better Science Makes Better Policy*. I have also taken the Editor's prerogative and developed two new sections (at least for this issue anyway): News Items and Point/Counterpoint.

No one should consider the News Section as standard for all upcoming IMPACT magazines as it's an experiment on my part and we'll see what feedback it generates. Speaking of feedback, Clay Landry's article in the May issue generated a response and we felt it good manners to provide the ink for the Bacchus and Samson riposte to Mr. Landry's May article or . . . *Point*. Of course, Mr. Landry gets equal time in his *Counterpoint*. Again please let the IMPACT Editorial Board know if this is something we should keep, revise, or simply throw out.

For November, authors write on hot topics appearing in newspapers and television programs across the country (MTBE, Blue Baby Syndrome, TMDL Developments, the Corps of Engineer Reforms and Sludge Application). Tom Randall, an environmental consultant, adapts his *Chicago Tribune* investigative report on sewage sludge, for our IMPACT readers. He also gives us the current state of controversy with MTBE and ground water pollution. Gretchen Randall provides us with a critique of the Corps of Engineers' reforms. In an excellent recap of the TMDL rules, Bonner Cohen notes that in EPA's haste to do something, the agency created additional opportunities to litigate over water quality. I'd add that additional litigation only detracts from the business of cleaning our nation's waters. Finally, Alex Avery closes this section with his review of the science behind blue baby syndrome (a version of this article appeared in *Environmental Health Perspectives*).

In the Features Section, two articles by Witter *et al.*, and Richard Halpern close the November issue of IMPACT. Scott Witter *et al.*, showcase a cutting edge idea for watershed management on the Michigan State campus, and Richard Halpern takes the profession to task with a critique of water quality modeling.

His ideas take me back to my time at Michigan State University and Dr. Paul Nickel's class on Environmental Inquiry. Dr. Nickel, borrowing from Karl Popper among others, always encouraged his students to apply critical reasoning tests and science process to our assignments. He always said, "models are representations of reality - not reality; model builders cheat and all models crash." The last two pithy comments refer to the tendency for modelers to tweak their programs until the thing fits their desired outcome (cheating) but rarely do models comport with reality (models crash). I should also add, he always insisted we never take ourselves too seriously. A good bit of advice when we go about water quality modeling.

"Directions in the Development of the Watershed Toolkit," for what its worth, has a common theme - *Better Science Makes Better Policy*. Without an understanding of where we've failed, we're most sure to repeat our mistakes.

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MTBE: THE WATER-POLLUTING GENIE EPA KNOWINGLY LET OUT OF THE BOTTLE

Tom Randall

Carol Browner, U.S. Environmental Protection Agency Administrator, complimented the Senate Environment and Public Works Committee during the closing days of the final session of Congress for considering a bill to phase-out the water-polluting gasoline oxygenate methyl tertiary-butyl ether (MTBE). Her statements echoed her comments of May 20, months after EPA's "Blue Ribbon" panel found MTBE to be a serious threat to water quality: Threats posed by MTBE to water supplies in many areas of the country are a growing concern. Action by Congress is the fastest and best way to address this problem."

There are several disturbing aspects to Browner's new opposition to MTBE use, which has now polluted ground water in 31 states, as well as the solutions being entertained.

EPA KNEW ALL ALONG

Browner made the water-polluting properties sound like a new finding that was unearthed by her panel, which was hastily assembled after Democratic Governor Gray Davis ordered a phase-out of MTBE use in California. The fact is, the problem was known by the agency as early as 1987 - three years before it succeeded in lobbying Congress for an oxygenate mandate in the Clean Air Act (CAA) of 1990.

In 1988 EPA notified its regional offices and state agencies that MTBE was a growing threat to the nation's water supply in its Bulletin, "Cleanup of Releases From Petroleum USTs [underground storage tanks]," EPA/530/UST-88/001, dated April 1998.

In that 1998 warning, EPA said, "... only about 10 percent of U.S. gasoline contains MTBE." However, they said the chemical is already "among the top 50 chemicals produced in the United States. MTBE is extremely soluble in water . . . Because of its high solubility, MTBE is easily transported in groundwater away from the spill site."

It also noted, "The health effects of MTBE are generally poorly understood, especially at low levels. It has been classified as an irritant, a possible central nervous system depressant and, formerly, as having medicinal value." Today, ten years after the CAA oxygenate mandate, various studies have indicated such diverse effects as carcinogenic potential and possible testicular degeneration, but EPA has still not taken action to definitively determine the health effects of the chemical it touted to reduce auto emissions.

In spite of the compelling reasons for ending the use of MTBE, doing so without removing the oxygenate mandate entirely could cause even higher gasoline prices and greater nationwide shortages of supply than those seen in the Midwest this summer

BUT LET THE POLLUTION SPREAD

As mentioned at the outset, MTBE is now found in the ground water of 31 states, even though the oxygenate mandate applies to only a few densely-populated urban areas that EPA has ruled out of attainment for clean-air standards. Illinois and Michigan are good examples of this paradox, though others are plentiful.

In Illinois, oxygenates are required only in the Chicago metropolitan area and near St. Louis - and it has been largely assumed by the public and most elected officials that the oxygenate used is ethanol, made from corn, since Illinois lies in the heart of the corn belt.

However, MTBE has been found in the water supplies of 25 localities throughout the state, leading to the shut down of wells in several communities.

In Michigan, which has no areas where the use of oxygenates is required, the state's legislature found their MTBE pollution sufficiently widespread to pass a phase-out of MTBE by June of 2003, which Governor John Engler signed into law this summer.

The spread of MTBE pollution throughout the country was made inevitable by three realities of the petroleum industry which EPA was either unaware or chose to ignore.

The first is the fact that a refinery can make only one type of distillate at a time. Therefore, if it is making a blend stock, or basic gasoline type, for use with MTBE, it cannot make, at the same time, a blend stock distilled for use without MTBE. Changing from one blend stock to another is both time-consuming and costly in an industry that is currently running at 97 percent capacity.

Secondly, the only way to efficiently ship petroleum products over long distances is via pipeline. Pipelines ship various products, one behind the other, which creates some co-mingling and does not permit convenient drop off of one product here and another there between closely-drawn geographical areas.

Lastly, pure, unblended ethanol cannot be shipped through pipelines (according to industry experts), because it combines with water (always present in pipelines) and cannot be separated from it (MTBE is a product of the refining process).

Therefore, in the Illinois-Michigan example, in which a group of refineries near Chicago produce gasoline for that area (where oxygenates are mandated) and also produce gasoline for Michigan, it is inevitable that what goes into the Wolverine Pipeline to Michigan will often be gaso-

MTBE: The Water-Polluting Genie EPA Knowingly Let Out of the Bottle . . . cont'd.

line blended with MTBE. This example holds true for at least the 31 states where the chemical has been discovered in ground water.

SOLUTION TO A NON-PROBLEM CREATES MORE

The irony of MTBE polluting ground water is that neither it or any other oxygenate, including ethanol, produces any significant improvement in air quality, according to a study by the National Research Council.

"Motor vehicle emissions of chemicals that form ozone have decreased in recent years," said NRC committee chairman William Chiamides, Regents Professor of Earth and Atmospheric Sciences at the Georgia Institute of Technology (at the time of the report's release). "But that's largely because of better emissions control equipment and components of reformulated gasoline - other than oxygen additives - that improve air quality. Moreover, it is not possible to attribute any significant portion of past reductions in smog to the use of [oxygenates]."

It was this improvement in engines that led State Representative Larry Julian, author of Michigan's MTBE ban, to thank the auto industry and auto workers for making the elimination of MTBE possible.

In spite of the compelling reasons for ending the use of MTBE, doing so without removing the oxygenate mandate entirely could cause even higher gasoline prices and greater nationwide shortages of supply than those seen in the Midwest this summer. Without MTBE, ethanol would be the sole remaining major oxygenate. It currently cannot be produced in sufficient quantity for nationwide use. It cannot be transported through pipelines, as previously noted. And, it is more difficult to blend as demonstrated when EPA ordered new standards for ethanol blends in the Midwest last summer.

In view of the National Research Council's findings, it would seem prudent to phase out the use of oxygenates altogether, though this carries potential political problems for some politicians due to the pressure of the farm lobby. However, only Congress can change the federal mandate. As Julian said when the Michigan ban passed, perhaps the state's measures will prompt the Congress to act.

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ARMY CORPS OF ENGINEERS

Gretchen Randall

It hasn't been a good year for the Army Corps of Engineers. First, a study of how to improve the Mississippi River locks and dams system, while still preserving the ecology of the river, was hit with charges of tampering by top Army officials. Several other projects have been labeled as pork by the Taxpayers for Common Sense. Finally, an attempt by the Clinton/Gore administration to move control of the Corps to the Executive Branch failed.

Back in 1993 a \$54 million study was begun to study the navigation needs of the Upper Mississippi and Illinois waterways. Agriculture interests want larger and more modern locks on this area of the Mississippi to speed up barge traffic. Environmental groups claim these changes would threaten the fish and wildlife populations according to the Seattle Daily Journal of Commerce (DJC).

Now, early in 2000, according to the Environmentl News Service, Donald Sweeney, an economist heading up the team in charge of the study, claimed he was replaced because he disagreed with the Corps on the cost/benefit analysis of the project. The Federal Office of Special Counsel was asked to look into his allegations and found, "[there is] substantial likelihood that officials in the Corps have engaged in violations of law, rule or regula-

tion and a gross waste of funds" after reviewing a 44-page affidavit filed by Sweeney.

Army Secretary Louis Caldera has since asked the National Academy of Sciences to conduct a review of the navigation's study as well as the Corps' management practices. However, the Corps and many of the projects they oversee have wide support in Congress. Senator Kit Bond, R-Missouri, said at a hearing of the Senate Subcommittee on Transportation, "The prosperity of the rural economy depends on having safe, efficient and reliable transportation alternatives to help expand export markets. The aging locks in question are creating bottlenecks because they are beyond their original design capacity."

Additionally, DJC reports that supporters of the study claim that 400,000 industry related jobs are at stake, while the dams also prevent flooding and provide recreational facilities for communities. They also claim that moving the grain by barge lessens air pollution that would be created if the same amount of grain were moved by train or truck.

According to DJC, proponents claim a minimum of seven locks need to be lengthened because as many as 15 barges are linked together and moved as one unit, sometimes 1195 feet long. But [barges] can't make it through

A BRIEF HISTORY OF THE CORPS OF ENGINEERS (from the *Washington Post*) . . .

1775 - Gen. George Washington appointed a chief engineer to direct the construction of the fortification at Bunker Hill in the Revolutionary War.

1802 - President Thomas Jefferson established the Corps to run the engineering school at West Point. The Corps began to build forts and coastal fortifications.

1824 - Congress established a civilian works program for the Corps beginning with clearing the Ohio and Mississippi Rivers for navigation.

1865 - After the Civil War, the Corps began work on river navigation, levees, harbor improvements as well as building the Washington Monument and Library of Congress.

1914 - Corps built the Panama Canal.

1928 - Congress gave Corps control over the Mississippi after a disastrous flood in 1927. They also began building dams on the Columbia and Missouri Rivers.

1941 - Supervised the Manhattan Project which built the atom bomb. After WWII, Corps built the St. Lawrence Seaway, Cape Canaveral, and the system of canals which drained the Everglades.

1972 - When Congress passed the Clean Water Act it required developers to get permits to drain wetlands from the Corps.

2000 - Allegations arose that Corps tried to rig the outcome of a study of Mississippi River lock improvements. Clinton/Gore administration tried to take Executive Branch control of Corps but Congress objected and the attempt was scrapped.

Army Corps of Engineers . . . cont'd.

the older, shorter locks without stopping to unhook, thus sending smaller groups of barges through the locks while the others wait. Barge traffic often have waits up to 10 hours, creating costly delays and the chance for more injuries to deckhands. In the newer 1200 foot locks near Alton, Illinois, the linked barges travel through the lock in about 25 minutes.

Ron Fournier, a Corps spokesman in Rock Island, Illinois, said, "We do what's best for the country and that's not going to please everyone. We have not ignored the environment in any way." But environmental groups especially are unhappy with the proposal to expand the locks. Jeff Stein, with American Rivers, said, "Mother Nature has an incredible capacity to fix itself if we give it a chance. But we have to release some of the pressure being put on it. It's a system on the brink and instead we're proposing to do more to push it over."

In early October, the Corps requested a one year delay to redo its analyses because two North Dakota State University economists hired by the Corps to review the Mississippi River study concluded that the traffic forecasts used to do its analyses were not realistic as reported by the *Washington Post*. The economists cited numerous "flaws in the methodology" that are "tenuous at best." Sweeney declared, "This is definitely a validation. I hope this means the Corps is going to stop cooking the books. I guess we'll see."

Another report by Taxpayers for Common Sense (TCS) and the National Wildlife Federation claims the Corps wasted more than \$6 billion of taxpayer money on beach restorations, flood control structures, and other water projects. It names 25 projects it claims are wasteful and lists the congressional supporters of each. The report is called *Troubled Waters: Congress, the Corps of Engineers and Wasteful Water Projects* and is available at www.nwf.org. Ralph DeGennaro, executive director of TCS, said, "Taxpayers should be outraged by this flagrant misuse of their money." The groups claim the 37,000 employee agency is addicted to costly projects which often cannot be justified. Recommendations include:

- Require the Corps to concentrate on its core missions of navigation, flood damage reduction, and environmental restoration.
- Increase the local cost share for water projects.
- Require the Corps to eliminate the low-volume maintained inland waterways.

