

IN THIS ISSUE

Feature

Envisioning the Agenda for Water Resources Research in the 21st Century

New Reports

Assessing the TMDL Approach to Water Quality Management, p. 3

Classifying Drinking Water Contaminants for Regulatory Consideration, p. 5

Compensating for Wetland Losses Under the Clean Water Act, p. 7

Current Projects, p. 6

Future Projects, p. 10

WSTB Reports, p. 12

WSTB New Membership, p. 12

National Research Council Meetings, p. 9

Find us at the web:
nationalacademies.org/wstb

Printed on recycled paper

Envisioning the Agenda for Water Resources Research in the Twenty-first Century

Henry J. Vaux, Jr.

Available evidence suggests that projected population growth, economic growth, and the need to preserve and enhance aquatic ecosystems will combine to create more intense pressures on U.S. water resources in the 21st century than was the case in the 20th century. Even as these pressures mount, important transitions are occurring in water management as the efficacy of dams is challenged, as questions are raised about potential changes in the hydrologic cycle and increased hydrologic uncertainty, and as new technology that permits innovative water management becomes available. These factors stimulated a series of discussions by the Water Science and Technology Board about the future of the nation's water resources and the appropriate research needed to promote sustainable management of those resources. The result is a cohesive national water resources research vision for the twenty-first century, which is presented in a new report entitled, *Envisioning the Agenda for Water Resources Research in the Twenty-first Century* (available online at <http://www.nap.edu>). This research agenda represents the consensus judgment of the WSTB about what research is likely to be most important in the early part of this century.

The report contains 43 recommendations that are cast broadly in three categories: **water availability**, focusing on matters that affect water supply including water quality; **water use**, dealing with factors that affect wants and demands for water; and **water institutions**, discussed separately to emphasize the need for relatively more research in this area and to recognize that answers to institutional questions frequently depend upon research

from the social sciences.

Water Availability

The report concludes that investigations of surface water and groundwater availability should focus on (1) the development of supply enhancing technologies, including desalting technologies and treatment technologies to promote reuse; (2) improving the understanding of linkages between the hydrologic and biogeochemical cycles that affect water quality; and (3) development of techniques and technologies to stem declines in water quality. The report emphasizes the need for more and better data to understand how water availability responds to variable climates at different temporal and spatial scales. Data from

continues on page 2

2002 Abel Wolman Lecture

January 24, 2002
National Academy of Sciences
Washington, D.C.

A Global Thirst for Safe Water: The Case of Cholera

By Rita Colwell
Director, National Science Foundation

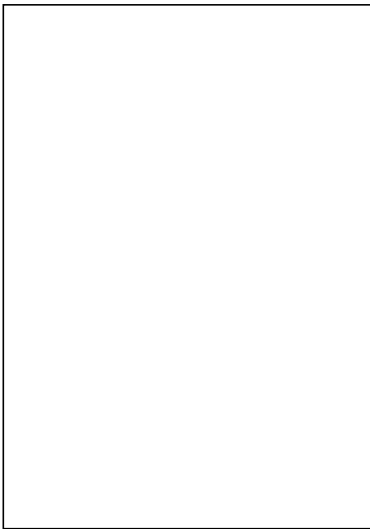
Assuring a safe water supply—both in quantity and quality—is becoming a more critical challenge globally as world population continues to grow. The scourge of cholera, a water-borne disease, provides a framework for looking at the multi-dimensional issue of water supply. An interdisciplinary research approach, employing sophisticated new tools such as information technology and satellite remote-sensing, alongside simple and culturally appropriate technologies on the local level, is helping us to make progress toward mitigating, predicting, and ultimately, preventing cholera epidemics. Mark your calendars!

Envisioning the Agenda

networks of continuous ground-based and remote sensing instrumentation will be particularly critical. Improved monitoring—and monitoring techniques—will be important for resource planning and regulatory activities and for assessing the effectiveness of water policies and management efforts.

Water Use

New and comprehensive investigations of the determinants of consumptive uses of water are needed since existing knowledge about determinants is either incomplete or outmoded. Irrigated agriculture is likely to remain the dominant consumptive user of water although the patterns and extent of use are likely to change. Improved methods of managing irrigation water, new and improved techniques of dryland farming, and assessments of the potential of genetic alteration for improving crop water use are among the priority topics here. Research is also needed to understand better the environmental roles of water. Aquatic ecosystems should be understood in a broad systems context if they are to be managed effectively. Research is needed to determine the water requirements necessary to maintain environmental functions such as the provision of wildlife



New technologies for removing pathogens, such as this microfiltration unit, will be needed to help ensure that wastewater is safe for potable reuse.

habitat, flood control and assimilation of contaminants. Other priority topics in this category include research to improve understanding of relationships between land and water resources—knowledge that is needed for effective watershed management, and research on issues related to the protection of species diversity in aquatic habitats.

Water Institutions

Noting that many of the nation's water institutions were devised in the 19th century in response to 19th century problems, the report recommends that new emphasis be given to institutional research if the innovative water institutions required to address the water problems of the 21st century are to emerge. Research is needed to help develop improved laws and policies, which will foster conjunctive use of ground and surface water; efficient and equitable use of transboundary waters; to clarify and resolve issues related to Native American water rights; and to facilitate the use of adaptive management schemes. Further research is needed to develop improved means for estimating the value of water in alternative uses. Studies focused on the potential of economic institutions to protect common pool and public good values are also needed as is work on the role of pricing, pricing structures, and markets in resolving water problems. The report also notes that there are a number of emerging social science issues that require the participation of anthropologists, geographers, political scientists, psychologists and sociologists in water research. Among these issues are: (1) the role of perceptions, particularly perceptions about risk, in devising water management plans; (2) how to elicit and account for stakeholder preferences; (3) the identification of cultural, religious and ethical facets associated with water use; and (4) analyses of over a century of water policy experi-



Certain flow regimes, like annual floods, are vital for maintaining the habitat of many migratory birds, such as these Sandhill cranes along the Platte River in Nebraska. These hydrologic regimes are often disrupted by dam construction. Photograph courtesy of Elizabeth Rogers.

ence to identify strategies that worked and those that did not.

Implementation

Finally, the report finds that investment in water research and existing organizational arrangements for guiding such investment are inadequate to meet the needs of the 21st century. Water research for the 21st century should be planned and prioritized in a systematic way. The report urges the creation of a national water research board, with representation from state and federal governments, research institutions, users and purveyors, nonprofit organizations and public interest groups. Effective implementation and administration of a strategic and proactive research agenda to be developed by the research board should provide the justification and accountability for augmented levels of investment in water resources research.

This study represents the effort of about 25 individuals who served on the WSTB from 1998-2001, and several federal agency liaison representatives as well. It was led by Henry J. Vaux, Jr. of University of California, Oakland, who chaired the WSTB during this period. To order the report, contact the Water Science and Technology Board at 202-334-3422 or visit their website at <http://www.nap.edu>.

Henry J. Vaux, Jr. is the outgoing chair of the Water Science and Technology Board (see page 12).

Assessing the Total Maximum Daily Load Approach to Water Quality Management

By Laura Ehlers

Over the last 30 years, water quality management in the United States has been driven by control of point sources of pollution and the use of effluent-based water quality standards. Although the quality of the nation's waters has generally improved, this focus on point sources has not achieved the Clean Water Act's goals of "fishable and swimmable" waters largely because discharges from other unregulated nonpoint sources of pollution have not been as successfully controlled. This is the context in which EPA implements the Total Maximum Daily Load (TMDL) program, the objective of which is attainment of ambient water quality standards through the control of both point and nonpoint sources of pollution. Under 1992 TMDL regulations, states must list waters that are not meeting water quality standards and then identify the amount by which point and nonpoint sources of pollution must be reduced in order for the waterbody to meet its stated water quality standards. Meeting these requirements, many of which have been imposed by court order or consent decree, has become the most pressing regulatory water quality challenge for the states since passage of the Clean Water Act. There are about 21,000 polluted river segments, lakes, and estuaries requiring more than 40,000 TMDLs. Under the 1992 EPA guidance, states are required to meet an 8- to 13-year deadline for completion of TMDLs. Budget requirements for the program are staggering, with most states claiming to not have the resources necessary to assess the condition of their waters, to list impaired waters, and to develop TMDLs.

