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Watershed and Water Quality Management for the Upper Mississippi River Basin

By Stephen D. Parker

The Water Science and Technology Board is preparing for a new study of the Upper Mississippi River basin with the goal of producing an action-oriented plan to address nonpoint source water pollution and associated watershed issues. The activity has been requested by Representative Ron Kind of Wisconsin, who co-chairs the bipartisan Upper Mississippi River Task Force—an 18-member body representing the 5-state basin area (IA, IL, MN, WI, and MO). The Task Force works on a wide variety of environmental, transportation, recreational, flood control, and economic development issues within the basin.

The Mississippi River and its tributaries are among the nation's most important inland waterway transportation systems. The Upper Mississippi River system supports a variety of economic and social activities, many of which have impacts on water quality and the basin's ecology. Key issues in the management of the Upper Mississippi River and its tributaries revolve around the relations between the 29 locks and dams on the upper Mississippi, agriculture in adjacent and upland areas in the basin, and river and riparian ecology. Further, there are tremendous recreational opportunities on the Upper Mississippi, especially boating and fishing, and the basin provides an important habitat for wildlife. Finally, with more than 24 million inhabitants in the region, the Upper Mississippi and its tributaries are an important source of water for households, municipalities, and industries.

Like elsewhere, in the 1960s and 1970s water quality issues in the region focused on point source pollution (e.g., discharge from wastewater treatment plants and factories). Today, many of the point pollution discharges have been reduced, but nonpoint source pollution problems from urban and agricultural runoff are increasing. A major water quality concern on the Upper Mississippi is sedimentation. The locks and dams on the river have created a series of large pools to help maintain a navigation channel depth of

Perry L. McCarty to Deliver Abel Wolman Lecture

The WSTB is pleased to announce that **Perry L. McCarty** will deliver the next Abel Wolman Lecture. Dr. McCarty is Professor Emeritus of Stanford University's Department of Civil and Environmental Engineering and a significant participant in the WSTB program. McCarty has been widely recognized for his teaching and cutting-edge research over the past three decades in biological processes for the control of environmental contaminants. His early research was on anaerobic treatment processes, biological processes for nitrogen removal, and biological degradation of hazardous chemicals. Currently, his interests are on aerobic and anaerobic biological processes for control of chlorinated solvents in groundwater, advanced wastewater treatment processes, and movement, fate, and control of groundwater contaminants. His lecture will be about frontiers in environmental science and technology. We look forward to this event, to be held on January 22, 2001 in Washington, D.C. Look for forthcoming announcements.

nine feet. These slackwater pools, combined with various soil erosion problems across the upper basin and the wakes and churning of waters from barges have created large amounts of suspended sediments in the upper river.

Sediments, pesticides, and nutrients that run off of farmland into streams and groundwater and ultimately into the Mississippi River result in a variety of undesirable impacts: reduction in the quality and quantity of farm crops; an increase in river channel and reservoir maintenance costs; a threat to drinking water supplies; eutrophication; reduction of flood control; and filling of side channels that are important aquatic habitat for many fish and waterfowl species. The public and private costs associated with this sediment and nutrient loss are considerable. It is estimated that farmers lose more than \$300 million worth of applied nitrogen each year. Dredging and dredge material disposal costs on the Mississippi exceed \$100 million per year. Total habitat preservation expenditures in the basin are difficult to estimate, but the efforts of an interagency environmental management program alone will soon exceed \$33 million each year.

While these issues are wide reaching and costly, they are also complex. To date, comprehensive, multidisciplinary understanding of the causes and effects of these phenomena is limited. Many previous and existing research efforts, while useful, tend to be specific to small areas or focused on satisfying particular programs (like CREP or TMDLs) and as a result are uncoordinated. The similarities in hydrogeography and land use patterns across the region, the preponderance of privately owned land, and the prevalence of sediment and nutrient problems suggest that lessons learned can be applied broadly. Thus, there appears to be significant potential for better integration of research activities and other management and restoration efforts on a basin-wide scale.

Better integration of river management efforts across the basin and across scientific disciplines and other sectors should have multiple benefits. Coordinating the monitoring and modeling efforts of government agencies, university researchers, and private parties will lead to more complete identification of sediment and nutrient sources in the region. Metrics of success for best management practices and other actions will need to reflect the diverse goals of the region's inhabitants and are best developed with maximum stakeholder input. Given the high percentage of privately owned land, river and riparian management may depend heavily on financial incentives and other innovative public-private programs to achieve reductions in nonpoint source pollution. By one estimate, there are more than 75 local, state, tribal, and federal public and private programs addressing sediment and water quality issues in the Upper Mississippi River basin. Despite the number of programs, a lack of collaboration may have resulted in redundancies and gaps—and a failure to allocate resources efficiently. A basin-wide approach to resource management involving advisory groups composed of stakeholders and government officials may be an

effective means to ensure the wise allocation of federal investments.