CORPS REFORM -SHORT LIVED

In May of 2000, Louis Caldera, Secretary of the Army (a Clinton appointee) sent a letter to the Army Corps of Engineers announcing "reforms to strengthen civilian oversight and control over the Army Corps of Engineers civil works program." The intent was to move control over the Corps from Congress to the Executive Branch but the attempt received intense disapproval in the Senate. (The Corps is an Executive Branch agency based in the Pentagon and run by military officers who report to civilians. It has enjoyed a close relationship with Congress because

members typically endorse expenditures the Corps has planned for their districts.) Less than a week after issuing the directive, Caldera withdrew it.

Courtney Cuff, a lobbyist for Friends of the Earth, said, "The senators feel like the Corps is their pot of pork to play with, and they don't want anyone in their way. This is their way of killing reform and keeping the gravy train running." The Army also weighed in on the proposal saying it was "unwarranted and unproductive." A spokesman for Sen. Pete Domenici, R-New Mexico, said, "[the senators] "want the Army Corps to stay the way it is. They want it to be accountable to Congress. They don't want to shift so much to the administration."

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EPA PROGRAM TO CLEAN WATER MOVES PATHOGENS TO LAND: AGENCY FORCED TO REEVALUATE RULE

Tom Randall

The U.S. Environmental Protection Agency has asked the National Institutes of Health to examine the potential health threats posed by the application of Class B biosolids, or "sludge" made from municipal sewage, on farm fields.

The request comes in response to the latest of two reports by the National Institute for Occupational Safety and Health (NIOSH) which identify Class B sludge as the source of pathogens which have caused severe, chronic illnesses in workers spreading sludge on fields. The report, NIOSH Publication No. 2000-158, dated August 2000, observed that the illnesses could be prevented by processing all sludge to the pathogen-free Class A level.

This report closely follows NIOSH's report of last year, HETA 98-0118-278, dated August 1999, which found Class B sludge to be the likely cause of a rash of illnesses among sludge handlers in LeSourdsville, Ohio. It said the workers contracted gastro-intestinal diseases through either ingestion or inhalation of pathogens contained in the material. Both reports recommend stringent safety precautions, never mentioned in the EPA sludge regulation, 40 CFR Part 503, for workers handling Class B sludge - including the wearing of "protective clothing, boots, goggles and face shields." They further say that such gear should be cleaned or discarded after use and workers immediately use on-site showers.

NIOSH did not discuss the health threat Class B sludge poses to the general public since such matters do not fall under its charter. It did observe that 40 CFR Part 503, often simply referred to as the "sludge rule," contains precautions for protecting the public but did not comment on the adequacy of those precautions or their enforcement. EPA Region 5 officials in Chicago, when contacted, said EPA has no enforcement policy for the application of Class B sludge and no enforcement personnel.

EPA microbiologist, David L. Lewis, Ph.D., who has been raising serious questions about EPA sludge policy since 1996 said, "The CDC (Centers for Disease Control and Prevention, of which NIOSH is a part) study shows what a serious oversight it was for EPA to approve Class B sludge without a comprehensive risk assessment for pathogens."

In addition to illnesses contracted by those working with Class B sludge in both Ohio and Pennsylvania, the material is also suspected by some experts to be responsible for the deaths of a young boy in Pennsylvania and a New Hampshire man several years ago.

A spokesperson for Northfield, Illinois-based Kraft Foods, Inc. said the company refuses to accept food products grown on it.

Kern County, California, supervisors were so concerned about sludge being trucked into their county, they voted to phase out the dumping of all but "exceptional-quality" sludge which is one grade above Class A. Neither "exceptional quality" nor Class A sludge have been linked to pathogen hazards. "It frightens me . . . what we don't know about biosolids and what scientists may learn tomorrow," Supervisor Pete Parra told *The Bakersfield Californian*.

CHICAGO AREA HIGHLIGHTS PROBLEM

The Chicago Metropolitan area is an example of the extensive threat posed by sludge nationwide. A recent investigation by the *Chicago Sun-Times* found over 20,000 tons of potentially disease-causing sludge made from human waste, including that from hospitals, is produced every year by the Metropolitan Water Reclamation District of Greater Chicago and spread over farm fields in several surrounding Illinois counties. The newspaper uncovered some 60 plus farm fields used for the disposal of sludge.

In contrast to the CDC report and other expert opinions, U.S. EPA, Chicago's Water Reclamation District, and Wheelabrator Technologies Inc., whose BioGro division is a prime sludge contractor for the district, strenuously denied the material poses a threat to human health and uniformly dismissed the CDC report as irrelevant to their operations.

Tom O'Connor, chief of maintenance and operations for the district, recognized as one of the largest and one of the best-run in the world, said he has confidence in the sludge rule but "would be open-minded" to any new data.

John Colletti, from U.S. EPA Region 5, in Chicago, said the CDC report just showed workers should use common sense when handling sludge and that it would not cause EPA to look at changing its regulations.

Wheelabrator public relations consultant, Bill Plunkett said, "The LeSourdsville study appears to be inconclusive and adds nothing to the body of knowledge about biosolids."

SLUDGE'S CONTROVERSIAL PAST

Class B sludge and the 503 Rule has been as controversial in the past as they are today. The rule was created in 1993 in lieu of ocean dumping of sludge from municipal waste treatment plants. But the rules author, EPA's Dr. Alan Rubin, testified before the New Hampshire legislature that, "[sludge] wasn't too toxic for the ocean (where much of it had been dumped previously). The reason we got it out of the ocean was basically an image-political deal."

The Chicago Metropolitan area is an example of the extensive threat posed by

EPA Program to Clean Water . . . cont'd.

Rubin was testifying, in part, to refute questions raised about the safety of Class B sludge and Lewis' concern about sludge's possible involvement in the death of a New Hampshire man, Shayne Connor.

Lewis is well known in the scientific community for his research into the ability of viral, bacterial, and fungal human pathogens to survive in the environment. His work led to extensive changes in the way dental instruments are sterilized. While his peer-reviewed work on sludge was published in a recent issue of British science journal *Nature*, he began raising concerns about the dangers of Class B sludge as early as 1996.

At the time of Rubin's testimony, Lewis was looking into the death of Connor, who was exposed to Class B sludge near his home in Greenland, New Hampshire, and became ill (along with other residents of the town) with flu-like symptoms.

"Medical records of Shayne Connor (who died in 1995) and Tony Behun (an 11-year old Pennsylvania boy who died within days of riding his motorcycle on a sludge-covered field in 1994) are consistent with exposure to a combination of chemical and biological hazards associated with sludge," Lewis said. "In both cases, workers handling the sludge experienced similar symptoms, including nausea, vomiting, severe headaches, sore throats, skin irritation, respiratory problems, and flu-like symptoms.

"In Shayne's case, the plant that produced the sludge responded to worker complaints by building enclosures to protect [workers] from noxious gases emitted by the material. In Tony's case, workers who were getting ill requested a Centers for Disease Control investigation (now under way).

For his trouble, Lewis has been subjected to EPA actions, enabling him to win two job discrimination lawsuits against the agency. EPA has since ordered him to cease even his private research on sludge.

Note: Much of the information in this article is the result of a *Chicago Sun-Times* investigation by Frank Main and Tom Randall.

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TMDL: EPA MUDDIES THE NATION'S WATERS

Bonner R. Cohen

If any single event in recent years can be said to embody the problems besetting Federal regulatory policy it is the manner in which the U.S. Environmental Protection Agency (EPA) set about to “revise, clarify, and strengthen” the nation’s approach to providing for cleaner rivers and streams.

In August 1999, EPA proposed sweeping changes to the Clean Water Act (CWA). EPA’s initiatives were contained in two proposed rules designed to dramatically alter existing practices for controlling levels of pollution in bodies of water throughout the country. The two CWA programs targeted by EPA are, like most Washington regulatory contrivances, known by their acronyms.

One is the Total Maximum Daily Load, or TMDL program. Created in 1972 when the CWA was enacted, the TMDL program is intended to ensure that the nation’s waters are of sufficient quality for the protection and propagation of fish, shellfish, and wildlife, and for recreation in and on U.S. waterways. TMDLs are used to restore water quality by identifying how much pollution a body of water can receive and still meet state standards. The amount of pollution entering the water is then reduced to that level.

EPA also decided to revise its National Pollution Discharge Elimination System (NPDES) program that controls discharges of chemicals from “point” sources. Point sources are entities such as industrial facilities and municipal wastewater treatment plants that discharge chemicals into bodies of water through an outlet such as a pipe. (Point sources of water pollution differ from “nonpoint” sources, in that the latter result primarily from agricultural runoff.) Although the NPDES program exists separately from the TMDL, as the controversy over the agency’s plans for their revision unfolded, both came to be known as EPA’s TMDL rule.

What generated so much opposition to EPA’s move was the agency’s clear intent to centralize decision-making authority over TMDLs in its own hands. The Clean Water Act established a Federal, State, and local partnership for stewardship of the nation’s waters, with states given primary and lead responsibility for implementation. EPA’s TMDL rule federalizes the program, expanding the agency’s regulatory reach and enabling it to intervene in decisions the CWA left to the states.

Among other things, EPA’s rule requires states to make comprehensive pollution surveys for individual bodies of water and determine pollution levels for each over the next 15 years. If a state does not abide by that 15-year deadline, or if the agency is not satisfied with the

state’s calculations, EPA can step in and set the standards itself.

Furthermore, the rule allows for EPA to use subjective criteria in determining whether states are in compliance. And, according to state environmental officials, the rule does not give states enough time to compile adequate scientific data to support their decisions. While 15 years may appear ample time for states to carry out their TMDL responsibilities, a look at the task EPA is handing them presents another picture. States estimate that over 40,000 TMDLs will have to be established – an average of one per week, nonstop, for the next 15 years.

GOVERNORS AND THE GAO CRITIQUE EPA’S TMDL RULES

What this means in practical terms was underscored in a July 6, 2000, letter from the National Governors’ Association to President Clinton. “Given the costs of collecting data in each waterbody, calculating the contribution from each discharger for each pollutant, and devising methods for reducing each contributor’s share, it becomes clear that the states simply do not have the enormous resources necessary to accomplish such a task,” the governors pointed out.

Indeed, lack of reliable data on the condition of the nation’s bodies of water adds to the burdens EPA is placing on state governments and the regulated community. The General Accounting Office (GAO) reported in June 2000 that “the key water quality data available to EPA to identify the number of waters not meeting standards and the number of TMDLs that will be needed are incomplete, inconsistently collected by states, and sometimes based on outdated and unconfirmed sources.” As of 1996, the latest national data available, states had assessed only 6 percent of ocean shoreline;

19 percent of rivers and streams; 40 percent of lakes, ponds, and reservoirs; and 72 percent of estuaries.

In the same report in which it cited the inadequate data on which EPA was basing its rule, the GAO also took issue with EPA’s estimates of what the TMDL revisions will cost. The GAO determined that EPA’s calculations that the cost of compliance would be under \$100 million a year were flawed and that the cost would likely be well above that figure. Representatives of state environmental agencies have testified before Congress that actual costs to states preparing TMDLs will be between \$1 billion and \$2 billion annually.

By rushing the TMDL rule into law before crucial questions about its content and implications could be answered, EPA opened the door to litigation that will last for years

In addition to the reams of paperwork EPA is requiring the states to produce, the agency originally wanted to designate certain silvicultural (tree farming), animal feeding, and aquatic operations as point sources of water pollution. This would have required owners of these businesses to seek permits directly from EPA to carry out their daily operations, a procedure entailing unacceptable delays in dealing with such problems as infestation, droughts, or floods. Under fierce pressure from Congress, and in the hope of fragmenting opposition to its rule, EPA scuttled its plans to treat farmers and growers as point sources. However, these people are by no means off the hook; their operations are, even as nonpoint sources, still included in the TMDL requirements EPA is imposing on the states. As such, they still could face direct control by EPA if the agency is not satisfied with the performance of the states.

Responding to a barrage of criticism from Congress, governors, state environmental officials, as well as business and agricultural groups, EPA, in the weeks and days preceding promulgation of the rule, frantically rewrote whole sections of its proposal. It did so, however, without allowing an opportunity for public comment on the changes it had made. In a May 31, 2000, report, the Congressional Research Service concluded that EPA had done little to respond to the concerns raised by stakeholders. Exasperated, the Association of State and Interstate Water Pollution Control Administrators concluded in a June 29, 2000, letter to EPA Administrator Carol Browner "that this set of rules is technically, scientifically, and fiscally unworkable."

The chaotic circumstances under which EPA pushed through the rule were captured in a statement issued by Rep. Sherwood Boehlert, chairman of the House Subcommittee on Transportation and Infrastructure. "On May 24, 2000, I asked Administrator Browner to withdraw EPA's TMDL proposal because of the overwhelming opposition to these proposals by stakeholders on all sides of the issue and because EPA could not explain how the proposed changes would be implemented," Boehlert said. "Unfortunately, Administrator Browner has not responded. Instead, over the past month, senior EPA officials have been calling members of Congress, calling interest groups, making conflicting promises, and negotiating changes with select stakeholders in a last-ditch effort to drum up support for these flawed proposals. This is not the type of open, public process, one should be able to expect when important federal regulations are under development."