Following issuance by EPA of updated TMDL regulations, in November 2000 Congress requested that the WSTB assess the scientific basis of the TMDL program. Of concern to the nation's lawmakers was the paucity of data and information available to the states to comply with program requirements and meet water quality standards.

Following an intense study between January and March, the resulting report, *Assessing the Total Maximum Daily Load Approach to Water Quality Management*, targets recommendations at (1) those issues where science can and should make a significant contribution and (2) barriers (regulatory and otherwise) to the use of science in the TMDL program. The eight-member committee met three times during a three-month period and heard the testimony of over 40 interested organizations and stakeholder groups.

TMDL Program Goals

The report lays out three broad goals for the program. First, it urges TMDL managers to focus first and foremost on improving the condition of waterbodies *as measured by attainment of designated uses*. Working to meet strict time demands within the budget constraints cited by most states has focused on administrative outcomes as measures of success for the TMDL program. Second, the program should encompass all stressors that determine the condition of the waterbody. Proposed regulations may limit the applicability of the program to only those water quality problems caused by chemical and physical pollutants. Finally, scientific uncertainty is a reality within all water quality programs that cannot be entirely eliminated. The states and EPA should move forward with decision-making and implementation of the TMDL program in the face of this uncertainty while making substantial efforts to reduce uncertainty.

Changes to the TMDL Process

Science plays a crucial role in the standards setting process, in the decision to list impaired waters, in the development of the TMDL plan, and in the allocation of pollutant loads among various sources. Although the state of the science is sufficient to develop TMDLs to meet ambient water quality goals in many situations, programmatic

issues substantially hinder the use of the best available science. Thus, two major programmatic changes in the TMDL process are recommended.

First, EPA should approve the use of both a *preliminary list* and an *action list* instead of one "303d" list. Many waters now on state 303d lists were placed there without the benefit of adequate water quality standards, data, or waterbody assessment. These potentially erroneous listings contribute to a very large backlog of TMDLs and foster the perception of a problem that is larger than it may be. States should be allowed to move those waters for which there is a lack of adequate water quality standards or data and analysis from the 303d list back to a preliminary list, as shown in Figure 1. The report states that if no legal mechanism exists to bring this about, one should be created by Congress.

Second, TMDL plans should employ iterative, adaptive implementation and revision. Adaptive implementation

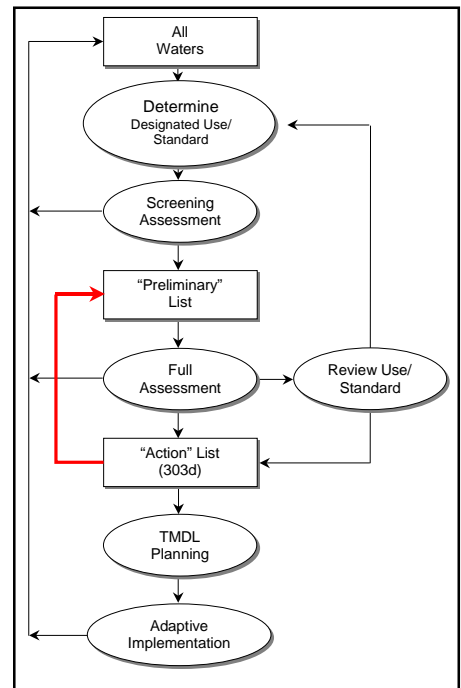


FIGURE 1 Framework for Water Quality Management

continued on page 4

TMDL Approach

is a cyclical process in which TMDL plans are periodically assessed for their achievement of water quality standards including designated uses. If the implementation of the TMDL plan is not achieving attainment of the designated use, scientific data and information should be used to revise the plan. Adaptive implementation is needed to ensure that the TMDL program is not halted due to a lack of data and information, but rather makes forward progress while better data are collected and analyzed with the intent of improving upon initial TMDL plans.

Use of Science in the TMDL Program

The following sections discuss the use of science in the TMDL program steps as illustrated in Figure 1.

Water Quality Standards. The TMDL process is primarily a measurement process and as such is significantly impacted by the setting of water quality standards. Water quality standards consist of two parts: a specific designated use appropriate to the waterbody and a criterion that can be measured to establish whether the designated use is being achieved. The report states that criteria should be defined in terms of magnitude, frequency, and duration. Establishing these three dimensions of the criterion is crucial for successfully developing water quality standards and subsequently TMDLs. In addition, biological criteria should be used in conjunction with physical and chemical criteria to determine whether a waterbody is meeting its designated use. In general, biological criteria are more closely related to the designated uses of waterbodies than physical or chemical measurements. In many states, there is a fundamental discrepancy between the criteria that have been chosen to determine whether a waterbody is achieving its designated use and the frequency with which water quality data are collected. Thus, water quality standards must be measurable by reasonably obtainable monitoring data.

Waterbody Assessment and Listing. Ambient monitoring and assessment programs should form the basis for determining whether waters are placed on the preliminary list or the action list. EPA needs to develop a uniform consistent approach to ambient monitoring and data collection across the States. The rotating basin approach used by several states is an excellent example of a framework that can be used to conduct waterbody assessments of varying levels of complexity, for example to place impaired waters on a preliminary or action list and to develop TMDLs. In that regard, the report recommends that EPA set the TMDL calendar in concert with each state's rotating basin program.

TMDL Development. TMDL development requires a wide variety of models to relate waterbody conditions to different land uses and other factors. The report makes several recommendations about the use of such models. In particular, it notes that uncertainty must be explicitly acknowledged both in the models selected to develop TMDLs and in the results generated by those models. The TMDL program currently accounts for the uncertainty embedded in the modeling exercise by applying a margin of safety (MOS). EPA should end the practice of arbitrary selection of the MOS and instead require uncertainty analysis as the basis for MOS determination.

The report advocates the development of models that can more effectively link environmental stressors (and control actions) to biological responses. Both mechanistic and empirical models

will be needed, although empirical models are more likely to fill short-term needs. Monitoring and data collection programs need to be better coordinated with anticipated water quality and TMDL modeling requirements. For many parameters, there are insufficient data to have confidence in the results generated by some of the complex models used in practice today. Thus, EPA should not advocate detailed mechanistic models for TMDL development in data-poor situations.

Through the adoption and use of the preliminary/action list approach, adequate monitoring and assessment approaches, sound selection of appropriate models, and adaptive implementation described above, the TMDL program will be capable of utilizing the best available scientific information. The report notes that the success of these approaches is directly related to the provision of adequate personnel and financial resources for data collection, management, and interpretation and for the development of sufficiently detailed and stratified water quality standards.

The study was funded by the Environmental Protection Agency and chaired by Kenneth Reckhow of Duke University. To order the report, contact the National Academy Press at 800-624-6242 or visit their website at <http://www.nap.edu>.

Laura Ehlers is a Senior Staff Officer with the Water Science and Technology Board.

WATERWORKS

John Cairns, Jr. was presented the 2001 Ruth Patrick Award for Environmental Problem Solving by the American Society of Limnology for his outstanding applications of aquatic science in ecosystem recovery and restoration. He is a professor (emeritus) and director (emeritus) of University Center for Environmental and Hazardous Materials Studies, Department of Biology, Virginia Polytechnic Institute and State University. He is a member of the National Academy of Science and has served in many NRC committees, including the WSTB of which he was a founding member.