The study being planned would provide an assessment of the water quality management issues facing the Upper Mississippi River basin. The aim will be to produce an action-oriented plan to deal with nonpoint source water pollution and associated watershed management issues. The following set of questions would likely form the basis for the study:

- (1) What is the extent of current water quality monitoring efforts in the Upper Mississippi River basin? Are current efforts appropriate for this resource?
- (2) What is the state of knowledge and the most pressing research needs concerning the transport and fate of nutrients, sediments, and other pollutants in this basin?
- (3) What is the state of knowledge and what are research needs concerning the effectiveness of riparian management systems and other nonpoint source pollution management practices that have potential in this region?
- (4) What is the most appropriate scale of landscape unit for developing nutrient and sediment management practices?
- (5) What institutions are appropriate for coordinating basin-wide nutrient and sediment monitoring efforts and basin-wide water quality improvement activities?
- (6) How will voluntary actions serve to supplement existing and/or future regulatory regimes dealing with pollutant runoff?
- (7) How can farm policy—particularly as it relates to USDA and other federal land conservation programs—be modified so as to promote land stewardship in the basin?

This project would be carried out by a committee of experts with experience relevant to water resources and water quality management in the Upper Mississippi River basin. Some members of the committee would have intimate familiarity with the basin while others will have more general experience. Individuals with academic, management, planning, and regulatory backgrounds would be included. An effort would be made to include some appropriate members from previous NRC committees to build on relevant work by the WSTB concerning watershed and water quality management.

Prior to formal launching of the study, the NRC staff and WSTB members plan to coordinate and develop a work plan with members of Congress and their staffs, relevant federal agencies (e.g., DOI, USACE, EPA, USDA), appropriate state-level agencies and non-governmental entities, and others to assure focus on the most appropriate issues, to garner background material, and to receive nominations for the committee. Presently, the WSTB is working with Congressman Kind and his staff to raise financial support from appropriate federal agencies and foundations.

Stephen Parker is the director of the WSTB.

New Reports

Clean Coastal Waters: National Strategy Needed to Protect Coastal Areas from Dangerous Levels of Nitrogen and Phosphorus

By Chris Elfring and Dan Walker

Over the past 20 years, scientists, coastal managers, and government decision-makers have come to recognize that coastal ecosystems suffer a number of environmental problems that can, at times, be attributed to the introduction of excess nutrients from upstream watersheds. Nutrient over-enrichment is the common thread linking such diverse coastal problems as red tides, fish kills, outbreaks of shellfish poisonings, loss of seagrass habitats, coral reef destruction, and the Gulf of Mexico's "dead zone." The problems are caused by a complex chain of events and they vary from site to site, but the driving force is the accumulation of nitrogen and phosphorus in fresh water on its way to the sea. Nutrient sources include runoff from agricultural land, animal feeding operations, and urban areas as well as discharge from wastewater treatment plants and atmospheric deposition of compounds released during the burning of fossil fuels.

Clean Coastal Waters: Understanding and Reducing the Effects of Nutrient Pollution, produced jointly by the Water Science and Technology Board and the Ocean Studies Board, concludes that the federal government together with state and local agencies should develop a comprehensive national strategy to combat nitrogen and phosphorus pollution in coastal waters. At a minimum, the effort should strive to reduce the number of severely damaged coastal areas by at least 25 percent before 2020 and ensure that no other healthy coastal areas get into trouble.

As long as nutrient loading from upstream sources increases due to continuing urbanization, deforestation, agriculture, and atmospheric deposition, nutrient over-enrichment will be a significant problem. It has major impacts, from economic losses associated with reduced fisheries to potential human health impacts. According to the report, 44 of 139 coastal areas assessed by NOAA were identified as severely affected by high levels of nitrogen and phosphorus. Problems are particularly severe along the mid-Atlantic coast and the Gulf of Mexico.

Given that the population in U.S. coastal communities now exceeds 141 million (over half the U.S. population) and that 17 of the 20 fastest growing counties are located along the coast, the problem is certainly a national priority. Success in addressing coastal nutrient problems depends on having a solid scientific understanding of the causes of the problem and the full range of possible management alternatives. The report describes a number of initiatives that could help address nutrient overabundance.

Expand monitoring and assessment programs.

Accurate estimates of nutrients in waterways are essential

for developing strategies to combat excesses. Federal, state, and local agencies should form partnerships with academic and research institutions to monitor the nation's coastal areas and a comprehensive national assessment should be conducted every 10 years.

Exert federal leadership on issues that span multiple jurisdictions or threaten federally protected natural resources. The government should continue to set clear guidelines for maximum nutrient loads in waterways. EPA should continue to develop standards for different types of regional watersheds, focusing on identifying the sources of nutrients and setting maximum daily loads.

Address overlaps and gaps in existing and proposed federal legislation. Because several federal agencies and regulations already address nutrient pollution in waterways, better coordination is key. Excess nutrients should be an important consideration in reauthorization of the Clean Water Act, the Clean Air Act, and the Coastal Zone Management Act.

Provide data, information, and technical assistance to state and local coastal authorities. Such efforts could include a federally managed clearinghouse that provides assistance on request, or a complete database on the Internet with links to information. Research should be expanded to improve the understanding of the causes, and environmental and economic impacts, of nutrient contamination.

Develop a classification scheme to provide better information on the likelihood that excess nutrients will damage coastal areas. Many factors influence how excess nutrients will affect coastal waters, such as depth of the water and whether nutrients are flushed out to sea by tides or currents. Better data on these factors would help coastal managers and scientists design more effective management strategies.