Convinced EPA's rule would wreak havoc in communities throughout the country, Congress, with wide bipartisan support, attached riders to appropriations bills barring EPA from spending any money on implementing its TMDL rule in FY 2000 and FY 2001. However, Administrator Browner signed the new rule into law one day before President Clinton put his signature on the appropriations measures.

"EPA is taking this action in the face of overwhelming opposition from the National Governors' Association, small businesses, farmers, and other landowners across America, and in direct defiance of a directive by Congress to forego finalizing or implementing these new rules this year or next," commented Rep. Bud Shuster (R-Pennsylvania and chairman of the House Committee on Transportation and Infrastructure).

"All of this is nothing but a political power grab by the people running the EPA," complained Rep. Marion Berry (D-Arkansas). "They have no scientific reason for doing any of these things."

By rushing the TMDL rule into law before crucial questions about its content and implications could be answered, EPA opened the door to litigation that will last for years. The resulting uncertainty means that state officials and the regulated community will not know what steps they must take until the courts, a new Congress, or a new administration can resolve the issue.

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BLUE BABY SYNDROME AND NITRATES: NEW RESEARCH CASTS DOUBT ON AN OLD REGULATION

Alex Avery

Dr. John Snow, a London obstetrician, in 1849 published a brief pamphlet, *On the Mode of Communication of Cholera*, introducing his then-novel theory that cholera is a contagious disease transmitted via water (Snow, 1855).

In an effort to prove his theory, Dr. Snow painstakingly mapped the locations of cholera cases around London during an outbreak in 1854. In one particularly hard-hit neighborhood, Snow found that most of the deaths occurred within 250 yards of a single public water pump. He quickly convinced local officials to remove the handle from the pump, rendering it unusable. To their surprise and delight, the epidemic soon abated, proving Snow's theory.

The world's view of water was forever changed – from a life-giver, to a potential life taker.

BLUE BABY . . . ARE NITRATES THE CAUSE?

Little wonder then that in the early 1940s, water became the central suspect when a small infant in Iowa was repeatedly hospitalized for diarrhea, vomiting, and blue baby syndrome. Blue baby syndrome is the common name for infantile methemoglobinemia, a condition in which the oxygen-carrying iron in the blood's hemoglobin is oxidized into met-hemoglobin, a form unable to transport oxygen in the body. Babies suffering methemoglobinemia literally turn blue, the color of nonoxygenated blood.

In this instance, because the infant became ill every time they brought it home from the hospital, the father became convinced that something in the well water used to reconstitute his baby's powdered formula was causing the illness. As much to humor the father as anything else, the physician treating the infant agreed to have the well water tested. What they found eventually led to perhaps the most extensive drinking water regulation on earth.

The tests of the water revealed unusually high levels of nitrate – over 140 ppm nitrate nitrogen when most ground water typically contains between 0.1-4 ppm. Nitrate, a simple compound of nitrogen and oxygen (NO₃), gets into ground and surface water via mineral sources, decaying plant matter, animal wastes, and nitrogen fertilizers. Past reports of blue baby syndrome caused by bismuth subnitrate, a compound similar to nitrate, led the doctors to suspect that the high concentration of nitrates in the water had caused the infant's blue baby syndrome.

After finding high nitrate levels in the water from several additional blue baby cases, the novel theory was reported in 1945 in the *Journal of the American Medical*

Association (Comly, 1945). This triggered a flurry of additional reports of blue baby cases where water used to prepare or dilute infant formula had high nitrate concentrations. Within three years, the American Public Health Association convened a special committee to determine a safe level of nitrates in drinking water.

The committee sent a questionnaire to State health departments for information on the nitrate content of the water in blue baby cases. Special emphasis was placed on restricting the data to those cases definitely associated with nitrate-contaminated water. Seventeen states reported data on nitrate levels for 214 cases (see Table 1).

As the data show, no blue baby cases were reported with water containing less than 10 ppm nitrate nitrogen. For this reason, the U.S. government eventually adopted 10 ppm as the federal drinking water standard. Many other countries also adopted 10 ppm as their health standard based on the APHA survey data, including Europe and the World Health Organization.

However, there are several reasons to believe that the 10 ppm standard may be unnecessarily strict, including new medical research indicating nitrates may aggravate but do not cause blue baby syndrome (Avery, 1999).

OR ARE NITRITES AND GASTROINTESTINAL CAUSES THE SOURCE OF BLUE BABY?

From the beginning, it was understood that the real culprit in blue baby syndrome was nitrite (NO₂), not nitrate. In 1948 research was published in the *Journal of Pediatrics* that showed feeding high nitrate formula (~100 ppm nitrate-nitrogen) to healthy infants for over a week failed to cause blue baby syndrome (Cornblath and Hartmann, 1948). Nitrates cannot react with hemoglobin. Nitrite, however, readily reacts with hemoglobin to form met-hemoglobin. Nitrite poisoning can kill even adults. The theory has always been that bacteria in the stomach and upper gastrointestinal tract of young infants converted ingested nitrates into nitrite, thereby poisoning the infant.

But doubts about this theory arose in 1981 when doctors at a hospital in Israel observed a spate of blue baby cases in an area where the water was centrally supplied and low in nitrates. It was soon discovered that virtually all of the infants with blue baby syndrome suffered acute diarrhea. Because these infants had not been exposed to nitrates or nitrites in their food and water, the doctors decided to reinvestigate blue baby syndrome.

They discovered that infants suffering from both diarrhea and blue baby syndrome excrete significant

*It is clear, however,
that limiting nitrates
in drinking water is
not the best approach
to preventing blue
baby syndrome*

Blue Baby Syndrome and Nitrates: New Research Casts Doubt on an Old Regulation . . . cont'd.

TABLE 1. Reported Cases of Nitrate Water-Induced Infant Methemoglobinemia Classified According to Nitrate-Nitrogen Concentration of Water Used in Feeding Formula.

State	Methemoglobinemia		Number of Cases Associated With Indicated Ranges of NO ₃ -N Conc. (ppm)						Number Of Cases For Which Data Are Available
	Reported Cases	Reported Deaths	0-10	11-20	21-30	31-50	51-100	100+	
California	1	0	0	0	0	0	1	0	1
Georgia	6	3	-	-	-	-	-	-	0
Illinois	75	6	0	1	2	2	12	11	28
Indiana	1	0	0	0	0	0	1	0	1
Iowa	Several	11	0	0	0	0	1	1	2
Kansas	13	3	0	0	1	1	2	8	12
Michigan	7	0	0	0	0	0	0	7	7
Minnesota	139	14	0	2	25		53	49	129
Missouri	2	0	0	0	0	0	0	2	2
Nebraska	22	1	0	1	0	4	9	8	22
New York	2	0	0	0	0	0	1	0	1
North Dakota	9	1	0	1	1	0	0	6	8
Ohio	0	0	0	0	0	0	0	0	0
Oklahoma	0	0	0	0	0	0	0	0	0
South Dakota	Several	0	-	-	-	-	-	-	-
Texas	0	0	0	0	0	0	0	0	0
Virginia	1	0	0	0	0	0	1	0	1
Total	278+	39	0	5	36	81	92	214	
Percent of Total			0.0	2.3	16.8	37.8	43.1	100	

Note: Based on Table 1 from Walton, 1951.

amounts of nitrates in their urine, even when their intake of nitrates is low. Although they were unable at that time to determine the source of the internally produced nitrates, they knew that the nitrates were linked to the blue baby syndrome because when nitrite and hemoglobin react to form met-hemoglobin, nitrate is formed as a byproduct. This was also supported by the fact that infants suffering from diarrhea without blue baby syndrome excreted no nitrates in their urine.

The doctors also observed that diarrhea and vomiting were prominent symptoms in the vast majority of blue baby cases reported in the medical literature as being caused by nitrate-contaminated water.

This was a critical observation: if diarrhea and gastrointestinal problems alone cause blue baby syndrome, and the vast majority of blue baby cases attributed to contaminated water also suffered from diarrhea or gastrointestinal problems, what was the role of nitrates? The Israeli doctors concluded that diarrhea and gastrointestinal problems are the real cause of blue baby syndrome (Hegesh and Shiloah, 1982).

Since this landmark research was published, additional research has unveiled the relationship between blue baby syndrome and gastrointestinal disorders (Levine *et al.*, 1998). Nitric oxide is produced as part of the immune/inflammatory response in gastrointestinal

disorders, including in young infants with diarrhea, gastroenteritis, bacterial or viral gastrointestinal infections or other inflammatory gastrointestinal ailments (including even simple protein intolerance). Nitric oxide (NO) is an extremely reactive molecule and hence short-lived in our bodies, so it wasn't until the mid-1980s that we discovered that nitric oxide is an important signaling molecule in our bodies. After it is produced, nitric oxide is metabolized into nitrite. If enough nitrite is produced, the infant will have blue baby syndrome.

The bottom line: nitrates in drinking water may aggravate, but not cause blue baby syndrome.

This is important because the current regulatory limit of 10 ppm on nitrate is based on the false assumption that nitrates in infant formula cause blue baby syndrome. In fact, the APHA survey was critically flawed. By limiting the survey to those cases "definitely associated with nitrate contaminated water" and thereby excluding low-nitrate blue baby cases, it was virtually guaranteed to find that any nitrate concentration above background was unsafe. If all blue baby cases had been included in the survey, not just those with above normal nitrate levels, it would have been discovered much sooner that severe blue baby syndrome can occur at all levels of nitrate

Blue Baby Syndrome and Nitrates: New Research Casts Doubt on an Old Regulation . . . cont'd.

exposure-from zero ppm nitrate-nitrogen upward-and that diarrhea and gastrointestinal problems are the real cause. The medical literature includes reports of cyanosis associated with diarrhea as far back as 1904.

Moreover, the APHA survey data on which most of the world's regulation is based was of poor quality and extremely limited scope: in many instances the samples of water for analysis were collected several months after the case; many of the reported blue baby cases were never definitively diagnosed by a doctor; and the survey did not report the presence of nitrite, bacterial contamination, diarrhea, or gastrointestinal disease (Walton, 1951).

CONCLUSION

There is little question that high levels of nitrates in drinking water can contribute to the severity of blue baby syndrome. What constitutes "high nitrate levels" is open to debate. Most blue baby cases reported in the literature occurred at water nitrate concentrations above 40 ppm. I have argued, based on extensive review of blue baby research and a century's worth of case reports, that the drinking water nitrate standard could be raised to 15 or 20 ppm without increasing the risks to infants.

The problem with any recommendation is the fact that blue baby syndrome can occur with zero nitrate exposure, which creates a conundrum: *how does one measure the impact of nitrates on the severity of a blue baby case in order to establish a nitrate standard?* This debate is further muddled by decades of entrenched beliefs and a regulatory system that abhors change. Thus, the debate is unlikely to be settled anytime soon.

It is clear, however, that limiting nitrates in drinking water is not the best approach to preventing blue baby syndrome. The best approach would be to prevent and treat the illnesses that actually cause blue baby syndrome, such as bacterial and viral gastroenteritis. We should also educate parents, doctors, and public health officers that any infant less than six months of age with diarrhea or other gastrointestinal illness - especially low birth weight and premature babies - is at risk of blue baby syndrome. Recent studies indicate that mild to moderate blue baby syndrome is not uncommon among such infants and several serious cases have been documented.

Finally, the most productive thing we could do is to conduct more research on blue baby syndrome - so that all of these unresolved questions can be properly answered.

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Contact the Associate Editor who is working on an issue which addresses a topic about which you wish to write. Associate Editors, their e-mail addresses, and their topics are listed on pg. 1. A less direct approach would be to contact the Editor-In-Chief Earl Spangenberg and let him know your interests and he can connect you with an appropriate Associate Editor. Our target market is the "water resources professional" - primarily water resources managers and such people as planning and management staffers in local, state, and federal government and those in private practice. We don't pay for articles or departments. Our only recompense is "the rewards of a job well done."



EXECUTIVE DIRECTOR – DIVISION OF HYDROLOGIC SCIENCES LAS VEGAS AND RENO, NEVADA

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The Desert Research Institute (DRI), an internationally recognized environmental research institution and a component of the University and Community College System of Nevada (UCCSN), invites applications for the position of Executive Director of its Division of Hydrologic Sciences (DHS).

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WATER MARKETING: THE OTHER SIDE OF THE COIN

S. Ansley Samson and Sydney Bacchus

In the May 2000 issue of *Water Resources IMPACT*, Clay Landry [Agriculture and Water Markets in the New Millennium] promoted the concept of water marketing in the new millennium, providing examples from the western United States. Water law is different in the eastern and western U.S. and the following discussion addresses several problems with water marketing, as currently proposed in Florida. Under the “western” system, whoever begins withdrawing water first has a right to continue withdrawing the water – first in time, first in right – provided that it goes for a “beneficial use” (including making a profit from it), and the use is continued. For that reason the western system is referred to as the “prior appropriation” system. There, water is considered the property of the user. By contrast, water is a public resource under the “eastern” system, making the protection of the public interest a major feature of the law. Therefore, in the east, a person can divert water from a stream, lake, or aquifer (via a well), if they can demonstrate that it will be put to a “reasonable use.” However, this water right can be reduced or supplanted if a subsequent user can demonstrate that their proposed use for the water is a more reasonable use.