Classifying Drinking Water Contaminants for Regulatory Consideration

By Mark Gibson

The provision of safe drinking water has been an important factor in improving public health in U.S. communities since the turn of the 20th century. Despite advances in water treatment, source water protection efforts, and the presence of several layers of local, state, and federal regulatory protection, many sources of raw and finished public drinking water in the United States periodically contain chemical, microbiological, and other types of contaminants at detectable and sometimes harmful levels. Furthermore, the production and use of new chemicals that can reach water supplies and the discovery of emerging microbial pathogens that potentially can resist traditional water treatment practices and/or grow in distribution systems pose a regulatory dilemma: Where and how should the U.S. government focus its attention and limited resources to ensure safe drinking water supplies for the future?

To help address these difficult issues, one of the major requirements of the Safe Drinking Water Act (SDWA) Amendments of 1996 is that every five years the U.S. Environmental Protection Agency (EPA) publish a list of unregulated chemical and microbial contaminants and contaminant groups that are known or anticipated to occur in public water systems and may pose risks in drinking water. The first such list, called the Drinking Water Contaminant Candidate List (CCL), was published in March 1998 under pressing time constraints stipulated by the amended SDWA. The primary function of the CCL is to provide the basis for deciding whether to regulate new contaminants from the list every five years. However, it is also used to prioritize additional research and monitoring on these contaminants.

Previous Committee Work, and the New Charge

This is the third and final report of the Committee on Drinking Water Contaminants. The committee was formed in 1998 at the request of EPA's Office of

Ground Water and Drinking Water to provide advice regarding the setting of priorities among drinking water contaminants in order to identify those contaminants that pose the greatest threats to public health. The committee was comprised of 14 experts in water treatment engineering, toxicology, public health, epidemiology, water and analytical chemistry, risk assessment, risk communication, public water system operations, and microbiology.

In its first report, *Setting Priorities for Drinking Water Contaminants*, the committee recommended a phased decision-making process, time line, and related criteria to assist EPA efforts to set priorities and decide which contaminants already on a CCL should be subjected to regulation development, increased monitoring, or additional health effects, treatment, and analytical methods research. That report also includes a review of several past approaches to setting priorities for drinking water contaminants and other environmental pollutants. The second report, entitled *Identifying Future Drinking Water Contaminants*, provided a conceptual two-step approach to the creation of future CCLs. It recommended that this

process should be made more scientifically defensible and transparent, and its development should take place with increased opportunities for public input and comment.

For present study, EPA asked the committee to further develop this new conceptual approach to the generation of future CCLs. In addition, EPA asked the committee to explore the feasibility of developing and using mechanisms for identifying emerging microbial pathogens (using what the committee now terms virulence-factor activity relationships, or VFARs; discussed below) for research and regulatory activities—also as recommended in the second report.

A Two-step Process for Creating Future CCLs

Despite data and resource limitations, this report continues to recommend that EPA develop and use a two-step process for creating future CCLs (see Figure 1). In this process, a broadly defined universe of potential drinking water contaminants would first be identified, assessed, and culled to a preliminary CCL (PCCL) that is likely to be on the order of several thousands of substances and microorganisms, using

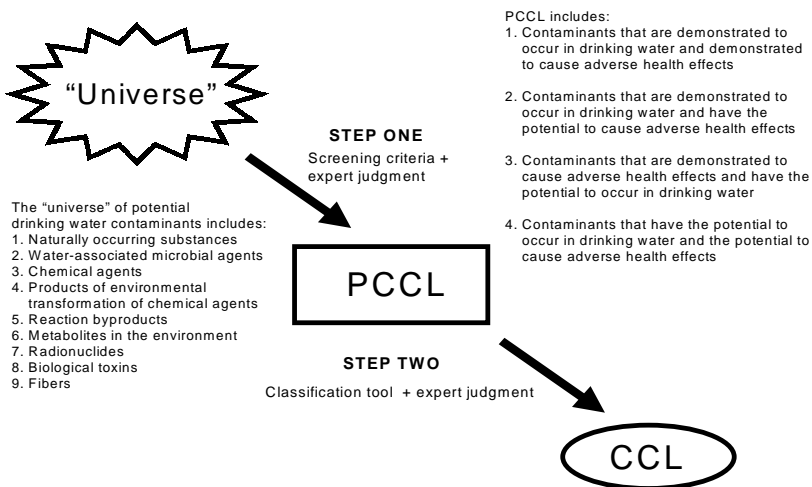


FIGURE 1 Recommended two-step process for developing future CCLs.

continued on page 6

Drinking Water Contaminants

simple screening criteria and expert judgment. To create the corresponding CCL, all PCCL contaminants would then be assessed individually using a "prototype" classification tool (neural network or similar methods) in conjunction with expert judgment to evaluate the likelihood that they could occur in drinking water at levels and frequencies that pose a public health risk. This two-step process would be repeated for each CCL development cycle to account for new information.

The report recommends a generally conservative approach to this process that errs on the side of public health protection. It also urges that the selection process place high priority on the protection of vulnerable subpopulations as intended by the SDWA Amendments of 1996.

Virulence-factor Activity Relationships (VFARs)

In this report, the committee also explored the feasibility of developing VFARs (virulence-factor activity relationships) as a tool to help identify emerging waterborne pathogens, and provided some initial guidance and recommendations on the necessary steps for their construction and use. A VFAR is defined as the known or presumed linkage between the biological characteristics of a microorganism and its real or potential ability to cause harm (pathogenicity). The term is rooted in a recog-

nition of the utility of using (quantitative) structure-activity relationships (QSARs or SARs) to compare the structure of new chemicals to known chemicals to enable prediction of their toxicity. Research has increasingly shown certain common characteristics of virulent pathogens such as the production of specific toxins, specific surface proteins, and specific repair mechanisms that enhance their ability to infect and inflict damage in a host. Recently some of these "descriptors" have been tied to specific genes, and it has become evident that the same can be done for other descriptors as well. Identification of these descriptors, either directly or through analysis of genetic databases, could become a powerful tool for estimating the potential virulence of a microorganism. This is particularly true for two important aspects of virulence: potency and persistence in the environment. The report conceives of VFARs as being the relationship that ties specific descriptors to outcomes of concern as illustrated in Figure 2.

The report reviews several aspects of feasibility of the VFAR concept for adoption and use by the EPA. These include scientific validity and applica-

bility; technological feasibility; application of these technologies to studying disease in humans (validation); the degree to which these methodologies are being universally adopted within the scientific community; and the need for their development and use to adhere to the principles of transparency, public participation, and other sociopolitical considerations. These elements either are present or can reasonably be expected to be available in the near future, so the report concludes that the use of VFARs is indeed feasible.

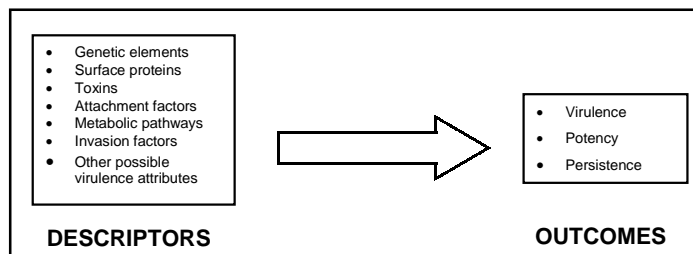


FIGURE 2 Schematic drawing of VFAR predicting outcomes of concern (virulence, potency, persistence) using the presence or quality of descriptor variables.