The committee was chaired by Robert Howarth of Cornell University. Funding was provided by NOAA, EPA, USGS, and the Electric Power Research Institute. To order a prepublication copy of the report, contact the National Academy Press at 800-624-6242 or <http://www.nap.edu>.

Risk Analysis and Uncertainty in Flood Damage Reduction Studies

By Jeffrey Jacobs

The U.S. Army Corps of Engineers is a key federal agency in helping reduce flood damages across the nation. While several federal agencies play various roles in flood damage reduction, the Corps' roles have traditionally focused on construction of levees and other river control works. Proper levee design must account for a variety of hydrologic, hydraulic, economic, and geotechnical considerations. Levees must be high enough to safely pass a large flood, but heights are limited by ecological and aesthetic considerations. For decades, the Corps used levee "freeboard," an additional levee height above the

estimated water surface of a given flood (e.g., the 100-year flood), for designing levees. Freeboard was used to help achieve specific design objectives, such as reducing the probability of a flood overtopping a levee. The standard "3 feet of freeboard" became an engineering tradition in the Corps and beyond.

Challenges to the freeboard concept emerged in the early 1990s from both within and outside the Corps. It was noted, for instance, that standard freeboard may not adequately account for geographic and hydrologic differences and thus may provide different levels of flood protection at different places. The Corps felt that risk analysis techniques held promise in addressing these issues, as these techniques aim to quantify and explicitly incorporate uncertainties in relevant hydrologic, hydraulic, economic, and geotechnical parameters into levee design. In the mid-1990s, the Corps abandoned the freeboard concept and adopted risk analysis as part of its flood damage reduction studies. There were, however, challenges to the new policy and, as a result, Congress asked the National Research Council to review and assess the Corps' risk analysis techniques in its flood damage reduction studies.

This new report from the WSTB commends the Corps for adopting the new techniques and departing from the traditional freeboard approach. The risk analysis paradigm for flood damage reduction studies represents a step forward for the Corps and has been accomplished with a modest amount of human resources. The report's recommendations are divided into four topical areas: risk analysis techniques, consistent terminology, levee certification, and floodplain management.

Risk analysis techniques. The report recommends that the Corps use *annual exceedance probability* as a key performance measure of engineering risk. Annual exceedance probability measures "the probability of getting wet" in any given year, considering the full range of floods that can occur.

The report describes the differences between *natural variability* and *knowledge uncertainty*. Natural variability refers to inherent variability in the physical world, while knowledge uncertainty refers to a lack of scientific understanding of natural processes and events. In the Corps' risk analysis, it is not always clear that these different types of uncertainty are clearly distinguished and treated appropriately. It is thus recommended that the Corps differentiate between these uncertainties, as each affect the calculation of risk in different ways.

It is also recommended that the risks associated with flooding and the benefits of a flood damage reduction project be conducted on a structure-by-structure basis, rather than conducting risk analysis on damages aggregated over groups of structures in "damage reaches."

Consistent terminology. Several terms describing risk and uncertainty are often used interchangeably within and between different Corps water resources programs. The report thus recommends that the Corps adopt a

consistent vocabulary for describing risk analysis concepts, specifically distinguishing between risk, natural variability, knowledge uncertainty, and measures of system reliability.

Levee certification. The Corps and the Federal Emergency Management Agency (FEMA) jointly conduct a federal levee certification program. Before the Corps' adoption of risk analysis, levee freeboard was the key criterion for levee certification. Abandonment of freeboard has resulted in complications to the certification criteria. The report recommends that levee certification focus on annual exceedance probability, rather than on the 100-year flood. The report recommends that a uniform criterion for the level of protection be adopted. While it is not obvious what that criterion should be, it is recommended that it be the historical median level of flood protection provided. The median annual exceedance probability of Corps flood damage reduction projects was estimated as approximately 1/230.

Floodplain management. Neither the Corps nor the U.S. Congress has identified an explicit goal for management of the nation's floodplains. The report recommends that the goal should be to use the land for the greatest social benefit. Toward this end, the report recommends that the Corps explicitly address social and environmental benefits in its risk analysis. It also recommends that social and environmental effects within Corps flood damage reduction studies be quantified to the extent possible and included within the National Economic Development water resources planning alternative.

The committee was chaired by Gregory Baecher of the University of Maryland. Funding was provided by the U.S. Army Corps of Engineers. To order a prepublication copy of the report, contact the National Academy Press at 800-624-6242 or <http://www.nap.edu>.

Seeing into the Earth: Noninvasive Characterization of the Shallow Subsurface for Environmental and Engineering Application

By Stephen Parker

As reported in the February/March issue of this newsletter, a committee overseen by the Board on Earth Sciences and Resources (BESR), with assistance from the WSTB, completed its study of noninvasive methods for characterizing the shallow subsurface of the earth. The ability to characterize the shallow subsurface is essential for many environmental and engineering concerns. The study examined new and improved noninvasive characterization methods and technical and institutional barriers to implementing new methods as well.

Seeing into the Earth: Noninvasive Characterization of the Shallow Subsurface for Environmental and Engineering Application is now available from the National Academy Press. The report examines why noninvasive characterization is important and how improved methods can be developed and disseminated. Looking at the issues from both the commercial and public perspectives, the

report makes recommendations for linking characterization and cost savings, closing the gap between the state of science and the state of the practice, and helping practitioners make the best use of the best methods.