In 1972, Florida adopted an improved system of water management that provided certainty to water users and protection for the public interest. The state began issuing permits for a fixed amount of water based on an estimated need over a specified period of time, up to 20 years (typically five to seven years). The following three-part test was put into place for people who applied for permits to withdraw water that was assumed to belong to the citizens of the state: (1) the water must be put to a reasonable and beneficial use, (2) the applicant must not interfere with an existing user, and (3) the use must be in the public interest. This law also directed water managers to set and maintain minimum flows and levels throughout the state for surface and ground water to protect those resources and the interdependent ecosystems from “significant harm.” In the event that existing ground water extractions are causing set minimum levels or flows to be violated, the recovery to the established minimum levels and flows must be ensured.

A pilot water market program recently was proposed for the Sarasota, Florida, area. This program purportedly would reduce the costs of, and expedite meeting future water needs via solutions less dependent on tax revenue, and would reduce environmental devastation due to continued overpermitting. In reality, the proposed market-based solution would exacerbate those problems by: (1) allowing current permittees to trade and delay the expiration of their water permits before establishing the critical conditions (e.g., minimum flows and levels) required to protect public resources from significant harm;

(2) not providing for sufficient government (District) oversight of proposed water permit sales or leases; (3) not ensuring that water will be available for future users; (4) allowing “the highest bidder” to determine who has access to a public resource that is essential for all life; and (5) requiring the public to pay to provide water for the environment (the original existing user) to prevent natural ecosystems (lakes, streams, wetlands) from being destroyed [see Bacchus (2000) for discussion of environmental impacts associated with ground water mining; and Glennon and Maddock (1997) for general discussion of stream capture].

Remedies to some of these problems are available. First, no water market should be instituted and no new ground water withdrawal permits issued until the conditions necessary to protect the public’s environmental resources (e.g., minimum flows and levels) have been established and all challenges to those conditions have been fully litigated. The legislature could require expedited procedures to apply to administrative challenges. Second, funding is needed for the development of alternative sources of water. If current users are permitted to sell their water permits, they should have to pay for the water first (currently no payment is charged for the use of ground water, only nominal costs for the permit and transporting the water). Incentives also could be provided to encourage permitted water users to reduce their current usage and permitted withdrawals, in exchange for legislative authorization to extend the duration of their permits. Finally, any water market transaction must be reviewed to ensure that the new use would not cause harm to the environment beyond the actual withdrawal of the water. For example, recently it was determined that “runoff” of ground water used for agricultural irrigation resulted in the destruction of approximately 1,000 acres of wetlands in a combination of public and private “preserves.”

The broader problems with instituting water markets, even on a limited scale, include the fact that money would determine who has access to this critical public resource and the fact that the original “existing users” (the environment) do not hold the permits, but probably would be relegated to a bidding war for access to the public’s ground water resources.

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Point: Water Marketing: The Other Side of the Coin . . . cont'd.

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Counterpoint**AGRICULTURE AND WATER MARKETS IN THE NEW MILLENNIUM****Clay J. Landry**

I want to thank Samson and Bacchus for pointing to a few of the differences between eastern and western water law. They suggest incorrectly, however, that these differences mean that water markets are unworkable in the eastern U.S. These differences simply mean that eastern water markets will take on a different form than their western counterparts.

Water markets may not be as unworkable as Samson and Bacchus suggest. In fact, there is a growing body of research examining ways to make water markets function for eastern states.

Johns and Yingling (2000) provide one of the most concise articles to date. They describe how markets could address Florida's growing water scarcity and environmental problems using the state's existing water permit system. Essentially, they contend that water would move to its highest valued and most efficient uses by simply allowing permit holders to trade their allocations. They also accurately point out that through trading "a water price will evolve" and that the price will encourage conservation among users.

Samson and Bacchus suggest a more bureaucratic approach. They assert that conservation should be encouraged by holding permit extensions ransom until efficiency measures are undertaken. This approach will likely result in ineffectual measures that simply attempt to appease regulators. Prices are far more powerful in achieving conservation. In addition, markets also ensure greater efficiency gains for water conservation. Trading encourages conservation from those water users that can implement it the cheapest and prevents other water users from undertaking expensive conservation measures to save small amounts of water.

Johns and Yingling's market proposal also addresses environmental protection. Florida currently applies a three-part test when issuing new water permits. One part of that test is that the water use must be "consistent with the public interest, which includes environmental protection." That same condition would apply to water transfers. In essence, regulators would have a chance to review and condition market exchanges for environmental needs. Johns and Yingling present a way forward for water markets in Florida. Yet that may not be enough. The short-term nature and bureaucratic uncertainty of water permits may stifle longer-term market development.

Two economists at Environmental Defense (formerly the Environmental Defense Fund), Vaughn and Emerson (1996), offer an alternative water market approach for Texas' Edwards Aquifer, an area facing problems similar to those in Florida. In recent years, overpumping of the aquifer has dropped water levels, threatening to dry up

several large springs that provide critical habitat to several endangered plants and animals. To address these problems, Vaughn and Emerson suggest a market with water rights that are based on a proportion of the aquifer's annual safe yield. This ensures that the aquifer maintains a minimum level. Each year the yield would be announced to determine the amount of water each right holder is allowed to extract. Water users are able to make up any shortfalls by purchasing rights from other users. This market design centers on environmental protection and Vaughn and Emerson feel they've developed a workable approach with proportional water rights.

Florida is just one of many eastern states that will be forced to deal with growing water scarcity in the next few years. One option is to proceed with command-and-control regulations that specify how much each water user gets. The problem with this approach is that politics determine who has access to this vital resource. Water and politics simply don't mix.

Samson and Bacchus sell markets short with their concerns. As demonstrated by Johns and Yingling (2000), Vaughn and Emerson (1996), and others, markets offer flexibility for addressing numerous problems. But one element fundamental to all market proposals is that price determines allocation. Samson and Bacchus see this as a problem; I don't. I see markets as offering the best hope among all other options for efficiently and equitably allocating this precious resource to its most highly valued uses. Any other solution ultimately results in a political race to the pumphouse. And you don't have to look very far in Florida (or in most states for that matter) to see the damage of mixing water and politics. If markets are to work, Florida and other eastern states must move away from bureaucratically controlled allocation permits and toward a system of well-defined and tradable water rights.

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The University of New Mexico School of Law has received a \$1.4 million federal grant for its Utton Transboundary Resources Center. The Utton Center, which will consider domestic and international water issues, invites applications and nominations for Director of its domestic programs. This non-tenure track, research faculty position, will begin in Spring 2001. Rank and salary will be commensurate with qualifications. Term: year-to-year, without presumption of tenure.

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- organize nationwide conferences;
- oversee publications production, and startup and maintenance of web site;
- work with School of Law faculty to supervise law students enrolled in natural Resources Law Certificate program;
- community education;
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- interaction with Water Resources Program and other related UNM programs/offices.

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**MSU-WATER
(WATERSHED ACTION THROUGH EDUCATION AND RESEARCH)**

Scott G. Witter, Ruth Kline-Robach, Fred Poston, and Michael J. Lang

The Challenge: “As we look at the twenty-first century, several challenges face us. Foremost among them is how to satisfy the food, drinking water, sanitation, and health needs of the ten or twelve or fifteen billion people, when we have failed to do so in the world of five billion” (Peter Gleick from *Water in Crisis*, 1993).

INTRODUCTION

In Michigan, where access to abundant supplies of fresh water is a reality, it is often difficult to think of water as a scarce or threatened resource. Some individuals throughout the state, nation, and world still believe that ample sources of clean water will always be available. However, the general public is becoming more attuned to today’s increasing water quality problems resulting from both point and nonpoint source pollution. The closing of beaches due to high *E. coli* levels and the contamination of ground water supplies because of high nitrate leaching have served as warnings that everyone should be concerned with the potential degradation of one of our most precious resources, water.

Across Michigan, surface water quality standards have been routinely exceeded. The City of Lansing has historically released more than 1.3 billion gallons of untreated wastewater to the Grand River every two years (Witter and Godbold, 1999). Local public health standards for partial and full body contact recreation are exceeded on the Grand River over half the year in the Lansing vicinity. In Ingham County alone, where Michigan State University (MSU) is located, there are more than 3,700 miles of drainage ditches and pipes that could potentially allow nonpoint source pollution to enter the surface waters (P. Lindemann, August 2000, personal interview with the Ingham County Drain Commissioner).

Upstream of Lansing, the community of Williamston has been faced with high levels of *E. coli* pollution at their new \$800,000 whitewater kayaking facility, prompting the Ingham County Environmental Health Department to post health advisories for potential users. Further upstream, smaller communities have been found to be releasing raw sewage directly into the Red Cedar River (R. Godbold, September 2000, personal interview with the Director of Ingham County Environmental Health Department). Downstream of MSU, the City of Lansing’s Public Works administrators have characterized the Sycamore Creek, a tributary of the Red Cedar River, as being an open sewer during parts of the year. Annualized costs for water quality protection in the Rouge River in

Detroit, Michigan, were estimated to be \$10,000 per day during its Phase I activities (Murray *et al.*, 1998).

MSU, which is located in the Red Cedar River Watershed, has recognized the importance of the water resources that flow through the University’s campus in East Lansing, Michigan, and has made the commitment to lead through example by designing a watershed management initiative that will strengthen its education program, expand its research opportunities, and focus on community outreach. The initiative, Watershed Action Through Education and Research (MSU-WATER), will include an assessment of campus resources, the development of a watershed management plan, and the construction of a series of water management demonstration sites on campus. These sites can be used to help villages, cities, developers, industries, and other stakeholders from across the state, nation, and world to learn how to best manage their water resources and protect our collective future.

As part of the Land Grant University system, MSU has played a lead role in managing and increasing agricultural land resources and production. An emphasis on

*MSU-WATER
will serve the needs of
Michigan communities
by developing affordable,
practical solutions to
current water quality
problems*

protecting water resources on a watershed basis should be a welcome challenge for the Land Grant Universities. While all of the universities in the Land Grant University system have faculty and staff with expertise in water resources issues, we have been unable to identify an institution that has adopted a watershed management approach for its own campus.

Historically, universities have hired consulting firms to complete the assessments and write a management plan. MSU has chosen instead to invest in the long-term by creating a multidisciplinary team of faculty and students who can, through their expertise, not only develop the plan, but also create unique teaching, research, and outreach opportunities. Projections show that this can be completed at a lower cost and with significant buy-in and ownership by the faculty and students.

MSU’S GUIDING PRINCIPLES AND PROMISE

MSU has made a strong commitment to “extend its national and international prominence in research, creative arts, and graduate and graduate/professional education, through selective investment in programs of distinction and unusual promise. MSU will be an exemplary engaged university, transforming and strengthening outreach partnerships to address key Michigan needs and developing broadly applicable models” (President

MSU-WATER (Watershed Action Through Education and Research) . . . cont'd.

Peter McPherson, 1999). The MSU-WATER committee has worked for more than a year with the University's President, Provost, and Vice President for Finance and Operations and Treasurer to work out the details necessary for MSU to invest \$1.4 million over the next four years to design MSU-WATER and to establish itself as a leader in interdisciplinary water sciences teaching, research, and outreach.

MSU-WATER

Led by faculty, staff, and students representing five colleges, 16 departments, and several support units within the University, as well as partners from state and local governmental regulatory agencies, MSU-WATER will include physical, chemical, biological, and human assessments in order to identify the most pressing water-related issues and research opportunities. A watershed management plan will be developed for campus, and multidisciplinary teams comprised of faculty, staff, and students will address each priority area identified in the plan in cooperation with public and private external partners in accordance with EPA requirements under Phase II of the Clean Water Act (EPA, 1999). A variety of watershed management techniques that integrate research, outreach and teaching will be implemented, and practical and affordable solutions to water quality problems will be generated and shared with others.

BACKGROUND

Recent amendments to the Federal Clean Water Act require that all communities with populations of 50,000 or more and densities equal to or greater than 1000 people per square mile obtain a storm water discharge permit if they discharge pollutants into a surface water body. In Michigan, a total of 22 counties and 252 institutions are affected by the Federal requirements. These communities are being encouraged to develop watershed management plans that clearly document how they will limit their discharges and meet the long-term goal of zero discharge before they are issued permits. Many of these communities possess neither the resources nor technical expertise necessary to address these requirements. This provides a tremendous opportunity for MSU, as a premier Land Grant University, to provide critically needed research, technical assistance, education, and outreach services to these communities.

Land Grant Universities have been credited with increasing agricultural output by seven fold during the last century. MSU-WATER will allow MSU to extend this leadership into the natural resources field and carry the Land Grant University mission into the new century. By developing its own watershed management plan and implementing a series of water management demonstration sites on campus, MSU will generate new ideas that can be transferred to local units of government, developers,

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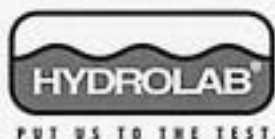
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industries, and other stakeholders to assist them in managing water resources.

Michigan State University has long been committed to both environmental management and integrated learning opportunities. This project provides a unique opportunity for the University to combine these missions and establish itself as a leader in water science and management, while diffusing solutions to critical watershed management problems to a variety of stakeholders.

Initiative team members will work closely with and build upon related programs that are currently in place at MSU, including the 2020 Vision Land Use Planning project, activities of the University Committee for a Sustainable Campus, and the MSU Wellhead Protection Program.