The committee chair was Deborah Swackhamer of the University of Minnesota, and the vice chair was R. Rhodes Trussell of Montgomery Watson, Inc. Funding was provided by EPA's Office of Ground Water and Drinking Water. To order the report, contact National Academy Press at (800) 624-6242, <http://www.nap.edu>.

Mark Gibson is a Staff Officer with the Water Science and Technology Board.

CURRENT PROJECTS

Restoration of the Greater Everglades

The committee on the Restoration of the Greater Everglades Ecosystem (CROGEE) is providing a scientific overview and technical assessment of the many complicated, interrelated activities that are occurring at the federal, state, local and non-governmental levels. In addition to strategic assessment and guidance, the committee provides more focused advice on technical topics of importance to restoration efforts. The committee met in February and in April to discuss performance measures for

restoration. At the February meeting at Everglades National Park, efforts were focused on the Ridge-and-Slough and Mangrove Estuary systems. Also at this meeting, the NRC released a report on the proposed pilot projects to test the feasibility of large-scale Aquifer Storage and Recovery (ASR). In April, the committee met in Key Largo to discuss Florida Bay indicators. Plans are currently underway for a September workshop on the Monitoring and Assessment Plan designed by Everglades scientists. A major committee report is expected to be generated as a result of the workshop.

Jim Davidson of the University of Florida, former committee chair, resigned for health reasons. Jean Bahr, an existing member of the committee, was appointed the new chair. Scott Nixon will continue as vice-chair and Henry Vaux was appointed to the committee. For more information, contact William Logan at 202-334-3422 or wlogan@nas.edu.

Bioavailability of Contaminants in Soils and Sediments

The committee on bioavailability of contaminants in soils and sediments will

continued on page 8



Compensating for Wetland Losses Under the Clean Water Act

A government program that allows developers to fill in wetlands in exchange for restoring or creating others nearby needs to be improved to meet the goal of “no net loss” in size and function of wetlands, says a new report from the National Academies’ National Research Council. Before granting permits to fill natural wetlands, regulators should give greater consideration to how restored or newly created wetlands can replicate the ecological functions of naturally occurring wetlands and become a sustainable part of the larger watershed, said the committee that wrote the report.

“A broader geographic area needs to be considered when deciding which wetlands to restore and where to place new wetlands so they continue to serve the ecological needs of the entire watershed and have a higher chance of long-term survival,” said committee chair Joy Zedler, professor of botany and Aldo Leopold Chair of Restoration Ecology, University of Wisconsin, Madison.

Wetlands are complex ecosystems such as marshes, swamps, and bogs that sometimes serve several ecological functions including improving water quality, controlling floods, diminishing droughts, and stabilizing shorelines. They also are home to many rare and endangered species of plants and animals as well as species of commercial and recreational value. Before the ecological value of wetlands was recognized in the 1970s, they were often destroyed indiscriminately to promote agriculture, build homes and businesses, and control mosquitoes. By the 1980s, the wetland area in the contiguous United States was about half what it had been in the 1780s.

The Clean Water Act prohibits the discharge of soil and sand into waters of the United States—which by defini-

tion include most wetlands, according to the U.S. Army Corps of Engineers and U.S. Environmental Protection Agency (EPA)—unless authorized by a permit issued under Section 404 of the act. Only the Corps and some EPA-approved state programs can issue such permits. The Corps requires permit applicants first to steer clear of, and at least minimize damage to, wetlands. If unavoidable damage cannot be minimized, the Corps requires the permit holder, or a third party paid by the permit holder, to restore, create, enhance, or preserve nearby wetlands as compensation for the damage. This “compensatory mitigation” is intended to comply with the general goals of the Clean Water Act, and the more specific goal of “no net loss” of wetlands that the White House called for in 1989. An agreement between the Corps and EPA emphasizes that no net loss means no loss in acreage or ecological function.

From 1986 to 1997, the annual rate of wetland loss in the contiguous United States decreased by 77 percent from the previous decade, and some of this decrease may come from developers being deterred by the Section 404-permit process, the committee said. However, despite progress in the last 20 years, the goal of no net loss for wetland function is not being met. From scientific literature, expert presentations, and site visits, the committee found that some required mitigation projects are never undertaken or are not completed. Of those completed, most are not fully evaluated, and in the ones that are, the committee and other scientists found shortcomings compared to nearby natural wetlands. The magnitude of the loss of wetland function is not precisely known since not enough data are kept on the ecological status of wetlands that are lost or those that are restored or created.

Likewise, because of insufficient data, it was impossible for the committee to determine whether there has been no net loss of wetland acreage. From 1993 to 2000, about 24,000 acres of wetlands were allowed to be filled, and 42,000 acres were required as compensatory mitigation, meaning nearly 2 acres should have been gained for every 1 acre lost. However, the lack of data prevented the committee from determining if the required compensation

was ever initiated or if it resulted in wetlands that would be recognized as such under federal guidelines.

To better understand the efficacy of the mitigation program, the Corps should create a national database to track the wetland area and functions gained and lost and to encourage the establishment of organizations to monitor mitigated sites, the committee said.

Whenever possible, restoration of a natural wetland should be chosen over creation of a new one, the committee said. It emphasized that wetland restoration or creation will be most successful when properly integrated into the larger watershed. Current federal guidelines express a preference for putting new wetlands as close as possible to degraded ones, however the committee concluded that this is not always the best choice. Rather, creating new wetlands in areas with proper water levels and flow rates is the key to achieving a self-sustaining wetland that will stand the test of time. Adaptive management practices should be followed, allowing changes to be made to the wetland based on results of early monitoring.

Some types of wetlands, particularly bogs and fens, cannot yet be effectively restored, so the agencies should not allow any part of them to be filled, the committee said.

Whether mitigation is carried out by the permit holder or a third party, restoration or creation of a wetland should occur simultaneously or before the filling of the natural wetland and according to established design criteria that are better monitored and enforced, the committee said. To ensure long-term stewardship similar to that accorded to other publicly valued assets, like national parks, the permit holder or third party should provide a stewardship organization, such as a state agency or private organization like the Nature Conservancy, with an easement on or title to the wetland site and funds for the long-term monitoring and maintenance of the site. It may take 20 years or more for some restored or new wetlands to achieve functional goals, the committee noted.

continued on page 8

Protecting Wetlands

“Enforcement of these requirements by the Corps and other responsible agencies is needed to ensure that mitigation projects begin on time, meet the design criteria outlined in the permit, and are monitored long term,” said committee vice chair Leonard Shabman, professor, Virginia Polytechnic Institute and State University, and director, Virginia Water Resources Research Center, Blacksburg.

The report was sponsored by the U.S. Environmental Protection Agency, the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, and the National Marine Fisheries Service. The National Research Council is the principal operating arm of the National Academy of Sciences and National Academy of Engineering. It is a private, nonprofit institution that provides scientific and technical advice under a congressional charter. Available online at <http://www.nap.edu>.

Press Release (June 26, 2001) from Office of News and Public Affairs. Contact: Bill Kearney, Media Relations Officer (202-334-2138) or email news@nas.edu.

Current Projects

assess broadly the current scientific understanding of processes—both in the environment and in the human body—that affect whether chemical contaminants present in soils and sediments at contaminated sites are bioavailable to humans, animals, and plants. At the committee’s fourth meeting April 23–24 in Washington, DC, the committee heard from Roman Lanno of Oklahoma State University, from Sharon Fleetwood-Williams of ATSDR, and from Diane Henshel of Indiana University. The fifth meeting is scheduled for August 23–25 in Stanford, CA. The committee is chaired by Richard G. Luthy of Stanford University. For more information, contact Laura Ehlers at 202-334-3422 or lehlers@nas.edu.