The book provides background on the role of noninvasive subsurface characterization in contaminant cleanup, resource management, civil engineering, and other areas; the physical, chemical, biological, and geological properties that are characterized; and methods of characterization and prospects for technological improvement. The study committee was chaired by Phillip R. Romig, Colorado School of Mines. To obtain a copy of the published report, contact the National Academy Press at 800-624-6242 or <http://www.nap.edu>.

Current Projects

Agenda for Water Resources Research in the Twenty-first Century

The WSTB hopes to soon be sending its report about water management challenges of the twenty-first century and the adequacy of the water research arrangements to meet those challenges to external review. The prepublication version of the report should be released sometime this fall. The report outlines key water resource challenges of the next two decades, identifies broad areas that should receive immediate emphasis in water resources research planning, and describes some ways in which the setting of water research agendas, the conduct of water research, and the levels of investment devoted to such research might be improved in the next decade or so. This activity was motivated by board members' concerns that water resources of the United States are likely to be subjected to more intense and broader arrays of pressure in the twenty-first century than they were in the twentieth century. The nation's ability to confront these challenges successfully and manage a critical resource under pressure will depend, in part, upon the availability of new knowledge and new technology. For information, contact Laura Ehlers at 202-334-3422 or lehlers@nas.edu.

Environmental Remediation at Navy Facilities

The first meeting of the Committee on Environmental Remediation at Navy Facilities, Phase 2, was July 17–18 in Washington, DC. 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 from Navy representatives about their interest in the study and from several EPA representatives about innovative technologies, long-term monitoring, the 5-yr review process, technical impractical-

bility waivers, and interagency guidance on the site closeout process. Patty Lovera from the Center for Health, Environmental, and Justice discussed public perceptions of the site closeout process. The committee will meet five times during its tenure, with the second meeting scheduled for October 30–31, 2000.

Committee members include Edward J. Bouwer, chair, Johns Hopkins University; Gene F. Parkin, vice-chair, University of Iowa; Sidney B. Garland, Bechtel Jacobs Co.; Patrick E. Haas, Air Force Center for Environmental Excellence; Robert Johnson, Argonne National Laboratories; Michelle M. Lorah, U.S. Geological Survey; Frederick G. Pohland, University of Pittsburgh; Danny D. Reible, Louisiana State University; Lenny M. Siegel, Center for Public Environmental Oversight; Mitchell J. Small, Carnegie Mellon University; Ralph G. Stahl, Dupont Co.; Alice D. Stark, New York State Department of Health; Albert J. Valocchi, University of Illinois; William J. Walsh, Pepper Hamilton LLP; and Claire Welty, Drexel University. For more information, contact Laura Ehlers at 202-334-3422 or lehlers@nas.edu.

Upper Mississippi River—Illinois Waterway Navigation System Feasibility Study Review

In 1993 the U.S. Army Corps of Engineers began a study of the Upper Mississippi River–Illinois Waterway navigation system to determine the feasibility of making improvements to several locks and dams. A newly-formed committee of the WSTB and the Transportation Research Board (TRB) is reviewing the Corps' ongoing feasibility study, focusing on the Corps' economic analysis, including assumptions, methods, and forecasts regarding future barge transportation demands on the Upper Mississippi–Illinois system. The committee will also comment on the extent to which larger water resources project planning considerations have been appropriately included in the feasibility study.

The committee held its first meeting in Washington, DC on June 19–21. The committee hosted several speakers, including staff members of the Corps of Engineers, Tim Searchinger of Environmental Defense, Chris Breschia of the Midwest Area River Coalition 2000, and George Dusenbury of the Northeast-Midwest Institute. Comments from interest groups and individuals were also invited during a public comment session. The second meeting is scheduled for August 7–8 in St. Louis, with a third and final meeting to be held in late September. Given the importance of this study to the Department of Defense, it is being conducted on a shorter time frame than usual for the WSTB. The report is scheduled for completion in late November 2000.

The committee is chaired by Lester Lave, professor of economics at Carnegie-Mellon University. Dr. Lave is a member of the Institute of Medicine and former WSTB member, and he has served on several NRC committees. The committee includes Philip Baumel, Iowa State

University; Kenneth D. Boyer, Michigan State University; Michael S. Bronzini, George Mason University; Kenneth L. Casavant, Washington State University; Bonnie G. Colby, University of Arizona; Jonathan P. Deason, The George Washington University; Jose A. Gómez-Ibáñez, Harvard University; Delon Hampton, Delon Hampton and Associates, Washington, D.C.; Edwin E. Herricks, University of Illinois; and David H. Moreau, University of North Carolina. For more information, contact Jeffrey Jacobs at 202-334-3422 or jjacobs@nas.edu.

Bioavailability of Contaminants in Soils and Sediments

The committee on bioavailability of contaminants in soils and sediments will assess 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. The first meeting of the committee was held on May 15–16 in Washington, DC. At its meeting, the committee heard from its seven sponsors about their interest in the project and their goals for the study. It also heard from Teresa Bernhardt of the Naval Facilities Engineering Service Center about the Navy's new guidance document for using bioavailability in risk assessment. Greg Planicka of the National Environmental Policy Institute spoke about NEPI's long-standing bioavailability policy project. The second meeting is scheduled for September 14–15, 2000, in Woods Hole, MA.