PROJECT OBJECTIVES AND COMPONENTS

MSU-WATER will serve the needs of Michigan communities by developing affordable, practical solutions to current water quality problems. By exploring the social dimensions of watershed management issues, the project will also generate ideas for building engaged, multidisciplinary teams to address water management issues. Strong education and outreach components will ensure that the ideas and solutions that are developed through the project are widely shared with interested individuals.

Other objectives include:

- Collaborate with upstream and downstream partners to meet and surpass current water quality standards.
- Increase awareness of water quality issues and encourage the adoption of individual actions that protect water among all stakeholders within the watershed.
- Enhance existing undergraduate and graduate level courses and explore the development of new interdisciplinary educational programs in water sciences and management in order to train future scientists and leaders in watershed management.
- Encourage partnerships between state and local governments and other organizations.
- Integrate graduate programs and new research projects and outreach programs into MSU's international programs.
- Conduct semi-annual water conferences at MSU that are problem-driven and solution-focused.

In the first stages of the project, assessments will be conducted of river, ground water, and sediment quality; human health; fish, wildlife, aquatic invertebrates, and physical habitat; wetlands; environmental soil conditions; and forestry. A social assessment of stakeholders' attitudes and behavior will also be completed. Other project components include the design of a data management and GIS system, watershed management plan development, education, outreach, and project evaluation activities.

IMMEDIATE RETURN ON INVESTMENT

Faculty members who are participating in MSU-WATER have attracted more than \$1 million in related

grants and contracts this year. In addition, two graduate and undergraduate classes have been developed and are being taught related to managing the Red Cedar River that flows through campus, and three doctoral students have developed research proposals to conduct dissertation research related to MSU-WATER.

We welcome all comments and information about similar programs!

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MSU-WATER (Watershed Action Through Education and Research) . . . cont'd.

City of Lansing's Wellhead Protection Team. Dr. Witter has over 19 years of experience conducting research, outreach, consulting, and teaching activities related to international and domestic watershed management issues and projects. He has 11 years of college-level administrative experience in MSU and has traveled and worked in 25 countries. Dr. Witter has published and presented 80 professional papers, articles, and book chapters on watershed management. He recently published *Water Policy: Security Issues* with Dr. Scott Whiteford, as part of the International Review of Comparative Public Policy book series.

Ruth Kline-Robach is an outreach specialist at the MSU Institute of Water Research and serves as the statewide water quality coordinator for MSU Extension.

Fred L. Poston is Vice President for Finance and Operations and Treasurer, Michigan State University. As Vice President for Finance and Operations and Treasurer, Fred Poston oversees the budget and operations for the University's 43,000-plus students and 12,000 faculty and staff. His work includes oversight of the University's budget and planning, MSU Police, housing, athletic

programs, and all business operations. During his tenure, the University has continued to keep student housing costs among the lowest in the Big Ten, even while it renovates residence halls and upgrades technology. It also is formulating a master plan for the campus of the future called 2020 Vision, which will ensure a campus that meets the needs of students, faculty, staff and visitors while remaining true to MSU's land-grant tradition. A native of Florida, Dr. Poston received his bachelor's degree from West Texas State University and his graduate degrees in entomology from Iowa State University. He is known for his candor and honesty and is viewed as a visionary and innovative leader.

Michael Lang is a Ph.D. candidate in the Resource Development and the Environmental Toxicology Programs at Michigan State University. Michael graduated with a J.D. this past year from Michigan State University Detroit College of Law and holds both a MBA and a Masters in Chemistry from Western Michigan University. In addition to his interests in wetlands and watersheds, Michael is co-authoring a book on brownfield redevelopment and is currently a member of the University Committee for Sustainable Campus.



ASSISTANT/ASSOCIATE PROFESSOR WATERSHED MANAGEMENT

THE DEPT. OF NATURAL RESOURCES CONSERVATION UNIVERSITY OF MASSACHUSETTS-AMHERST

The Department of Natural Resources Conservation at the University of Massachusetts, Amherst is seeking applications from qualified applicants for a full-time 9-month appointment, tenure-track faculty position in Watershed Management/Water Quality. We seek a person with knowledge of land management effects on water quality and quantity in areas with high human populations. The position will be filled at the Assistant/Associate Professor level. Salary is commensurate with experience and qualifications.

AVAILABILITY: The position will begin **September 1, 2001**. The letter of application must include a statement of personal research, teaching, and outreach goals; official transcripts; curriculum vitae; and three letters of reference and should be sent by January 1, 2001, for priority consideration. The position will remain open until filled. Contact:

William C. McComb, Head
Department of Natural Resources Conservation
204 Holdsworth Natural Resources Center
University of Massachusetts
Amherst, MA 01003-4210
Phone: (413) 545-1764
E-Mail: bmccomb@forwild.umass.edu

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The School of Forestry at The University of Montana seeks candidates for a full-time (9-month), tenure-track position in Watershed Science at the rank of Assistant Professor (67% teaching, 33% research). A Ph.D. in forest hydrology, soil science, or related discipline is required. Responsibilities include teaching an upper-division course in watershed management, a lower-division course in introductory soil science, a graduate-level course, and possibly an additional course in soils or hydrology. The successful candidate will be expected to develop a research program focusing on management-related issues in forested watersheds in the northern Rocky Mountains. Research activities in the area of ecological restoration are of particular interest.

Initial screening of applicants will begin **January 2, 2001**, and will continue until a suitable candidate is identified. Applications should include a letter summarizing interest and qualifications for the position, curriculum vitae, and university transcripts. Applicants should also arrange to have three letters of professional reference sent at the time of application.

The position announcement, description, and application information (available in alternative formats upon request) may be obtained from Lloyd P. Queen, Search Committee Chair, School of Forestry, The University of Montana, Missoula, MT 59812, Phone: (406) 243-2709, Fax: (406) 243-6656, E-Mail: search@forestry.umt.edu.

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THE NEW WATERSHED TOOLS: GENUINE STEEL OR CHROME-PLATED PLASTIC?

Richard A. Halpern

Water resources professionals – especially in the academic and regulatory communities – are eager to deploy watershed management tools newly developed in the past two decades – tools like predictive modeling, rainfall simulation, and rotational basin-monitoring. Empowered by a recent federal rulemaking that officially entrusts the nation's water quality to their “professional judgment,” they are packing their toolkits, heading into the field (or at least to the office cubicle), and pushing ahead with sweeping measures to improve the nation's water quality.

It started with the Chesapeake Bay 15 years ago, but now the targets are growing ever larger. The Gulf of Mexico and its Mississippi River watershed, and indeed through the new TMDL rule published this year (see Bonner Cohen's article, this issue), every watershed in the country can theoretically be managed by these new tools – affecting millions of American families and, perhaps, changing how they live. Because such management decisions will have far-reaching effects on real people, every water resource professional has an ethical obligation, I believe, to assess fairly what these tools can and cannot legitimately do. We should consider seriously whether the tools in this “toolkit” are the real thing – fashioned from the steel of reliable data and sound science – or whether they are, perhaps, something less – less worthy of the trust and authority we seem eager to give them?

These concerns are not merely academic. The July 2000 issue of *IMPACT*, (“Long Term Water Data”) emphasized convincingly that high-quality long-term monitoring is not only desirable but necessary to making sound judgments on water, air, and climate issues. The same issue focused on the dangers of extrapolation and generalization from limited or localized data, and lamented not only the lack of long-term data but the continuing loss of long-term monitoring stations (Slaughter, 2000; Slaughter and Richardson, 2000; Redmond, 2000; Norris, 2000). The quality of our data has a direct and inescapable bearing on the quality of our policy and management decisions. The “Garbage In/Garbage Out” rule is as unimpeachable now as ever. Yet is becoming an inescapable conclusion that the definition of what constitutes “garbage” is rapidly changing, and that, in some cases, researchers are deciding that garbage doesn't stink after all.

WISH LISTS AND FABRICATIONS

Congressional hearings this spring on EPA's TMDL rule made incontestably clear that the nation's water

quality databases are desperately inadequate – something that most water resource professionals have long known. A Virginia POTW official testifying on behalf of the Association of Metropolitan Sewerage Agencies (AMSA) reported that many states' water quality standards and criteria “were established in the 1960s and early 1970s without much scientific analysis.” In essence, he said, they were “wish lists” that “don't make any sense” in the current regulatory environment (LeBlanc, 2000).

An exhaustive state-by-state study by the General Accounting Office (GAO) also presented to Congress this spring during the Clean Water Act hearings found that, at most, ten percent of the nation's rivers have ever been sampled, even once. A much smaller percentage has, in fact, been monitored on a long-term basis for multiple parameters. Only one state in the nation claimed to have significantly more than half the data needed to make a sound assessment of its waters. Many states reported that their 305 (b) water quality reports are based on outdated assessments, anecdotal evidence, and random observations. In fact, some reported that the EPA even encourages them to pad their impaired waters lists. The GAO also noted that “considerable subjectivity” is unavoidable in assessments based on “best professional judgment.” While such an assessment may be a “reasonable guess,” one state official told GAO, it nonetheless represents “a subjective process,” by which incomplete or nonexistent data can lead to scientifically indefensible management decisions. Most disturbingly, state water officials told GAO investigators that, overall, less resources are being devoted to monitoring and assessment at the state level than ever before (Guerrero, 2000).

*... the temptation
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SINS OF OMISSION

The States, however, are not the only ones failing to monitor water quality accurately and adequately. The Federal government's record is disastrous. Debra Knopman, formerly chief of the USGS systems analysis branch for water resources, likens the Federal monitoring system to “controlling the heat and air conditioning in a 50-room mansion with one cheap thermostat” (Knopman, 1997). The entire Federal monitoring record at Point of Rocks, Maryland – the confluence of the Shenandoah and Potomac Rivers – covers the period 1974 through 1989, yet contains only a single value for total nitrogen concentration (.73 parts per million) dated August 31, 1976. Yet USGS's official published data erroneously indicate a median concentration of total nitrogen of 2.3 parts per million based on record of 90 samples taken between 1969

and 1992 (Langland *et al.*, 1995). The error has been acknowledged by an author of the USGS report. Nevertheless, these nonexistent data were used – and are still being used – to calibrate and verify the Chesapeake Bay Model, a computerized environmental simulation that influences thousands of land use decisions affecting the lives of millions of people.

Writing in 1993, Knopman and USGS hydrologist Richard Smith, expressed hope that full implementation of a new long-term National Water Quality Assessment would correct the sins of omission in USGS data and bring “accurate and meaningful water quality information to the forefront of the policy debate” (Knopman and Smith, 1993). Those expectations have been disappointed. Monitoring of the Potomac River watershed, for example, was discontinued after only three years. Federal agencies now characterize nutrient concentrations in the watershed from monthly samples at only 11 sites in the 15,000 square-mile basin over three years, 1993-1995 – a wholly inadequate record by USGS’s own standards (Ator *et al.*, 1998). The federal government continues to suggest that these data are appropriate for management decisions in the Chesapeake Bay watershed.

From 1988 to 1990, an attempt by Purdue University professor Steven Lovejoy to analyze nutrient contributions of major tributaries to the Mississippi River using USGS data ended in frustration. According to Lovejoy, he and research associate Barbara Dunkelberg spent weeks “trying to make sense” of the data coming out of EPA’s STORET data dump. They finally “gave it up,” Lovejoy reports, because the numbers coming out of the database were simply not credible (Stephen B. Lovejoy, October 9, 2000, personal communication). In his 1992 report published by EPA, Lovejoy states that the USGS data “are not comparable in their timeframes, methods employed, or the water quality parameters reported.” In addition “data on nutrient concentrations in rivers often are not accompanied by data on water flow,” making it impossible to determine nutrient loadings. Moreover, Lovejoy observed, “Federal budget constraints have led to bimonthly and quarterly sampling, leading to a very low number of measurements” for large geographic areas during particular seasons and for many of the years in the record. “The measurements of actual concentrations of pollutants and flows were nonexistent, both temporally and spatially,” he concluded (Lovejoy, 1992).

Surprisingly, however, these same data, decisively rejected as useless in 1992, apparently constitute a key portion of the database of a new USGS model that purports to trace nutrients in the Mississippi River to their sources in upper basin tributaries. A Federal task force is also using these data to argue that nitrogen concentrations in the basin have increased by two to three-fold since the mid-20th century and must be reduced by draconian changes in land use. Ultimately, the task force hopes to create Federally-inspired land use policies in the states of the Mississippi Basin based on this analysis. The changes in land use policy may be desirable from some environmental and even economic points of view, but the use of deficient data makes the policy goals

suspect and vulnerable to challenge—both scientifically and legally.

Data proposed by EPA for use in the BASINS watershed model also came under unfavorable scrutiny recently. In a less-than-flattering critique of the model in the *Journal of the American Water Resources Association*, Ray Whittemore and John Beebe (2000) warn that many records from the EPA Office of Water “are incomplete or suggest data quality that does not comply with the content of the standard for digital geospatial data.” The reviewers observe, “stakeholders in contentious [watershed management decisions] . . . will demand that the tools be of unquestionable veracity when faced with expensive treatment upgrades or restrictive land management BMPs” – and rightly so.

DATA QUALITY: WHAT ME WORRY?