Environmental Remediation at Navy Facilities

The third meeting of the Committee on Environmental Remediation at Navy Facilities—Phase 2 was February 28–March 2, 2001, in San Diego, CA. This committee is advising the Navy as it proceeds with the cleanup of contaminated soils, sediments, and groundwater at naval bases and other relevant defense facilities. This phase of work will focus on the latter stages of hazardous waste site management. At its meeting, the committee heard about the cleanup of contaminated sediment at Navy facilities and was briefed on several local remediation projects. It also took a half-day field trip to the Navy’s SPAWAR laboratory on Pt. Luma and to Naval Air Station North Island. The committee will meet five times during its tenure, with the fourth meeting scheduled for June 28–29, 2001 in Washington, DC. The committee chair is Edward J. Bouwer of Johns Hopkins University. For more information, contact Laura Ehlers at 202-334-3422 or lehlers@nas.edu.

Missouri River Ecosystem Science

The U.S. Army Corps of Engineers constructed and operates six mainstem dams on the Missouri River. Due partly to drought in the basin in the late 1980s and early 1990s, and due partly to concerns over aquatic habitat degradation, the Corps considered many options for revising its Missouri River dam operations policies. One recommendation (from the Missouri River Basin Association) to the Corps was that a solid scientific knowledge base was essential for improved river management.

This WSTB committee has been charged to characterize the historical and current ecological status of the Missouri River and floodplain ecosystem, and review scientific research on the river-floodplain ecosystem. The committee will also identify appropriate institutional arrangements for improving ecosystem monitoring and research, and identify institutional arrangements that can enhance adaptive management of the river-floodplain ecosystem.

The committee held its fifth meeting in Irvine, CA on February 16–17, where they spoke with Missouri River expert

John Thorson, and held its sixth and final meeting in Great Falls, MT on May 6–7. The committee’s report is scheduled to be released late in 2001. Steve Gloss of the University of Wyoming chairs the committee. For more information, contact Jeffrey Jacobs at (202) 334-3422 or jjacobs@nas.edu.

Opportunities to Improve the National Water Quality Assessment (NAWQA) Program

The committee held its fifth and last meeting on June 11–12, 2001 in Riverside, CA. At the meeting, the committee reviewed each chapter and all preliminary conclusions and recommendations of the draft report and developed a strategy to complete the report. The USGS National Water Quality Assessment program is a perennial program, launched in the early 1990s, to describe the status of, trends in, and factors affecting the water quality conditions. The WSTB has provided advice to the USGS regarding the establishment and development of this program on three previous occasions. The current study will make recommendations for improvements as the NAWQA Program enters its second 10-year cycle of monitoring. The committee’s report is slated to enter external review in August 2001 and for subsequent release in Fall 2001. George Hallberg of the Cadmus Group, Inc. chairs the committee. For more information, contact Mark Gibson at 202-334-3422 or mgibson@nas.edu.

Privatization of Water Services in the United States

Water supply and sewerage services were initially privately owned and operated in many U.S. cities. With the growth of large cities and stronger governments, local government entities eventually assumed ownership and operation of most of the nation’s water service facilities. But a range of economic, regulatory, and fiscal factors have driven many municipalities to consider the prospects of privatizing parts or all of these services. Many U.S. cities today lease various parts of their water supply and wastewater treatment systems to private operators.

Current Projects

But although it holds promise for improving water service deliveries and cutting costs, the long-term consequences of U.S. water service privatization are not clear. This committee is reviewing water service privatization in the U.S. in light of its economic and fiscal, regulatory, public service and public health, environmental, and water quality implications. The committee held its fifth and final meeting in Irvine, CA on June 1-2. The committee's report is scheduled to be released late in 2001. Charles Howe of the University of Colorado chairs the committee. For more information, contact Jeffrey Jacobs at (202) 334-3422 or jjacobs@nas.edu.

Riparian Zones: Functions and Strategies for Management

The joint WSTB/BEST Committee on Riparian Zones held its fifth and final meeting in Washington, DC on February 22-23. The committee's charge is to describe the nature and functioning of riparian zones and assess the condition and trends of riparian habitats with respect to water quantity and quality. The study is reviewing criteria for the improved management of riparian lands and for mitigation of impacts on such habitats. The committee's report will be sent to external review in early summer 2001 and is expected to be completed in the fall. Mark Brinson of East Carolina University chairs the committee. For further information, contact Laura Ehlers at 202-334-3422 or lehlers@nas.edu.

Studies in Hydrologic Science

The joint WSTB/BASC committee met in Washington, DC on June 14-15. Most of the first day was dedicated to a round-table where the different sponsoring agencies outlined their major unresolved hydrologic science issues, and their plans for implementation of the Water Cycle Initiative of the U.S. Global Change Research Program. The second day was spent working on reports related to the two workshops held

last year on "Predictability and Limits to Prediction in Hydrologic Science" and "Research at the Boundary of Ecology and Hydrology." A workshop on Groundwater Fluxes across Interfaces is being planned for May 2001.

Dara Entekhabi of the Massachusetts Institute of Technology chairs the committee. For more information please contact William Logan at 202-334-3422 or wlogan@nas.edu.

USGS Water Resources Research

The committee met on March 8-9 in Reston, VA, and on June 21-23 in Lawrence, Kansas. The primary activity was work on the first and second drafts of a report on the National Water-Use Information Program (NWUIP). At the March meeting they heard presentations on the USGS minerals assessment programs, which are partly analogous to the NWUIP. At the June meeting, they heard from the water-use coordinator of the Central Region of the USGS, and various Kansas government agency "cooperators". They also began work on evaluation of the selected minimum national streamflow information needs and design characteristics of the National Streamflow Information Program. Two new members were recently appointed to the committee: Allen Bradley of the University of Iowa and Leroy Poff of Colorado State University. This committee is chaired by David Maidment, University of Texas, Austin. For more information, contact William Logan at 202-334-3422 or wlogan@nas.edu.

Risks from Toxicants and Pathogens in Biosolid Fertilizers

The Board and Environmental Studies and Toxicology (with assistance from the WSTB) recently formed the Committee on Toxicants and Pathogens in Biosolid Fertilizers to review the risks and risk-assessment methods used by EPA for establishing regulatory standards for chemical pollutants and pathogens in sludge applied to land as fertilizer. The study will consider whether approaches for assessing risks from chemical and pathogenic pollutants should be integrated and, if so, which approaches for integration will be

recommended. It will also build on the 1996 WSTB report *Use of Reclaimed Water and Sludge in Food Crop Production*. The committee met on March 14-15 in Washington, DC and June 3-5 in Irvine, CA.

The committee is chaired by Thomas Burke of The Johns Hopkins University. The committee also includes Robert Cooper, BioVir Laboratories, Inc., Benicia, CA; Lawrence Curtis, Oregon State University; Charles Haas, Drexel University; Carolyn English, Cytec Industries, Inc., Stamford, CT; John Kaneene, Michigan State University; Greg Kester, Wisconsin Department of Natural Resources; Thomas McKone, Lawrence Berkeley National Laboratory, Berkeley, CA; Ian L. Pepper, University of Arizona; Suresh Pillai, Texas A&M University; Frederick Pohland, University of Pittsburgh; Robert S. Reimers, Tulane University; Rosalind Schoof, Gradient Corporation, Mercer Island, WA; Donald Sparks, University of Delaware; and Robert Spear, University of California, Berkeley. For further information, contact Susan Martel at smartel@nas.edu.