The committee is chaired by Richard G. Luthy of Stanford University. Subsequent to the first meeting, a new committee member was added, Dr. Stephen Roberts from the Center for Environmental and Human Toxicology at the University of Florida. Project sponsors include EPA, the Strategic Environmental Research and Development Program, the National Institute of Environmental Health Sciences, the Army, the Air Force, the Agency for Toxic Substances and Disease Registry, the Department of Defense Office of Environmental Security, and the Department of Energy. For more information, contact Laura Ehlers at 202-334-3422 or lehlers@nas.edu.

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

The USGS National Water Quality Assessment (NAWQA) program is a perennial program, launched in the early 1990s, to describe the status of, trends in, and factors affecting surface and groundwater quality throughout the United States. The WSTB has provided advice to the USGS regarding the establishment and development of this program on three previous occasions. The current effort will make suggestions for improvement during its second 10-year cycle. The committee recently held its second of four meetings May 1–2 in La Jolla, CA. At the meeting, the committee heard presentations from USGS

representatives about the national synthesis of pesticide data, modeling efforts within NAWQA, and the activities of the Santa Ana study unit, the most urban of the 60 units. Greg Woodside of the Orange County Water District described their interactions with the Santa Ana Study Unit. The committee also reviewed writing assignments and refined its strategy for completing its report. The third meeting, to be held August 24–25 in Woods Hole, MA, will include additional presentations by NAWQA personnel on ecological, microbiological, and organic carbon studies. The committee's final meeting will be November 9–10, 2000. George Hallberg of the CADMUS Group, Inc. chairs the committee. For more information, contact Mark Gibson at 202-334-3422 or mgibson@nas.edu.

Mitigating Wetland Losses

The joint BEST/WSTB Committee on Mitigating Wetland Losses is evaluating the effectiveness of wetland restoration and mitigation practices in replicating pre-disturbed wetland functions and ecological attributes. The committee held its second meeting on March 26–28 in Orlando, FL. The open session consisted of a field trip to Orlando International Airport mitigation sites and presentations by guest speakers. During the closed session, the report outline and writing assignments were discussed. In response to comments that the committee lacked expertise in wildlife biology, a new committee member was appointed—Whit Gibbons, a wildlife biologist from the Savannah River Ecology Laboratory.

The committee held its third meeting on June 11–13 in Chicago, IL. The open session consisted of a field trip to various mitigation sites in the Chicago area and presentations by guest speakers. The fourth meeting is scheduled for September 19–21 in Irvine, CA. Joy Zedler of the University of Wisconsin chairs the committee. Project sponsors are the U.S. EPA, U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, and National Marine Fisheries Service. For more information, contact Suzanne Jacobson at sjacobson@nas.edu or David Policansky at dpolican@nas.edu.

Restoration of the Greater Everglades

The Committee on the Restoration of the Greater Everglades Ecosystem (CROGEE), formed at the request of the Secretary of the Interior, Bruce Babbitt 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 assessments and guidance, the committee will provide more focused advice on technical topics of importance to the restoration efforts. The third committee meeting was held at the South Florida Water Management District in West Pam Beach, FL, on July 6–7. It focussed on the hydrologic and ecological performance measures that will guide adaptive assessment and monitor-

ing of the restoration efforts. Committee members also heard an update from the Science Coordination Team and worked on plans for a workshop to be held in October 19 (in conjunction with the full committee's fourth meeting on October 20-21) to address aquifer storage and recovery, one of the restoration activities under consideration. The committee has also been invited to play a major role in the synthesis of the results from the "Greater Everglades Ecosystem Restoration Science Conference: Defining Success", to be held December 11-15, 2000 in Naples, FL. James Davidson of the University of Florida (retired) chairs the committee. For more information, contact William Logan at 202-334-3422 or wlogan@nas.edu.

Missouri River Ecosystem Science

The U.S. Army Corps of Engineers 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 has considered many options for revising its Missouri River dam operations policies. One recommendation to the Corps (from the Missouri River Basin Association) was that a solid scientific knowledge base was essential for improved river management. Thus, a 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 third meeting in Bismarck, ND on July 10-11 at the offices of the North Dakota Game and Fish Department. Speakers included Greg Power of North Dakota Game and Fish, Roger Collins of the U.S. Fish and Wildlife Service, and Larry Spears of the North Dakota Consensus Council. The committee was also briefed by Jack Stanford from the University of Montana in a session on the current state of, and important trends in, large river science. The committee will hold its fourth meeting in Pierre, SD on October 13-14. Steve Gloss of the University of Wyoming chairs the committee. For more information, contact Jeffrey Jacobs at 202-334-3422 or jjacobs@nas.edu.