Unfortunately, not everyone worries about the soundness of our data. The TMDL debate this spring illustrated that the professional water resource community must shoulder the burden of demanding quality data – or no one will. In May, the lobbying and maneuvering surrounding the rulemaking became intense. Six mainstream environmental organizations – apparently indifferent to the data quality issues – wrote to EPA Administrator Carol Browner complaining that “comprehensive TMDLs” were to have been developed and implemented, and water quality standards fully attained by 1984. They charged that further delays of “up to 15 years” for 40,000 TMDLs to be developed was “unconscionable and contrary to law.”

Testifying before a subcommittee of the Senate Committee on Environment and Public Works last March, Executive Director of the Northwest Environmental Advocates Nina Bell acknowledged the “states do not collect adequate data” and that “the data states do collect are neither comprehensive in geographic scope nor in sufficient depth on individual waterbodies to develop TMDLs . . .” But because we face imminent environmental and public health catastrophes, Bell claimed, we should “[count] on public policy to fill in the gaps . . .” (Bell, 2000). There seems to be little awareness within some concerned communities, that without credible data, environmental policy simply becomes one sector’s forcing lifestyle choices on other sectors of society – without reference to any objective reality. Policy is made the strong arm of prejudice. It may be so in Congress, but it ought not be so in the professional water resources community.

THE PERILS OF MODELING

The EPA clearly hopes that BASINS and models like it will be used to manage tens of thousands of watersheds around the country for which poor or no monitoring data exist. Without good long-term records it is impossible to produce coherent and defensible management goals. The lack of real world data will mean that instead of credible watershed-specific information, models will be forced to rely on questionable defaults – one time grab samples,

professional guesstimates, and the like. We are likely to see an increasing number of watershed plans based on “presumptions of pollution” according to which land uses are presumed to cause or contribute to specific impairments – without benefit of monitoring – and are assigned levels of responsibility per acre or unit of production, by default.

These defaults may be based purely on “professional judgment,” but may also reflect the outcomes of limited field trials and simulations. In either case, such defaults are no substitute for monitoring. They are almost certain to falsify reality. As Kelly Redmond argues so convincingly (Redmond, 2000), “Ecological disturbances – and impacts on human systems – in many environments often occur in just minutes or hours . . . and affect the evolution of those systems for decades or centuries afterwards. Such typically unpredictable events can only be adequately captured and quantified by monitoring systems recording at sufficiently short intervals that such a significant event does not pass through undetected.”

Charles Slaughter cautions that “landscapes and watershed are spatially variable and may exhibit highly diverse characteristics over short horizontal distances.” He reports that even on a small catchment of 11 acres, two rain gauges were required to produce an accurate model (Slaughter, 2000). Thus, rainfall simulations on small test plots cannot be expected to predict nutrient concentrations in runoff for an entire farm, let alone entire regions of the country. Uncritical use of such data will, in the end, destroy rather than build confidence in watershed models.

The reviewers of the BASINS model caution that “effective calibration is still an ‘art’ where multiple parameter datasets can achieve the same degree of simulation matching to monitoring data.” Because models contain many variables, there are an unlimited number of scenarios that will yield the same result. If $a + b + c = d$, an infinite number of values can be assigned to a , b , and c to reach the sum “ d .” Where “ a ” is temperature, “ b ” is flow, and “ c ” is nitrate concentration, and so on, with every known variable represented, it is possible for the modeler/artist to construct an unlimited number of scenarios with the same numeric outcome. The reviewers question, therefore, whether “a majority of BASINS users will have sufficient professional judgment and insight to use the system wisely and to fairly represent the results to the broad array of TMDL stakeholders.”

Whittemore and Beebe (2000) also worry about what they term “rogue analyses,” which they regard as “always possible and even probable in some adversarial situations.” The public, they observe accurately “is ill-equipped to distinguish the good science from inappropriate analysis when it come to technical watershed assessment and modeling issues.” With considerable charity, the reviewers suggest that “most water quality professionals would acknowledge that these resources are not infallible and error free.” Hopefully they are right, but the temptation to pass off a fallible model as a reliable representation of reality is great and not always resisted.

USGS hydrologist Leonard Konikow, winner of the American Geological Society’s 1997 Meinzer Award for distinguished contributions to hydrology, along with his USGS colleague John D. Bredehoeft take the critique of modeling a step further (Konikow and Bredehoeft, 1992). They write persuasively about the quandary regulators face when confronted by the insurmountable obstacles which lie between them and verifiable scientific conclusions about the environment. Regulators argue that their models, if not really faithful to reality, are at least “adequate representations of the real system.” As Konikow and Bredehoeft tell it, “Defining what is adequate will, in the end, be a subjective decision made by the regulator.”

“It is natural,” they write, “for people who apply . . . models, as well as those who make decisions based on model results, to want assurance that the model is valid . . . Case histories of model applications . . . illustrate that calibration produces a nonunique solution and that validation, per se, is a futile objective. Although models are definitely valuable tools for analysis . . . their predictive accuracy is limited. The terms ‘validation’ and ‘verification’ are misleading and their use . . . should be abandoned . . .” Such terms, they object “tend to lend undue credibility to a process that . . . is, in the end, inherently subjective.”

As Whittemore and Beebe (2000) also suggest, the modeler can never know which values among all the real-world parameters were responsible for arriving at a “good” answer, regardless of how much “good” data are used. Konikow and Bredehoeft add “The nonuniqueness of models’ solutions means that a good comparison can be achieved with an inadequate or erroneous model.” A “. . . competent and reasonable scientist may declare a model as validated while another may use the same data to demonstrate that the model is invalid. In science and engineering, such an operational definition [‘valid’ or ‘invalid’] would not appear to be meaningful,” they conclude.

NO SUBSTITUTE FOR THE REAL THING

Models, in other words, cannot be used as a substitute for knowledge of the real world, and the only reliable way to attain such knowledge is through intensive, long-term monitoring. This is an investment in our environment and our economy that we cannot afford not to make.

In the last eight years alone, we have spent \$1 trillion for air quality monitoring, but between 1972 and 1990 an estimated \$33 million has been spent on scientific assessment of our waters. It is time for a true and complete national water quality inventory. It will take all of 20 years just to make a proper start, and we don’t have a moment to lose.

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Dr. Richard Halpern joined the Center for Global Food Issues in 1997. He is noted for his work assessing the real world impacts of agriculture on the environment. Since 1993, he has focused on the importance to American agriculture and the global environment of a scientific assessment of national water quality, and documented the compatibility of intensive farming practices and good water quality around the nation. As a policy analyst for

Rockingham County, Virginia (1986-1994), one of the country's top poultry and dairy producing counties, Dr. Halpern developed the first local nutrient management program and ordinances in the U.S, which have served as a model for similar resource management programs across the U.S., Europe, and Central America. Halpern was educated at the University of California at Berkeley (A.B., 1966), Oxford University (B.A. Honours, 1968), and Princeton University (Ph.D., 1976). His publications have appeared in the *Washington Times*, *Regulation*, *American Outlook*, and *Consumers' Research*. Dr. Halpern is also a frequent contributor to the *Global Food Quarterly*. He has been a featured speaker at recent meetings of the American Farm Bureau Association, Farm Credit Council Services, the Texas Farm Bureau, the Arkansas Poultry Federation, and the Virginia Agribusiness Council.



ASSISTANT PROFESSOR IN HYDROLOGY/HYDROGEOLOGY

- The Department of Earth and Geographic Sciences at the University of Massachusetts Boston (UMB) invites applications for a tenure-track Assistant Professor in Hydrology or Hydrogeology. The successful candidate must have a PhD in the geosciences with an established record of publications, grants and teaching. We are seeking a candidate with strong applied research potential. Expertise in GIS and quantitative hydrology is expected. Ideally the candidate would also have teaching experience and a record of obtaining grants. The Department of Earth and Geographic Sciences is within the Science Division of the College of Arts and Sciences and emphasizes quantitative and integrative approaches to earth and geographic studies using information technologies. The Department has a state-of-the-art GIS laboratory that is maintained by a full-time system and network administrator and that houses both PCs and UNIX workstations and most of the commonly used software packages. The Department offers an undergraduate major in Earth and Geographic Science and certificate programs in GIS and hydrogeology. The incumbent would be expected to play a significant role in the further development of the existing undergraduate hydrogeology program. Send a cover letter that includes statements of interest and goals in research and teaching, curriculum vitae, and three letters of reference to: **Search Committee (Box 605), Department of Earth and Geographic Sciences, 100 Morrissey Blvd., Boston, MA 02125. Fax (617) 287-3929 or to zgx@earth.geog.umb.edu.** Application review will begin immediately and continue until position is filled. An Affirmative Action, Equal Opportunity, Title IX employer. Minorities and women are encouraged to apply.

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A WORD FROM OUR PRESIDENT . . . Janet L. Bowers

As the year comes to a close, it seems appropriate to share with the readership of *IMPACT* the accomplishments of AWRA throughout 2000. In January 2000, the AWRA Board of Directors adopted an ambitious "action agenda" of 52 action items focused toward four objectives: (1) foster fiscal growth and sound management of AWRA, (2) establish avenues for advancement of young professionals as future leaders, (3) expand services and outreach to state sections, and (4) achieve technical superiority by focusing on emerging issues most relevant to AWRA's customers. Due to the commitment and efforts of the AWRA staff, committee chairs and members, conference planning committees, Board of Directors, and general membership and customers, all 52 action items were successfully completed. As a result, the following key accomplishments were achieved by AWRA:

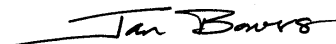
- Achieved an 88 percent retention rate for existing members (exceeding our annual goal) and welcomed over 500 new members during the year.
- The annual budget and revenue projections are anticipated to be met.
- Sponsored three highly successfully conferences in Anchorage, Portland, and Miami.
- Held our inaugural series of stand-alone continuing education courses, with CEU credits.
- Unveiled an updated and expanded AWRA website with numerous information portals, links, and on-line services.
- Established on-line financial transactions at the AWRA website for membership renewal, conference registrations, and other purchases.
- Established 13 new On-Line Technical Committees with individual websites and on-line communications.
- Established and awarded the new *Pyramid Award* to acknowledge the achievements of young professionals in water resources.
- Hosted a "Leadership Forum" for water resources professionals.
- Welcomed a new AWRA state section – the *Philadelphia Metropolitan Area State Section*.
- Conducted visits to eight state sections by members of the Board of Directors.
- Assembled a suite of 13 services available from AWRA National to assist state sections and provided on-line information, communications, and individual websites for all state sections.
- Hosted a state section leadership luncheon.
- Conducted a competitive search and selection of a new Editor for *JAWRA*.

Other initiatives that are being pursued include: expanding the role and presence of AWRA in the global water resources arena; continued advancements in the on-line services and product delivery by AWRA to its members and customers; and exploring opportunities regarding on-line distance learning.

AWRA membership is fortunate to have a staff of seven talented and dedicated individuals whose contributions to our organization are countless. The continued advancement and development of the professional staff during 2000 included:

- *Ken Reid*, Executive Vice President, received the *ASAE Key Award*, their most prestigious recognition of professional achievement.
- *Harriette Bayse IV* joined the AWRA staff as Coordinator of Marketing and New Product Development.

I extend my heartfelt thanks and appreciation to the AWRA staff and each AWRA member whose contribution of time, energy, and talent allowed us to achieve these successes. It has been my honor and pleasure to serve this organization and I wish the best of success to incoming AWRA President *Mr. John Grounds III* and to the 2001 Board of Directors!!



Jan Bowers, AWRA President, 2000

Richard A. Herbert Memorial Scholarship Fund Awards Announced

AWRA has selected the following individuals as recipients for its 2000 **Richard A. Herbert Memorial Educational Scholarship Fund**. Each recipient receives a \$1,000 scholarship.

MICHAEL SEIDER of Neenah, Wisconsin, is the recipient of the Richard A. Herbert Memorial Educational Scholarship, **Undergraduate Student Category**. Mike is enrolled at the University of Wisconsin-Stevens Point, College of Natural Resources, as a fisheries student. He has been recognized for his academic excellence and student involvement and is a member of Phi Kappa Phi and Xi Sigma



Pi. Mike currently serves as the Student Advisory Panel representative for AWRA and was the president of the student chapter of the American Fisheries Society during the 1999-2000 academic year. Besides being very active in fisheries in an academic sense, he is an active fisherman who works hard to conserve the natural resources. Mike's goal is to eventually get a Ph.D. in a water resources subject and teach at the university level.

KURT KELSEY of Marinette, Wisconsin, is the recipient of the Richard Herbert Memorial Educational Scholarship, **Graduate Student Category**. Kurt is enrolled at the University of Wisconsin-Stevens Point, College of Natural Resources, and received his B.S. degree in Watershed Management (five-time Dean's List member), and is now pursuing his Masters of Science Degree in Natural Resources.



Kurt was a member of the UWSP-AWRA Student Chapter for five years (serving as Treasurer during the 1998-1999 term) and has been a National member for the last three years. He is a member of the UWSP Soil and Water Conservation Society Student Chapter and a National member of the International Erosion Control Association. Kurt's goal is to make a difference in society by reducing the amount of sediments entering our water bodies, with the ultimate goal of improving the quality of our water resources. He feels that a job in the erosion control or water conservation fields will provide him with the opportunities he desires to accomplish his goals.



PAPERS APPEARING IN THE JOURNAL OF THE AMERICAN WATER RESOURCES ASSOCIATION OCTOBER 2000 • VOL. 36 • NO. 5

DIALOGUE ON WATER ISSUES

- Should Dams Be Modified for the Probable Maximum Flood?