NRC MEETINGS

August 23-25

Committee on Bioavailability
Stanford, California

September 13-14

Water Science and Technology
Board
Washington, DC

September 17-18

Committee on Restoration of the
Greater Everglades Ecosystem
Fort Myers, FL

FUTURE PROJECTS

Watershed and Water Quality Management in the Upper Mississippi River Basin

The WSTB convened a January 2001 planning workshop for a future study on watershed management issues in the Upper Mississippi River Basin. Several scientists and federal agency representatives attended the planning workshop and the level of interest and enthusiasm regarding the prospective study was high. While the WSTB was discussing prospects for sponsorship with the agencies, a bill was introduced in Congress that includes a provision for a National Academies' study on the Upper Mississippi. H.R. 1800, The Upper Mississippi River Basin Conservation Act, was introduced in the House of Representatives on May 10. As this newsletter was being published, the bill had been referred to House agricultural and resources subcommittees. For more information on this prospective study or H.R. 1800, contact Jeffrey Jacobs at (202) 334-3422 or jjacobs@nas.edu.

Water Disinfection Issues and Alternatives

WSTB staff is seeking funding for a new initiative that will broadly assess our current scientific understanding of water and wastewater disinfection processes and their alternatives. For a broad suite of chemical and physical disinfectants—including chlorine, ozone, and UV irradiation—this study would explore the mechanisms of microbial inactivation via disinfection and inactivation kinetics, and it will critically evaluate the methods used to quantify disinfection efficacy. In addition, it will examine how well emerging and existing disinfectants provide for residual maintenance within distribution systems and it will describe how disinfectant residuals should be managed to protect against microbial regrowth. A workshop was held March 28, 2000, in Washington, DC to bring together public and private stakeholders, generate interest in the study, and identify potential sponsors and committee members. Although several organizations

expressed interest in the project, funding has not yet been committed. For more information or to suggest funding sources, contact Laura Ehlers at 202-334-3422 or lehlers@nas.edu.

Assessment of U.S. Army Corps of Engineers' Economics and Environmental Analysis and Peer Review of Feasibility Studies

Section 216 of the Water Resources Development Act of 2000 (WRDA 2000) mandated two National Academies studies of Corps of Engineers planning procedures within its feasibility studies: (a) a review of the Corps' state-of-the-art planning and analytical methods, and (b) a review of the Corps' independent peer review procedures.

In cooperation with the Ocean Studies Board and the Transportation Research Board, the WSTB has created a work plan for executing its congressional mandate. This activity—the “216 studies”—will include the following four panels, each of which will produce a report: (1) Corps of Engineer's Peer Review Procedures, (2) Methods and Techniques of Project Analysis (project-specific), (3) River Basins and Coastal Systems (basin-wide), and (4) Resource Stewardship and Adaptive Management. An oversight committee will follow and guide the activities of these four panels and will produce a report synthesizing their findings. Membership of the oversight committee will include the chairs of each of the sub-panels and 4-6 other water sciences and policy experts.

The peer review study will begin its study in the late summer/fall and conduct its study over one year, with its report scheduled for completion by Summer 2002. The other three panel studies will begin their studies this fall; those studies will be conducted over two years. The oversight committee will release its synthesis report after the four panels have completed their studies. For more information on this activity, contact Jeffrey Jacobs at (202) 334-3422 or jjacobs@nas.edu.

Water Quality Improvement for the Pittsburgh Region

Thousands of residents of southwestern Pennsylvania, particularly in rural areas, lack clean and reliable water supplies, adequate wastewater systems, or both. Moreover, nearly all of the region's residents receive water from surface and groundwater sources that are periodically compromised by inadequate sanitation (i.e., contain unacceptable levels of potentially harmful microbial pathogens). The cost of the improvements necessary to correct this regional water quality problem are large (projected to cost between 8 and 9.5 billion dollars). However, the cost of letting the water quality problem continue unabated may be greater over time in terms of adverse impacts on public health, the environment, and economic growth. Regardless of the funding approach ultimately taken, for many communities a significant gap will remain between what is needed and what can be afforded. Thus, infrastructure investment must be strategic. Such a proactive approach will help obtain infrastructure how and where it is needed rather than where it is forced through regulatory actions or as a result of protracted and expensive litigation.

The Water Science and Technology Board has been contacted by the Allegheny Conference on Community Development and The Pennsylvania Economy League to undertake a study of the wastewater and related water quality problems of the Pittsburgh, Pennsylvania area and make recommendations on how these issues and needs of the region can be best addressed by the multiple jurisdictions on a cooperative basis. The study should help the public and private organizations of the Pittsburgh region develop public awareness of the issues and the need for collaborative strategies for water quality improvement and management. It is envisioned that such a WSTB study can provide an instructive model for the EPA and other urban areas where a regional cooperative approach to wastewater management can be considered. Efforts to obtain necessary funding are underway and the WSTB hopes to initiate the

study in late 2001 or early 2002. For more information, contact Mark Gibson at (202) 334-3422 or mgibson@nas.edu.

Services and Values of Aquatic and Related Terrestrial Ecosystems

Aquatic and related terrestrial ecosystems include lakes, rivers, streams, estuaries, wetlands, adjacent riparian systems, and upland areas together with their associated flora and fauna. They perform numerous environmental functions, such as recycling nutrients, purifying water, attenuating floods, recharging groundwater, and providing habitats for wildlife. In addition, aquatic and related terrestrial ecosystems often form the basis of economic livelihood and are widely used for recreational purposes. But human activities of all kinds have increasingly led to pollution, adverse modification, and devaluation of these valuable natural resources. While ecosystem functions may be useful markers for studying the physical, biological, and chemical processes at work in aquatic resources, they are seldom experienced directly by users of the resource. In contrast, economists find it more helpful to think of the “services” of a resource—the things that create value for human users. Thus for aquatic and related terrestrial ecosystems, the intrinsic value of hydrologic, biogeochemical, and biological services can be more readily assessed.

The WSTB held a planning workshop with an internal grant from the Academies in late 1999 to identify major issues, important literature, potential experts, and sponsors for such a study. The workshop deliberations indicated that a full committee-based NRC study that focused on the value of aquatic ecosystem (and to a lesser extent, related terrestrial ecosystem) services, rather than functions, was both warranted and timely. Following the workshop, the WSTB received approval from the National Academies to organize a study to identify and assess existing methods for defining and assigning economic values to the services of aquatic ecosystems. The assessment will also include consideration of the errors and biases characteristic of such methods

and whether their increased use will lead to improved decision-making with respect to the environmental decision-making. The proposed study will be conducted by an expert committee over an 18-month period that will meet four or five times during this period to gather information, deliberate critical issues, and write its report. At present, funding efforts for the study are nearing completion and a committee may be formed and meet as early as Fall 2001. For more information, contact study director Mark Gibson at (202) 334-3422 or mgibson@nas.edu.

Indicators for Waterborne Pathogens

The United States has secured one of the cleanest and safest supplies of drinking and surface water in the world. Regardless, several documented disease outbreaks resulting from waterborne pathogens still occur every year in this country and epidemiologists generally agree that reported outbreaks represent only a fraction of the total waterborne disease outbreaks that actually occur. To help ensure high water quality in the United States, regulators have traditionally used indicator microorganisms to determine the possible presence of microbial contamination from human waste. Enumeration of total coliforms in water samples has proved to be a useful method for assessing sewage contamination of water, and with chlorination to reduce coliform levels, has led to a decrease in diseases such as cholera and typhoid fever. However, an increased understanding of the diversity of waterborne pathogens and their physiology has resulted in a growing concern that, among other limitations, traditional total coliform tests do not indicate the presence of other important classes of pathogens such as parasites and viruses, or of bacterial pathogens that do not have their origins in human waste.