Committee on Drinking Water Contaminants

The joint WSTB/BEST Committee on Drinking Water Contaminants held the final two meetings of its second phase of study on March 6-8 in Irvine, CA and on July 17-18 in South Portland, ME. Following the first phase of study, EPA's Office of Ground Water and Drinking Water requested that the committee develop and recommend a process to prioritize all types of potential drinking water contaminants (including microbiological contaminants) for

inclusion on future Drinking Water Contaminant Candidate Lists (CCLs). The process must also include a semi-quantitative prioritization tool (or tools) to assist in this process as recommended by the committee in their first two reports, *Setting Priorities for Drinking Water Contaminants* and *Identifying Future Drinking Water Contaminants*. At the Irvine meeting, the committee heard presentations by representatives of EPA's Office of Research and Development and conducted a short workshop with presentations on developing mechanisms for grouping related microbial pathogens for research and regulation. At the South Portland meeting, the committee reviewed the draft report, developed tentative conclusions and recommendations, and identified additional work and writing assignments needed to complete the report which is due in late 2000 or early 2001. Deborah Swackhamer of the University of Minnesota 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 during the past 15-20 years, a range of factors has driven many municipalities to consider privatizing part or all of these services. In fact, many U.S. cities currently lease various parts of their water supply and wastewater treatment systems to private operators. But while it holds promise for improving water service deliveries and cutting costs, the long-term consequences of 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 third meeting at the White River Environmental Partnership in Indianapolis on June 8-9. Guest speakers included Mike McKee of Environmental Management Corporation (St. Louis), Richard Farnham of United Water (Indianapolis), and Peter Cook of the National Association of Water Companies (Washington, D.C.). The committee will hold its fourth meeting in Woods Hole on October 2-3. 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 third meeting in Ames, IA, on June 4-6. The meeting was preceded by field trips to agricultural sites, the Bear Creek and Walnut Creek watersheds. Hosted by Iowa State scientists Dick Schultz and Tom Isenhardt and

ARS scientist Jerry Hatfield, the field trips described efforts to reduce the impacts of nitrogen pollution on nearby streams and drainage ditches. During the meeting, the committee heard presentations from the University of Illinois' David Kovacic about the effect drainage systems on riparian zone functioning, from committee member Theo Dillaha about the importance of the TMDL program in restoring riparian areas, and from Mike Dosskey about the activities of the USFS National Agroforestry Center in Lincoln, NE. Two presentations on the economics of riparian areas were given by Joe Colletti of Iowa State University and John Braden of the University of Illinois.

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. It will also review criteria for the improved management of riparian lands and for mitigation of impacts on such habitats. The fourth committee meeting, September 24–26 in Eugene, OR, will focus on riparian areas in old growth forests of the Pacific Northwest, including the role of large woody debris, and provide a training session on Proper Functioning Condition. Mark Brinson of East Carolina University serves as chair. For further information, contact Laura Ehlers at 202-334-3422 or lehlers@nas.edu.

Studies in Hydrologic Science

The joint WSTB/BASC Committee on Hydrologic Science met in Washington on May 1 to review plans for a series of focused workshops on scientific challenges in the hydrologic sciences. Two such workshops, which will be attended by scientists and agency representatives, are planned for the fall. "Towards Integration of Hydrological and Ecological Sciences" is being chaired by Bill Nuttle on October 26–27 at Pine Jog Nature Center, West Palm Beach, FL. The aims of the workshop are: (i) to better define the research problems at the interface between hydrological and ecological sciences and to assess their importance and (ii) to interact with agency representatives to assess whether these problems are being adequately addressed by current agency programs. The other workshop chaired by Dara Entekhabi, "Predictability and Limits-of-Prediction for Hydrologic Systems," will be held September 21–22 in Boulder, CO. The event will address such issues as the conceptual frameworks required to define limits-to-prediction, how the stability and feedback characteristics of coupled hydrologic systems affect predictability, and extending the lead-time and accuracy of hydrologic predictions. These events will likely produce material to be published in an NRC report on strategies for hydrologic science. Dara Entekhabi of the Massachusetts Institute of Technology chairs the committee. For more information, contact William Logan at 202-334-3422 or wlogan@nas.edu.

USGS Water Resources Research

The Committee on USGS Water Resources Research is currently assessing the USGS National Water-Use Information Program (NWUIP). NWUIP produces the reports titled "Estimated Use of Water in the United States" every five years. The committee received an introduction to the program when it met February 7–8 in Washington, DC. At this meeting, the committee decided to split roughly in half and conduct site visits to learn about the state water-use programs and how they relate to the national program. The first visit was to the district office in Nashville, TN on June 6–7. Five committee members met with the water-use officers for the states of Tennessee, Georgia, and Arkansas, and learned about some of the financial and organizational challenges facing the program. The other committee members visited the USGS district office in Boise, ID on July 18–19. The perspectives of the western districts were represented by water-use officers from Idaho, California, and Nevada. This project is scheduled to run until about mid-2001. The committee's report *Investigating Groundwater Systems on Regional and National Scales* is in the final stages of review and should be released in early August. Kenneth Bradbury of the Wisconsin Geological and Natural History Survey, Madison chairs the committee. For more information, contact William Logan at 202-334-3422 or wlogan@nas.edu.

Future Projects

Scientific Basis for the Land Application of Sludge

The NRC is planning for a new study that will evaluate the scientific underpinnings of current standards for metals, organic pollutants, and pathogens in sludge from waste-water treatment plants. For metals and other pollutants, the multi-pathway exposure and risk assessment that form the technical basis of current numerical standards will be appraised. The study will consider questions such as whether the pathways of exposure, model scenarios, and default assumptions used in these assessments are appropriate. For pathogens, control approaches for sewage treatment will be evaluated for their adequacy in protecting public health. Risk assessment methods for pathogens in sludge will be explored, and, if appropriate, improved methods and approaches will be recommended.