TECHNICAL PAPERS

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- A GIS-Assisted Distributed Watershed Model for Simulating Flooding and Inundation
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- Water Conservation in Casablanca, Morocco
- Effectiveness of Waste Minimization Projects in Reducing Water Demand by UK Industry
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- Remote Monitoring of Selected Ground-Water Dominated Lakes in the Nebraska Sand Hills
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- Quality of Runoff From Plots With Simulated Grazing
- Velocity and Concentration Distributions of Sediment-Laden Open Channel Flow
- Spectral Analysis of Tidal Fluctuations in Ground Water Level
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- Hydrologic Analysis of Discharge Sustainability From an Abandoned Underground Coal Mine
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JAWRA

Journal of the American Water Resources Association

Portland Conference a Huge Success! AWRA International Conference on Riparian Ecology and Management in Multi-Land Use Watersheds August 28-31, 2000

Reported by
Parker J. Wighting, Jr., Conference Chair
Richard A. Engberg, AWRA Technical Specialist

One of the best technical meetings I have ever attended. This was the comment of the newest member of AWRA who joined at the conclusion of the 2000 Summer Specialty Conference. During August 28-31, 560 people from around the world gathered together to share knowledge and to learn about riparian areas. More than 200 oral and poster presentations provided insights into the ecological, social, and economic aspects of riparian function and management.

Riparian areas are vital interfaces between terrestrial and aquatic ecosystems. They exert strong influences on stream environments and serve as important habitat for plant and animal species. Although management efforts are increasing, knowledge of the integrated function of riparian areas in multi-land use watershed is still quite limited. Increased knowledge of this function was the purpose of the Conference.

The Conference featured 106 platform papers and 87 poster presentations. Six commercial exhibitors also were in attendance. The platform papers were presented over three days during concurrent sessions that were extremely well attended. Posters were displayed during the first two days of the Conference.

Paul Risser from Oregon State University and Henri Decamps from Centre National de la Recherche Scientifique in France started the Conference with keynote talks that stressed the importance of the human dimensions of riparian management. Dr. Risser's topic was "Riparian Corridors - How Many Practical Answers Do We Have?" and Dr. Decamps' topics was "Accounting for Cultural Preferences and Desires in Riparian Ecology and Management." On the second day of the Conference, Joan Nassauer from the University of Michigan continued the theme of the importance of the human dimension of riparian management during her plenary talk entitled "Ecological Innovation: Placing Familiar Expectations in New Landscape Patterns." David Correll, with the Smithsonian Environmental Research Center, focused on an important riparian function during the final plenary talk, "The Current Status of Our Knowledge of Riparian Buffer Water Quality Functions."

A wide range of multi-disciplinary topics were covered during the 27 concurrent sessions and in the poster session. Concurrent topics included: hydrologic flow-paths, western ecosystems and rangelands, social aspects of riparian management, water quality buffers, vegetation - water interactions, temperature, channels - geomorphology, watersheds, ecological function, urban and built-up land, assessment, large woody debris, ecosystem trajectories, fish in multi-land use settings, restoration principles and methods, agriculture and stream condition, forest riparian areas, birds and terres-

trial vertebrates, and the Willamette River Basin. The poster session had many excellent presentations and allowed more in-depth interactions between presenters and the audience than was possible in the oral sessions.



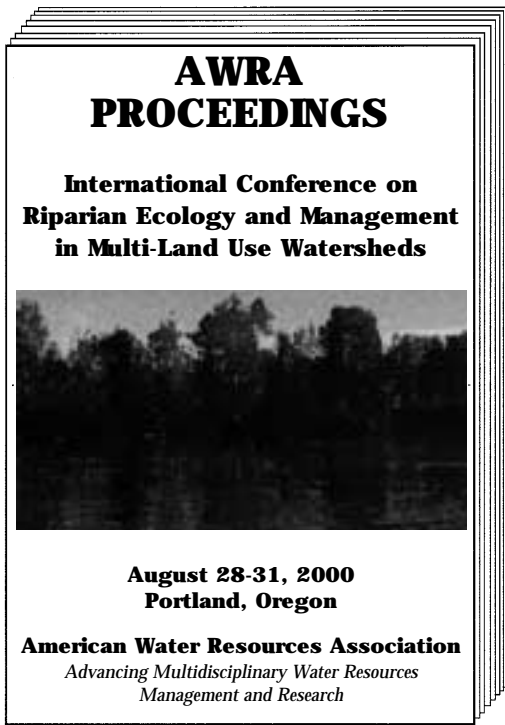
One of 87 Outstanding Posters Displayed at the Conference.

The oral and poster presentations culminated with a synthesis session on Wednesday afternoon. Judy Meyer from the University of Georgia, Tony Prato from the University of Missouri, and Mark Hill with Ecosystem Sciences in Boise, Idaho, provided opening remarks about future directions for riparian management, restoration, and research in multi-land use watersheds. A period of lively and wide ranging questions and comments from the audience followed. Although it is impossible to summarize this session in a few sentences, the presentations and discussions emphasized the importance of multi-disciplinary approaches to riparian research, restoration, and management.

A Welcoming Networking Reception was held for all attendees Monday evening and a Conference Luncheon was held on Wednesday. Two busloads of attendees enjoyed a dinner and the scenery at Multnomah Falls Lodge on Tuesday evening. The last event of the Conference was an all-day field trip in the Willamette River Basin of Oregon. Eighty-six people made visits to urban, agricultural, and forested sites across the basin to learn about riparian management issues in each of these land use settings.

An e-mail/website survey conducted following the Conference received responses from 140 attendees. Seventy percent indicated that the Conference was their first AWRA meeting. Overwhelmingly, the primary reason for attending was the timely topic. A total of 85 percent of the respondents found the presentations excellent-good. (See the following page for an order form for a copy of the Proceedings from this meeting.)





Natural resource issues such as salmon recovery in the Pacific Northwest of the United States highlight the importance of riparian area ecological functions. Riparian areas are vital interfaces between terrestrial and aquatic ecosystems and efforts to manage, protect, and restore riparian areas are increasing worldwide. Knowledge about the integrated functions of riparian areas in multi-land use watersheds and about the influence of social and economic factors on riparian areas is still limited. The goal of this conference was to provide an integrated forum for the presentation and discussion of biological, physical, chemical, social and economic aspects of riparian areas and stream corridors in multi-land use watersheds.

The conference and proceedings were organized around three themes: • **Processes, Functions and Structure of Riparian Areas** – disturbance regimes, landscape and watershed scale processes, vegetation-hydrology interactions, plant-animal interactions, biogeochemistry, fluvial processes and hydrology; • **Multiple Human Influences on Riparian Areas** – social, economic, and ecological topics included cumulative effects at watershed scale, ecosystem trajectories, case studies from urban, agricultural, forest, rangeland settings, and social/economic valuations; and • **Future Management of Riparian Areas – Use and Restoration** – restoration and protection strategies, assessment approaches, watershed analyses, monitoring, model evaluations, ecological constraints and opportunities, design of conservation practices, and methods of study at various scales.

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▲ Water Resources Puzzler (answers on pg. 36)

ACROSS

- 1 America's Cup boat
- 6 water catcher?
- 11 river in Africa
- 14 poetic close-by
- 15 19th Century armored warship
- 17 _____, New York
- 18 ice house
- 20 an Emperor of Rome
- 21 raw egg whites used in glazing
- 23 military officer (abbr.)
- 24 Bening or Funicello
- 26 save for a _____ day
- 27 tone on the diatonic scale
- 28 football player position (abbr.)
- 29 location of the Danube River
- 31 Chairman _____
- 32 _____ Sea
- 34 dead when born
- 37 McMahan or Asner
- 38 queen or honey
- 39 shoe width
- 40 _____-wan Kenobi
- 41 no. of electrons
- 43 explosive situation
- 47 location of the Yukon River
- 49 symbol for tin
- 50 waterway (Brit.)
- 51 Aaron or Greenberg
- 52 42-gallon wine casket
- 55 paradise?
- 57 Walter or Willis
- 59 location of the Mosquite River
- 60 symbol for bromine
- 61 classic drama of Japan
- 63 military badge of distinction
- 67 cloudlike mass of water droplets
- 68 dissimilar
- 71 double curves
- 72 location of Tombigbee River
- 73 location of Pawcatuck River
- 74 remover of water
- 76 arch or gravity
- 77 followed by plain or tide
- 78 for children's safety

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- 13 process of surficial wear
- 16 relating to the spleen
- 19 Toronto's Province
- 22 location of the Ponaganset River
- 25 puller of ships
- 30 Canadian Province
- 31 engulfed by a crowd
- 32 Miami or Manhattan
- 33 followed by manifold or valve
- 35 utensil for dipping liquids
- 36 followed by line or collie
- 41 to temper
- 42 location of Sheyenne River
- 44 rowboat with oarlocks
- 45 committee member (abbr.)
- 46 stigma pollination
- 48 river in Switzerland
- 53 elements of ft.
- 54 producers of canework for chairs
- 56 _____ Gay
- 58 surrounded by an earthen berm
- 60 Persian Gulf port
- 62 to float on the crest of a wave
- 64 not old
- 65 very small quantity
- 66 engineering professional society
- 67 a temporary fashion
- 69 nothing
- 70 vows
- 75 type of current (abbr.)



DOWN

- 1 Black Sea port
- 2 made sacred
- 3 unit of weight of 50 kg
- 4 site of 1899 Peace Conference
- 5 prince of Authurian legend
- 6 enclosed areas in ship's hull
- 7 _____ Sea
- 8 sound navigation ranging
- 9 a Hoosier
- 10 location of Neuse River
- 11 a worthless horse
- 12 not busy

▲ Water Resources Continuing Education Opportunities

MEETINGS, WORKSHOPS, SHORT COURSES

DECEMBER 2000

3-6/2000 Midwest Fish & Wildlife Conf. (62nd Annual), Minneapolis, MN **Contact** (<http://midwest2000.fws.gov>)

3-6/Conf. on Dredged Material Management: Options & Environmental Considerations. MIT, Cambridge, MA. (co-sponsored by several Sea Grant Programs). **Contact** The MIT Sea Grant College Program at sediments@mit.edu or <http://massbay.mit.edu/marinecenter/conference/>

11-12/Monitoring & Evaluating Wetlands for Ground Water and Lake Impacts. Las Vegas, NV. **Contact** NGWA (fax: 614/898-7786; www.ngwa.org/education)

JANUARY 2001

3-5/Second Intern'l. Sym. on Preferential Flow - Water Movement & Chemical Transport in the Environment. Honolulu, HI. **Contact** (800/371-2723; e-m: <http://asae.org>)

15-18/Conf. on Tailings & Mine Waste '01. Colorado State Univ., Ft. Collins, CO. **Contact** Linda Hinshaw, Dept. of Civil Engr., Colorado State Univ., Ft. Collins, CO 80523-1372 (970/491-6081; fax: 970/491-3584; e-m: lhinshaw@engr.colostate.edu)

25-26/Sym. on Spatial Methods for Solutions of Environment. & Hydrol. Problems. Reno, NV. **Contact** Dr. A. Ivan Johnson, 7474 Upham Ct., Arvada, CO 80003-2758 (303/425-5610; fax: 303/425-5655)

22-23/Sixth Caribbean Islands Water Resources Congress. Mayaguez, PR. **Contact** Puerto Rico Water Resources Res. Inst., P.O. Box 9040, Mayaguez, PR 00681-9040 (787/265-3826; fax: 787/832-0119; e-m: WRRI_RUM@rumac.upr.clu.edu)

MARCH 2001

11-14/American Water Works Association - Infrastructure Conf. Orlando, FL. **Contact** AWWA, 6666 W. Quincy Ave., Denver, CO 80235

14-17/Riparian Habitat & Floodplains. Sacramento, CA. **Contact** Diana Craig (707/562-8930; e-m: drcraig01@fs.fed.us; <http://www.tws-west.org/riparian>)

20-23/Arid West Conf. 2001. Albuquerque, NM. **Contact** Les Bond (505/682-1359; e-m: bond@wazoo.com; web: <http://www.weather.nmsu.edu/nmfma/index.htm>)

20-23/Small Watershed Programs: Past, Present, & Future - 7th Nat'l. Watershed Conf. Richmond, VA. **Contact** John W. Peterson, Nat'l. Watershed Coalition, 9304 Lundy Ct., Burk, VA 22015-3431 (703/455-6886; fax: 703/455-6888; e-m: jwpeterson@erols.com)

APRIL 2001

4-6/Eleventh Tennessee Water Res. Sym. Montgomery Bell State Park, Burns, TN. **Contact** Dr. John "Jack" Gordon, TTU, Civil & Environ. Engr., Prescott Hall 216, Box 5015, Cookeville, TN 38505 (931/372-3257; fax: 931/372-6352; e-m: jgordon@tntech.edu)

30-May 2/AWRA's Spring Specialty Conf. - Water Quality Monitoring and Modeling. San Antonio, TX. **Contact** AWRA, 4 West Federal St., P.O. Box 1626, Middleburg, VA 20118-1626 (540/687-8390; fax: 540/687-8395; e-m: info@awra.org)