Acknowledging recent advances in microbiology and molecular biology and in response to recent rules and legislation concerning microbial contamination of water (e.g., the Long-Term 2 Enhanced Surface Water Treatment Rule and the Beaches Environmental As-

essment and Coastal Health Act of 2000, respectively), EPA's Office of Water contacted the NRC's Board on Life Studies (BLS; administrative lead) and WSTB to undertake a study of indicators of microbial pathogen contamination in U.S. recreational waters (excluding coastal marine water and marine/estuarine water) and source water (including groundwater). The study will result in a report that suggests candidate indicators and/or indicator approaches that are deemed scientifically defensible and practical to monitor. The committee will consider the strengths and weaknesses of the candidates and how a list of candidates might change with future technological developments. As part of this effort, the committee will also review and provide perspective on the current and future importance and public health impact of waterborne pathogens both in terms of drinking water and recreational contact activities. For more information, contact Mark Gibson at (202) 334-3422 or mgibson@nas.edu.

Mass Removal of Contaminants in the Subsurface

The U.S. Army has over 100 sites where they are spending >\$1 million per year on environmental clean up. They are finding it difficult, however, to make reliable estimates of the time and money that will be required to bring these sites into compliance with the various federal environmental regulations. One of their specific problems is the assessment of the value of incomplete source removal. For example, how much risk reduction is achieved by removing 80% of the mass of a source? What data would one need to collect to answer this kind of question? The Water Science and Technology Board and representatives from the U.S. Army Environmental Center (USAEC) discussed these issues at the WSTB meeting in Woods Hole, MA in June 2001. The WSTB and the USAEC are putting together a prospectus for a proposed study on this topic. For more information, contact Laura Ehlers at (202) 334-3422 or lehlers@nas.edu.

New WSTB Membership

On July 1, the WSTB underwent several membership changes. Six new members—Kenneth Bradbury of the Wisconsin Geological and Natural History Survey and University of Wisconsin, James Crook of CH2M Hill, Peter Gleick of Pacific Institute, John Letey of the University of California-Riverside, Christine Moe of the Rollins School of Public Health of Emory University, and Leonard Shabman of Virginia Polytechnic Institute and State University—were appointed to three-year terms. Concurrent with these new appointments, Henry Vaux's stellar four-year term as chair ended. Richard Luthy is appointed as new chair, and Joan Rose as new vice-chair. John Briscoe of The World Bank, William Jury of the University of California-Riverside, Gary Logsdon of Black & Veatch, John Morris of J.W. Morris, Ltd., Philip Palmer of E.I. du Pont de Nemours & Co., and Rebecca Parkin of The George Washington University "retired" from the board. We thank these individuals for their extraordinary service to the board and will look forward to their continued association through WSTB committee activities.

Following is the current WSTB roster:

Richard Luthy, *chair*, Stanford University, California

Joan B. Rose, *vice-chair*, University of South Florida, St. Petersburg

Richelle Allen-King, Washington State University, Pullman
Gregory Baecher, University of Maryland, College Park
Kenneth R. Bradbury, Wisconsin Geological and Natural History Survey and University of Wisconsin, Madison
James Crook, CH2M Hill, Boston, Massachusetts
Efi Foufoula-Georgiou, University of Minnesota, St. Paul
Peter Gleick, Pacific Institute, Oakland, California
Steven Gloss, University of Wyoming, Laramie
John Letey, Jr., University of California, Riverside
Diane M. McKnight, University of Colorado, Boulder
Christine L. Moe, Rollins School of Public Health of Emory University, Atlanta, Georgia
Rutherford H. Platt, University of Massachusetts, Amherst
Jerald L. Schnoor, University of Iowa, Iowa City
Leonard Shabman, Virginia Polytechnic Institute and State University, Blacksburg
R. Rhodes Trussell, Montgomery Watson, Pasadena, California

WSTB REPORTS

Envisioning the Agenda for Water Resources Research in the Twenty-first Century

2001

This report discusses the future of the nation's water resources and appropriate research needed to promote sustainable management of those resources. Available from the WSTB at 202-334-3422.

Inland Navigation System Planning: The Upper Mississippi River-Illinois Waterway

2001

This report reviews the Corps' draft feasibility study that gauges the economic viability of extending several locks on the Upper Mississippi River-Illinois Waterway. Available for \$29.75 (*see order form*).

Aquifer Storage and Recovery in the Comprehensive Everglades Restoration Plan

2001

This report evaluates pilot projects for ASR in the Everglades. It makes recommendations for studies of regional impacts, water quality, and system performance. Available from the WSTB at 202-334-3422.

Investigating Groundwater Systems on Regional and National Scales

2000

This report makes recommendations concerning the USGS Ground Water Resources Program, which is designed to do regional groundwater assessment and science. Available for \$29.00 (*see order form*).

Clean Coastal Waters: Understanding and Reducing the Effects of Nutrient Pollution

2000

This report assesses how coastal and watershed processes affect nutrient overenrichment of coastal ecosystems and recommends ways to improve research, monitoring, and management at the federal, state, and local levels. Available for \$54.95 (*see order form*).

Environmental Flows for River Systems March 3-8, 2000 Cape Town, South Africa

An international conference entitled *Environmental Flows for River Systems: An International Working Conference on Assessment and Implementation* is to be held in Cape Town, South Africa on March 3-8, 2002. It will incorporate the Fourth International Ecohydraulics Symposium, and address the critically important topic of sustainable use of water resources in the new millennium. For further information and registration please call +(27) 21 685 4166 or email conference2002@southernwaters.co.za.

Risk Analysis and Uncertainty for Flood Damage Reduction Studies
2000

This report reviews and assesses the U.S. Army Corps of Engineers risk analysis techniques in its flood damage reduction studies. The prepubli-cation form is available from the WSTB at 202-334-3422.

Seeing Into the Earth: Noninvasive Characterization of the Shallow Subsurface of Environmental and Engineering Application
2000

This report examined new and improved noninvasive methods for characterization of the shallow subsurface of the earth. Available for \$35.00 (*see order form*).

Natural Attenuation for Groundwater Remediation
2000

This report examines natural attenuation issues about such as public concerns, scientific bases, and the criteria for evaluating its potential for success or failure. Available for \$47.95 (*see order form*).

Watershed Management for Potable Water Supply: Assessing the New York City Strategy
2000

This report evaluates the New York City watershed management plan that is allowing the City to avoid filtration of its large upstate surface water supply. A broad range of conclusions and recommendations are made, many of which are applicable to surface water supplies across the country. Available for \$56.00 (*see order form*).

Ecological Indicators for the Nation
2000

The report provides a framework for selecting ecological indicators, and also provides recommendations on several specific indicators for gauging the integrity of the nation's ecosystems. Available for \$39.95 (*see order form*).

Hydrologic Science Priorities for the U.S. Global Change Research Program: An Initial Assessment
1999

This report makes recommend-ations for the U.S. Global Change Research Program. Two broad science areas—predictability and variability of regional and global water cycles and coupling of hydrologic systems and ecosystems through biogeochemical cycles—are identified that could augment the current hydrologic sciences content of the USGCRP. Available from the WSTB at 202-334-3422.

Downstream: Adaptive Management of Glen Canyon Dam and the Colorado River Ecosystem
1999

This report evaluates the strengths and weaknesses of the Long-Term Monitoring and Research Plan of the Grand Canyon Monitoring and Research Center. Available for \$41.50 (*see order form*).

Identifying Future Drinking Water Contaminants
1999

This report summarizes a workshop based on prioritizing potential drinking water contaminants for inclusion on future Drinking Water Contaminant Candidate Lists. Available for \$45.00 (*see order form*).

Water for the Future: The West Bank and Gaza Strip, Israel, and Jordan
1999

This report recommends that Israel, Jordan, and the Palestinian Authority work together to preserve aquatic ecosystems in the Middle East to ensure that an adequate supply of fresh, high-quality water is available for future generations. The report offers a range of findings and observations on water resource management options for this area. Available for \$35.00 (*see order form*).