Requested by EPA, this study is meant to update the 1996 WSTB report, *Use of Reclaimed Water and Sludge in Food Crop Production*. It is expected that a 12-member committee will meet 4–5 times over an 18-month period. In conjunction with the first committee meeting, the committee will host a public workshop to obtain outside input, develop a study plan, and properly delineate study questions. This workshop will include many members

from the aforementioned WSTB study committee, EPA scientists and regulators, other experts, and the interested public. The study will be supported and overseen by BEST, who will take the lead on the study, with assistance from the WSTB and other units. For more information or to nominate committee members, contact Laura Ehlers at 202-334-3422 or lehlers@nas.edu.

Microbes in the Environment

EPA has requested an extensive, multi-board study to assess issues involving microbes in the environment. Accordingly, the Board on Biology, BEST, and WSTB are planning to convene a committee, which over the next five years will oversee a series of workshops and sub-panel reports on microbes in the environment. Issues falling under the purview of the committee include, but are not limited to, the ecology and natural roles of microbes; their sources and life-cycles in the environment; the consequences of ecosystem changes (human or naturally-induced) on their balance and function; their effects on plant, animal, and human health; their potential beneficial uses; and research needs and methods for assessing their risks and benefits. The design of genetically engineered microorganisms for environmental applications and the associated policy issues and management options will also be considered. The role of antibiotics in regulating microbial communities, the potential use of genomic information for assessing microbial activity, the use of microbes for bioremediation, and the development of microbial indicators are likely to be topics considered by the subpanels. Many of these issues will build on the work of several prior WSTB committees. For more information or to nominate committee members, contact Laura Ehlers at 202-334-3422 or lehlers@nas.edu.

Services and Values of Aquatic Ecosystems

Aquatic ecosystems include lakes, rivers, streams, and wetlands 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 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 ecosystems, the intrinsic value of hydrologic, biogeochemical, and biological services can be more readily assessed. The WSTB has written a proposal for 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 environment. At present, funding efforts for the study are underway. For more information, or if you are interested in sponsoring the study, contact Mark Gibson at 202-334-3422 or mgibson@nas.edu.

Evaluating the Impacts of Removal of Existing Dams

The WSTB is pursuing development of a project of considerable national interest and importance—the removal of existing dams. The planned study would focus on hydrologic and ecological issues associated with dam removal, including the redistribution of contaminated sediments; water quality and temperature change issues; hydrogeomorphic changes; channel and riparian area re-establishment; instream flow-change considerations; and removal of structures so as to maximize the natural stream valley and channel functions. The study would aim to (1) define the likely physical, chemical, and biological impacts to the river and riparian system that result from dam removal; (2) determine the likelihood that dam removal can reverse the negative effects brought about by dam installation; (3) estimate the length of time required to restore pre-dam conditions to river reaches upstream and downstream from dams that are removed; and (4) assess the adequacy of relevant science, research, and monitoring programs to provide information needed to evaluate the effects of dam removal. The report resulting from this study would address decision makers, researchers, and agencies and groups deciding the future of dams and trying to assess the likely impacts of removal. The report will include selected studies of cases where dams have already been removed as a way of understanding the consequences, including socioeconomic consequences, of dam removal. Presently, the WSTB is developing sponsorship for the study. To suggest sources of funding or nominate committee members, contact Stephen Parker at 202-334-3422 or sdparker@nas.edu.

Assessment and Control of Nonpoint Source Pollution

Nonpoint source (NPS) pollution has become the major threat to water quality in the nation's waterbodies, both coastal and inland. NPS pollution is associated with a wide variety of human activities that involve changes in vegetative cover, disturbance of soil, or alteration of hydrology. The consequences of NPS pollution range from minor to very severe, depending on the intensity of activity, the vulnerability of the natural systems where the activity occurs, and the technologies that are used to mitigate the adverse effects on water quality and aquatic ecosystems.

This proposed study would investigate (1) the sufficiency of knowledge about sources of NPS pollution, including land use change and other factors, (2) the state of modeling to predict pollutant loads from these sources, and (3) the effectiveness of regulatory and management approaches in controlling NPS pollution. The study would complement the recently completed report *Clean Coastal Waters* by focusing more on inland nonpoint sources of pollution and considering a broader range of pollutant types. An initial increment of funding has been secured from EPA and additional sources are being sought. To suggest funding sources or possible committee membership, contact Laura Ehlers at 202-334-3422 or lehlers@nas.edu.

Water Disinfection Issues and Alternatives

WSTB staff are 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 in Washington DC to bring together public and private stakeholders, generate interest in the study, and identify potential sponsors and committee members. Several organizations expressed interest in the project and funding is currently being sought, particularly from the EPA. For more information or to suggest funding sources, contact Laura Ehlers at 202-334-3422 or lehlers@nas.edu.