MAY 2001

9-12/Lake Superior Geology - 47th Annual Institute. Madison, WI. **Contact** 47th Annual Inst. on Lake Superior Geology, c/o M.G. Mudrey, Jr., WI Geological & Natural History Survey, 3817 Mineral Pt. Rd., Madison, WI 53705 (608/263-2495; fax: 608/262-8056; e-m: mgmudrey@facstaff.wisc.edu; web: <http://www.ilsgeology.org/2001mtg.html>)

20-24/World Water and Environmental Resources Congress. Orlando, FL. **Contact** www.asce.org/conferences/wwercongress

31-June 2/Water & Rural History. Reno, NV. **Contact** W.D. Rowley, History Dept., Univ. of NV, Reno, NV 89557 (e-m: rowley@scs.unr.edu)



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5-9/Intern'l. Erosion Control Assn. - 32nd Annual Conf. Las Vegas, NV. **Contact** IECA, P.O. 774904, Steamboat Springs, CO 80477-4904 (970/879-3010; fax: 970/879-8563; ecinfo@ieca.org; <http://www.ieca.org>)

JUNE 2001

- 3-8/Association of State Floodplain Managers - 25th Annual Conf. Charlotte, N.C. **Contact** asfpm, 2809 Fish Hatchery Rd., Ste. 204, Madison, WI 53713-3120 (608/274-0123; fax: 608/274-0696; e-m: asfpm@floods.org; <http://www.floods.org>)
- 6-8/2001 Watersheds of Change - Canadian Water Res. Assn. - 54th Annual Conf. Guelph, Ontario, Canada. **Contact** CWRA, www.cwra.org
- 6-8/ECOSUD 2001 - 3rd Intern'l. Conf. - Ecosystems & Sustainable Development. Alicante, Spain. **Contact** Conf. Secretariat, <http://www.wessex.ac.uk/conferences/2001/ecosud01/>
- 10-15/5th Intern'l. Conf. - Diffuse/Nonpoint Pollution & Watershed Mgmt. Milwaukee, WI. **Contact** IWA Conf. c/o Inst. for Urban Environmental Risk Mgmt., Marquette Univ., Milwaukee, WI 53201-1881 (fax: 414/288-7521; e-m: mburkart@nstl.gov; <http://www.mu.edu/environment/iwa-page.htm>)
- 18-27/6th Scientific Assembly of the Intern'l. Assn. of Hydrological Sciences. Maastricht, The Netherlands. **Contact** IAHS Maastricht 2001, c/o Conf. Agency Limburg, P.O. Box 1402, 6201 BK Maastricht, The Netherlands
- 25-27/3rd Intern'l. Conf. - Future Groundwater Resources at Risk. Lisbon, Portugal. **Contact** L. Ribeiro, Centro De Valoizacao de Recursos Minerais DO I.S.T., I.S.T. Av. Rovisco Pais 1096, Lisboa, Codex, Portugal (351-1-841 72 47; fax: 351-1-841 74 42)
- 27-30/Joint AWRA/UCOWR Summer Specialty Conf. - Decision Support Systems for Water Resources Mgmt. Snowbird, UT. **Contact** AWRA, 4 West Federal St., P.O. Box 1626, Middleburg, VA 20118-1626 (540/687-8390; fax: 540/687-8395; e-m: info@awra.org)**
- 27-30/Transbasin Water Transfers - U.S. Committee on Irrigation & Drainage. Denver, CO. **Contact** Larry D. Stephens (303/628-5430; fax: 303/628-5431; e-m: stephens@uscid.org)

JULY 2001

- 30-Aug. 2/Managing River Flows for Biodiversity: A Conf. on Science, Policy, & Conservation Action. Ft. Collins, CO. **Contact** Nicole Silk (e-m: nsilk@tnc.org; www.freshwaters.org/ccwp/conference.html)
- 18-27/Intern'l. Association of Hydrological Sciences - 6th Scientific Assembly. Maastricht, The Netherlands. **Contact** IAHS Maastricht 2001, c/o Conference Agency Limburg, P.O. Box 1402, 6201 BK Maastricht, The Netherlands (43 3619192; fax: +31 43 3619020; e-m: cal.conferenceagency@wx.nl)

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SEPTEMBER 2001

- 10-12/Environmental Health Risk 2001. Cardiff, Wales, UK. **Contact** Conf. Secretariat RBM 2001, Wessex Inst. of Technology, Ashurst Lodge, Ashurst, Southampton SO40 7AA, UK (<http://www.wessex.ac.uk/conferences/2001/envh01/>)
- 11-13/River Basin Mgmt. 2001. Cardiff, Wales, UK. **Contact** Conf. Secretariat RBM 2001, Wessex Inst. of Technology, Ashurst Lodge, Ashurst, Southampton, SO40 7AA, UK (<http://www.wessex.ac.uk/conferences/2001/river01/>)
- 11-14/Modflow 2001 and Other Modeling Odysseys - Intern'l. Ground Water Modeling Conf. & Workshops. Golden, CO. **Contact** Internat'l. Ground Water Modeling Ctr., 1500 Illinois St., Colorado School of Mines, Golden, CO 80401. (303/273-3103; fax: 303/384-2037; e-m: igwmc@mines.edu)
- 19-21/Introductory & Advanced Workshops on USEPA, SWMM4.4 & PCSWMM GIS 2000 Stormwater Modeling. Toronto, ON, Canada. **Contact** Dr. Lyn James, CHI, 36 Stuart St. Guelph, ON, Canada N1E 4S5 (519/767-0197; fax: 519/767-2770; e-m: info@chi.on.ca; web: <http://www.chi.on.ca>)

22-23/Conf. on Stormwater & Urban Water Systems Modeling. Toronto, ON, Canada. **Contact** Dr. Lyn James, CHI, 36 Stuart St. Guelph, ON, Canada N1E 4S5 (519/767-0197; fax: 519/767-2770; e-m: info@chi.on.ca; web: <http://www.chi.on.ca>)

24-26/Water Resources Mgmt. 2001. Halkidiki, Greece. **Contact** Conf. Secretariat WRM 2001, Wessex Inst. of Technology, Ashurst Lodge, Ashurst, Southampton, SO40 7AA, UK (<http://www.wessex.ac.uk/conferences/2001/wrm01/>)

NOVEMBER 2001

12-15/AWRA's Annual Water Res. Conf. Albuquerque, NM. **Contact** AWRA, 4 West Federal St., P.O. Box 1626, Middleburg, VA 20118-1626 (540/687-8390; fax: 540/687-8395; e-m: info@awra.org)

CALLS FOR ABSTRACTS

ASAP (Abstracts Due)

Environmental Health Risk 2001. September 10-12, 2001. Cardiff, Wales. **Contact** Conf. Secretariat RBM 2001, Wessex Inst. of Technology, Ashurst Lodge, Ashurst, Southampton, SO40 7AA, UK (<http://www.wessex.ac.uk/conferences/2001/envh01/>)

ASAP (Abstracts Due)

River Basin Mgmt. 2001. September 11-13, 2001. Cardiff, Wales. **Contact** Conf. Secretariat RBM 2001, Wessex Inst. of Technology, Ashurst Lodge, Ashurst, Southampton, SO40 7AA, UK (<http://www.wessex.ac.uk/conferences/2001/river01/>)

DECEMBER 31, 2000 (Abstracts Due)

Managing River Flows for Biodiversity: A Conference on Science, Policy, & Conservation Action. July 30-August 2, 2001. Colorado State Univ., Ft. Collins, CO. **Contact** Nicole Silk (e-m: nsilk@tnc.org; www.freshwaters.org/ccwp/conference.html)

JANUARY 12, 2001 (Abstracts Due)

2001 Watersheds of Change – Canadian Water Resources Assn. – 54th Annual Conf. June 6-8, 2001. Guelph, Ontario, Canada. **Contact** Reid Kreutzwiser, Dept. Geography, Univ. of Guelph, Guelph, ON N2L 3G1 (549/824-4120; fax: 519/837-2940; e-m: reidk@uoguelph.ca)

JANUARY 15, 2001 (Abstracts Due)

Modflow 2001 & Other Modeling Odysseys – Internat'l. Ground Water Modeling Conf. & Workshops. September 11-14, 2001. Golden, CO. **Contact** Internat'l. Ground Water Modeling Ctr., 1500 Illinois St., Colorado School of Mines, Golden, CO 80401; (303/273-3103; fax: 303/384-2037; e-m: igwmc@mines.edu); submit abstract to: <http://www.mines.edu/igwmc/events/modflow2001>

JANUARY 22, 2001 (Abstracts Due)

Joint AWRA/UCOWR Summer Specialty Conf. – “Decision Support Systems for Water Resources Mgmt.” June 27-30, 2001. Snowbird, Utah. **Contact** AWRA, 4 West Federal St., P.O. Box 1626, Middleburg, VA 20118-1626 (540/687-8390; fax: 540/687-8395; e-m: info@awra.org)

JANUARY 30, 2001 (Abstracts Due)

Conf. on Stormwater & Urban Water Systems Modeling. February 22-23, 2001. Toronto, ON, Canada. **Contact** Dr. Lyn James, CHI, 36 Stuart St. Guelph, ON, Canada N1E 4S5 (519/767-0197; fax: 519/767-2770; e-m: info@chi.on.ca; web: <http://www.chi.on.ca>)



FEEDBACK! . . .

Let us know what you think. We want to encourage dialogue. Write or e-mail your comments to the Associate Editor or to me. We appreciate everyone who has sent their comments to us so far and ask that you continue to do so. We would like to get everyone involved in some “conversation” on various topics.

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

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HISTORICAL ASPECTS OF WATER RESOURCES
 E-MAIL: rhmccuen@eng.umd.edu

NOVEMBER 2001

JONATHAN JONES, ASSOCIATE EDITOR
URBAN BMPS AND RECEIVING WATER IMPACT
 E-MAIL: krwright@wrightwater.com

JANUARY 2002

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Solution to Puzzle on pg. 32

1	Y	2	A	3	C	4	H	5	T	6	B	7	A	8	S	9	I	10	N	11	N	12	I	13	L	14	E
14	A	15	N	16	E	17	A	18	R	19	I	20	R	21	O	22	N	23	C	24	L	25	A	26	D	27	R
17	L	18	O	19	N	20	G	21	I	22	S	23	L	24	A	25	N	26	D	27	I	28	G	29	L	30	O
20	T	21	I	22	T	23	U	24	S	25	G	26	L	27	A	28	I	29	30	31	32	33	34	35	36	37	38
24	A	25	N	26	N	27	E	28	T	29	T	30	E	31	R	32	A	33	34	35	36	37	38	39	40	41	42
28	T	29	E	30	A	31	U	32	S	33	T	34	N	35	A	36	M	37	38	39	40	41	42	43	44	45	46
32	B	33	E	34	R	35	I	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
37	E	38	D	39	N	40	B	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
41	A	42	A	43	T	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65
47	C	48	A	49	N	50	A	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70
51	H	52	A	53	N	54	K	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74
57	R	58	E	59	E	60	D	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
62	S	63	A	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87
68	U	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
73	R	74	I	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
77	F	78	L	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102

AWRA MEMBERSHIP APPLICATION – 2001

American Water Resources Association
4 West Federal St. • P.O. Box 1626 • Middleburg, VA 20118-1626
(540) 687-8390 • Fax: (540) 687-8395 • E-Mail: 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 NO.

► **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).....\$120.00
- STUDENT MEMBER (IMPACT) FULL YEAR ONLY.....\$25.00
- INSTITUTIONAL MEMBER (JAWRA, IMPACT, & PROC.).....\$225.00
- CORPORATE MEMBER (JAWRA, IMPACT, & PROC.).....\$325.00
- AWRA NETWORKING DIRECTORY (MEMBERSHIP LISTING).....\$5.00
- MEMBERSHIP CERTIFICATE.....\$6.00

► **FOREIGN AIRMAIL OPTIONS:** PLEASE 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

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

DEMOGRAPHIC CODES

(PLEASE LIMIT YOUR CHOICE TO ONE IN EACH CATEGORY)

JOB TITLE CODES

- JT1 Management (Pres., VP, Div. Head, Sect. 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 | IN Industry |
| EI Educational Institution (faculty/staff) | LF Law Firm |
| ES Educational Institution (student) | FG Federal Government |
| LR Local/Regional Gov't. Agency | RE Retired |
| SI State/Interstate Gov't. Agency | NP Non-Profit Organization |
| | OT Other |

WATER RESOURCES DISCIPLINE CODES

- | | |
|-----------------------------------|----------------------|
| AG Agronomy | HY Hydrology |
| BI Biology | JR Journalism |
| CH Chemistry | LA Law |
| EC Economics | LM Limnology |
| ED Education | OE Oceanography |
| EG Engineering | PH Physics |
| FO Forestry | PS Political Science |
| GR Geography | PB Public Health |
| GE Geology | SO Soil Science |
| GI Geographic Information Systems | OT Other |

EDUCATION CODES

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

PLEASE NOTE YOUR SELECTED CODE NUMBERS FROM ABOVE

JOB TITLE CODE	<input type="text"/>
EMPLOYER CODE	<input type="text"/>
WATER RESOURCES DISCIPLINE CODE	<input type="text"/>
EDUCATION CODE	<input type="text"/>

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Send us your feedback on this issue (comments on previous issues are also welcome) . . . Water Resources IMPACT has been in business for a almost two years 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're doing. Send your letters by land-mail or e-mail to Jefferson G. Edgens (Associate Editor for this issue) or if you prefer, send your letters to Earl Spangenberg (Editor-in-Chief). 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.

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AWRA

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