New Directions in Water Resources Planning for the U.S. Army Corps of Engineers
1999

This report identifies several ways in

which the Corps might reduce the time required in water project planning. The report also recommends that the federal Principles and Guidelines for Water and Land Resources Implementation Studies be thoroughly reviewed and modernized. Available for \$39.00 (*see order form*).

Hydrologic Hazards Science at the U.S. Geological Survey
1999

This report provides advice to the U.S. Geological Survey with respect to its research, interpretive studies, and data collection efforts in the area of hydrologic hazards, which includes droughts, flooding, and related phenomena. Available from the WSTB at 202-334-3422.

Improving American River Flood Frequency Analyses
1999

This report evaluates the useful-ness of various kinds of data, including historical and paleoflood data; recommends flood flow frequency distribution for the American River; and reviews recent scientific literature on climate variability and flood frequency. Available from the WSTB at 202-334-3422.

New Strategies for America's Watersheds
1999

This report provides a timely and comprehensive look at the rise of "watershed thinking" among scientists and policymakers and recommends ways to steer the nation toward improved watershed management. Available for \$49.00 (*see order form*).

Setting Priorities for Drinking Water Contaminants
1999

This report provides a phased decision process for determining which contaminants on the Contaminant Candidate List are appropriate for regulatory decisions and which will require research or monitoring. Available for \$35.00 (*see order form*).

Environmental Cleanup at Navy Facilities: Risk-Based Methods
1999

This report reviews and critiques risk-based cleanup methods, including those developed by the EPA and the American Society of Testing and Materials, and identifies eleven criteria that must be part of any risk-based methodology adopted by the Navy. Available from the WSTB at 202-334-3422.

Issues in Potable Reuse: The Viability of Augmenting Drinking Water Supplies With Reclaimed Water
1998

This report looks at the issues involving the use of reclaimed water to supplement drinking water supplies. It discusses issues of water treatment technology, monitoring, and testing of reclaimed water to ensure public safety. Available for \$44.95 (*see order form*).

Hydrologic Sciences: Taking Stock and Looking Ahead
1998

The WSTB used the opportunity of its 1997 Abel Wolman Distinguished Lecture to assess the vitality of the hydrologic sciences by the hydrologic community. This report is a compilation of the Wolman Lecture and four invited papers, preceded by a summarizing overview. Available for \$35.00 (*see order form*).

Innovations in Ground Water and Soil Cleanup
1997

This report provides a comprehensive review of the status of innovative technologies for subsurface cleanup. It also recommends strategies for increasing market demand for innovative remediation technologies, standardizing the collection of pilot and field test data on these technologies, and evaluating cost data. Available for \$44.95 (*see order form*).

Valuing Ground Water
1997

This report examines approaches for assessing the economic value of groundwater and the costs of

contaminating or depleting this resource. It suggests a framework for policymakers and managers to use in evaluating tradeoffs when there are competing uses for groundwater. Available for \$39.95 (*see order form*).

Building a Foundation for Environmental Research
1997

This report outlines a new framework for organizing the research program at EPA's Office of Research and Development. The report calls for the establishment of two kinds of research *problem-driven* research and *core* research. Available from the WSTB at 202-334-3422.

Watershed Research in the U.S. Geological Survey
1997

This report is intended to assist the USGS in improving its overall strategy for watershed research. Available from the WSTB at 202-334-3422.

Safe Water from Every Tap: Improving Water Service to Small Communities
1997

This report assesses the quality of drinking water in small communities and recommends a three-part strategy for improving it. Available for \$44.95 (*see order form*).

Alluvial Fan Flooding
1996

This report provides an updated regulatory definition of alluvial fan flooding, presents criteria for assessing whether an area is or is not subject to such flooding, and provides examples of applying the definition and criteria to real situations. Available from the WSTB at 202-334-3422.

Freshwater Ecosystems: Revitalizing Educational Programs in Limnology
1996

This report provides an overview of the status of inland waters, the history of limnology, and key future problems that may face water resource managers. It recommends changes in limnology education and research to meet the needs of water resource management.

Available for \$54.95 (*see order form*).

A New Era for Irrigation
1996

This report explores the impacts of changing supply and demand conditions, assesses current and potential technologies that might help water users adapt to changing conditions, and considers how to mitigate short- and long-term problems associated with irrigation. Available for \$39.95 (*see order form*).

Hazardous Materials in the Hydrologic Environment: The Role of the U.S. Geological Survey
1996

This report attempts to help shape the overall framework of the U.S. Geological Survey's research in hazardous materials science and technology and identifies general areas of scientific opportunity. Available from the WSTB at 202-334-3422.

River Resource Management in the Grand Canyon
1996

This report assesses the achievements and shortcomings of the Bureau of Reclamation's Glen Canyon Environmental Studies and reviews the final research done under the program. Available for \$35.00 (*see order form*).

Use of Reclaimed Water and Sludge in Food Crop Production
1996

This report reviews the current state-of-the-practice, public health concerns, existing guidelines and regulations, and implementation issues of using municipal wastewater and sludge in food crop production. Available for \$34.00 (*see order form*).

Wetlands: Characteristics and Boundaries
1995

This report analyzes present regulatory practice related to wetlands delineation and recommends changes that should bolster the objectivity and scientific validity of wetlands delineation and identification. Available for \$42.95 (*see order form*).

Flood Risk Management and the American River Basin: An Evaluation
1995

This book reviews the U.S. Army Corps of Engineers' investigations of flood control options for the American River basin and evaluates flood control feasibility studies for the watershed. Available for \$29.00 (*see order form*).

Mexico City's Water Supply: Improving the Outlook for Sustainability
1995

This bilingual report addresses the technical, health, regulatory, and social aspects of groundwater withdrawals, water use, and water quality in the Mexico City metropolitan area and recommends ways to improve the balance of water supply, demand, and conservation. Available for \$30.00 (*see order form*).

Review of EPA's Environmental Monitoring and Assessment Program: Overall Evaluation
1995

This final review of EPA's Environmental Monitoring and Assessment Program (EMAP) evaluates whether EMAP's goals of assessing the status of and trends in the nation's ecosystems are achievable, given the difficult scientific,

practical, and management challenges of implementing them. Available for \$35.00 (*see order form*).

Alternatives for Ground Water Cleanup
1994

This report evaluates the efficacy of pump and treat systems at nearly 80 contaminated sites, providing detailed case studies for several of the sites. Available for \$64.75 (*see order form; print on demand*).

Ground Water Recharge: Using Waters of Impaired Quality
1994

This report examines the use of waters of less-than-ideal quality, such as treated municipal wastewater and urban stormwater runoff, as sources for artificial groundwater recharge projects. Available for \$59.25 (*see order form; print on demand*).

Managing Wastewater in Coastal Urban Areas
1993

This report examines the problems of wastewater and stormwater management in coastal urban settings, recommending a system of integrated coastal management. Available for \$54.95 (*see order form*).

In Situ Bioremediation: When Does It Work?
1993

This report provides direction for decision-makers and offers detailed explanations of the processes involved in *in situ* bioremediation, circumstances in which it is best used, and methods for evaluating the results of bioremediation projects. Available for \$34.95 (*see order form*).

Water Science and Technology Board

The Water Science and Technology Board (WSTB) is a unit of the National Research Council, which serves as an independent advisor to the federal government on scientific and technical questions of national importance. The National Research Council, jointly administered by the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine, brings the resources of the scientific and technical community to bear on national problems through its volunteer advisory committees.

This newsletter is produced three times a year and is distributed at no charge to subscribers in February, June, and October each year. Editorial office: National Research Council, Water Science and Technology Board, HA 462, 2101 Constitution Avenue., N.W., Washington, D.C. 20418, 202-334-3422.

Editor: William Logan
Associate editor: Ellen de Guzman