Watermarks

New WSTB Membership

On July 1, the WSTB underwent several membership changes. Four new members—Efi Foufoula-Georgiou of the University of Minnesota, Diane McKnight of the University of Colorado, Rutherford Platt of the University of Massachusetts, and Jerald Schnoor of the University of Iowa—were appointed to three-year terms. Together with these new appointments, Henry Vaux's term as chair was extended by one year, Richard Luthy was appointed vice-chair, and William Jury's term was extended. Vice chair Carol Johnston of the University of Minnesota, John Boyer of the University of Delaware, Denise Fort of the University of New Mexico, and Eric Wood of Princeton 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:

Henry J. Vaux, Jr., *chair*, Division of Agriculture and Natural Resources, University of California, Oakland
Richard G. Luthy, *vice-chair*, Stanford University
Richelle Allen-King, Washington State University, Pullman
Gregory Baecher, University of Maryland, College Park
John Briscoe, The World Bank, Washington, DC
Efi Foufoula-Georgiou, University of Minnesota, St. Paul
Steven Gloss, University of Wyoming, Laramie
William A. Jury, University of California, Riverside
Gary S. Logsdon, Black & Veatch, Cincinnati, Ohio
Diane M. McKnight, University of Colorado, Boulder
John W. Morris, J. W. Morris Ltd., Arlington, Virginia
Philip A. Palmer, E. I. du Pont de Nemours & Co., Wilmington, Delaware
Rebecca T. Parkin, The George Washington University, Washington, DC
Rutherford H. Platt, University of Massachusetts, Amherst
Joan B. Rose, University of South Florida, St. Petersburg
Jerald L. Schnoor, University of Iowa, Iowa City
R. Rhodes Trussell, Montgomery Watson, Pasadena, California

2000 Clark Prize

On June 16, **Charles R. O'Melia** was presented the 2000 Clarke Prize and delivered the Clarke Lecture in Los Angeles. The Clarke Prize, including a cash prize, has been awarded annually since 1994 by the National Water Research Institute for demonstrated excellence in the fields of water science and technology and to honor the vision of NWRI's co-founder, Athalie Richardson Irvine Clarke. O'Melia is the Abel Wolman Professor of Environmental Engineering at Johns Hopkins University, a past member of the WSTB and present member of BEST, and the chair of the WSTB's recently completed New York City Watershed Management study. The Clarke Prize citation notes his substantial contributions to the basic understanding of physical and chemical processes for water treatment and the behavior of particles in the natural water environment over four decades.

Stockholm Water Prize

Kader Asmal was awarded the prestigious 10th Stockholm Water Prize on March 12. Professor Asmal was the 1998 WSTB Abel Wolman Lecturer. The current South African Minister of Education was recognized for his work while Minister of Water Affairs and Forestry. He was cited for his unprecedented achievements in the field of water management and water policy reform.

Jury Elected to the National Academy of Sciences

The WSTB congratulates board member **William A. Jury**, who on May 2 was one of 60 new members elected to the National Academy of Sciences. Bill is a professor of soil physics in the department of soil and environmental sciences, University of California, Riverside. He was cited for his distinguished and continuing achievements in subsurface hydrology, including creation of the transfer function model for solute transport. Election to the NAS is considered one of the highest honors that can be accorded a U.S. scientist or engineer.

CGER Staff Awards

Mark Gibson received a Certificate of Appreciation for Outstanding Service at the CGER awards ceremony held on June 14. Having joined the WSTB in January 1998 as a research assistant, he has since assumed full leadership of the joint WSTB/BEST Committee on Drinking Water Contaminants and was recently promoted to staff officer. Mark is also supporting the ongoing Committee to Improve the USGS National Water Quality Assessment (NAWQA) Program.

Ellen de Guzman, WSTB senior project assistant, received her second Certificate of Appreciation for Outstanding Service at the CGER awards ceremony held on June 14, 2000. Ellen joined the WSTB staff in October 1995 as a project assistant. Aside from assisting in study projects, she also manages the WSTB website and is associate editor of the WSTB newsletter.

WSTB congratulates Mark and Ellen for receiving recognition of their hard work.

WSTB Reports

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*).

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 prepublication 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 recommendations 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 usefulness 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*).

National Research Council Meetings

August 24–25, 2000 Committee on the NAWQA Program, Woods Hole, MA

September 14–15, 2000 Committee on the Bioavailability of Contaminants in Soils and Sediments, Woods Hole, MA

September 18–19, 2000 Water Science and Technology Board Meeting, Irvine, CA

September 19–21, 2000 Committee on Mitigating Wetland Losses, Irvine, CA.

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 March, July, and November 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: Laura Ehlers
Associate editor: Ellen de Guzman

September 21–22, 2000 Committee on Navigation in the Upper Mississippi River–Illinois Waterway, Washington, DC

September 21–22, 2000 Committee on Hydrologic Science workshop “Predictability and Limits-of-Prediction for Hydrologic Systems,” Boulder, CO

September 24–26, 2000 Committee on Riparian Zone Functioning and Strategies for Management, Eugene, OR

October 2–3, 2000 Committee on Privatization of Drinking Water Supplies, Woods Hole, MA

October 13–14, 2000 Committee on the Missouri River Basin, Pierre, SD

October 26–27, 2000 Committee on Hydrologic Science workshop “Towards Integration of Hydrological and Ecological Sciences,” West Palm Beach, FL

October 30–31, 2000 Committee on Environmental Remediation at Navy Facilities, TBD

November 9–10, 2000 Committee on the NAWQA Program, Washington, DC