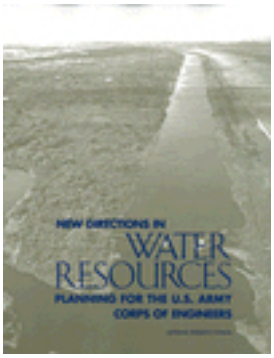


New Directions in Water Resources Planning for the U.S. Army Corps of Engineers

Committee to Assess the U.S. Army Corps of Engineers Water Resources Project Planning Procedures, National Research Council

ISBN: 0-309-57005-0, 120 pages, 8.5 x 11, (1999)

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

Committee to Assess the U.S. Army Corps of Engineers Water Resources Project Planning Procedures
Water Science and Technology Board
Commission on Geosciences, Environment, and Resources
National Research Council

NATIONAL ACADEMY PRESS
Washington, D.C. 1999

NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competencies and with regard for appropriate balance.

This study was supported by Contract No. DACW-72-96-C-0005 between the National Academy of Sciences and U.S. Army Corps of Engineers. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the organizations or agencies that provided support for this project.

Library of Congress Catalog Card Number 99-60701
International Standard Book Number 0-309-06097-4
Additional copies of this report are available from: National Academy Press 2101 Constitution Ave., NW Box 285 Washington, DC 20055 800-624-6242 202-334-3313 (in the Washington metropolitan area) http://www.nap.edu

Cover by Van Nguyen, National Academy Press, using a photo from the South Florida Water Management District (http://www.sfwmd.gov).

Printed in the United States of America.

COMMITTEE TO ASSESS THE U.S. ARMY CORPS OF ENGINEERS WATER RESOURCES PROJECT PLANNING PROCEDURES

DAVID H. MOREAU, *Chair,* University of North Carolina, Chapel Hill
FRED P. BOSSELMAN, IIT, Chicago-Kent College of Law, Chicago, Illinois
RICHARD T. CARSON, Jr., University of California, San Diego
JEANNE NIENABER CLARKE, University of Arizona, Tucson
LEO M. EISEL, McLaughlin Water Engineers, Denver, Colorado
WILFORD R. GARDNER, University of California, Berkeley
RICHARD F. GORINI, J. Simmons Group, Houston, Texas
CONSTANCE E. HUNT, World Wildlife Fund, Washington, D.C.
RAY B. KRONE, University of California, Davis
ANN L. RILEY, Waterways Restoration Institute, Berkeley, California
RICHARD E. SPARKS, University of Illinois, Urbana-Champaign
BORY STEINBERG, Steinberg and Associates, McLean, Virginia
DOUGLAS C. WOOLLEY, Radford University, Radford, Virginia

Staff

JEFFREY W. JACOBS, Study Director
ELLEN A. DE GUZMAN, Senior Project Assistant

WATER SCIENCE AND TECHNOLOGY BOARD

Staff

COMMISSION ON GEOSCIENCES, ENVIRONMENT, AND RESOURCES

Staff

THE NATIONAL ACADEMIES

National Academy of Sciences
National Academy of Engineering
Institute of Medicine
National Research Council

The **National Academy of Sciences** is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. Upon the authority of the charter granted to it by the Congress in 1863, the Acade my has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Bruce M. Alberts is president of the National Academy of Sciences.

The **National Academy of Engineering** was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. Wm. A. Wulf is president of the National Academy of Engineering.

The **Institute of Medicine** was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, upon its own initiative, to identify issues of medical care, research, and education. Dr. Kenneth I. Shine is president of the Institute of Medicine.

The **National Research Council** was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both Academies and the Institute of Medicine. Dr. Bruce M. Alberts and Dr. Wm. A. Wulf are chairman and vice chairman, respectively, of the National Research Council.

www.national-academies.org

Preface

The U.S. Army Corps of Engineers, like many other federal agencies, is a large, complex organization driven by executive and legislative directives, as well as its own traditions. It is also an organization in transition, moving from its traditional role as a leader in engineering solutions to the nation's flood and other water-related problems to a new role as a cooperative partner with nonfederal entities and addressing diverse, new priorities.

Our committee was charged to review the Corps' planning procedures, consider the necessity for a major evaluation of the federal *Principles and Guidelines*, assess the implications of the Water Resources Development Act of 1986, and comment upon the impacts of the use of risk and uncertainty analysis in Corps planning. Through the course of this study, it became clear to the committee that many desired improvements to the Corps' planning process can only be pursued in the context of broader, federal policy considerations. Moreover, at its first meeting the committee was encouraged by Assistant Secretary of the Army, Martin Lancaster, to "think outside the box" and assume a broad view of Corps planning. Our committee thus chose to consider some additional issues regarding the Corps' planning process, such as basinwide and regional planning and the Corps' environmental restoration activities.

Our task was complicated by the numerous views about how the Corps does business. Traditional stories and anecdotes about the Corps abound. Many are true and supported by evidence; some are probably true but lacking documentation; others are probably untrue. Given our committee's diversity and wide range of perspectives, we spent considerable time trying to separate fact from fiction. In some instances were we able to do so. In others, a lack of time and resources limited our investigation, and we concluded by recommending to the Corps that they investigate the issues in greater depth.

Our report does not call for radical changes in Corps planning procedures, although we do recommend several steps to modernize planning concepts and techniques. Several steps within the Corps' planning process require detailed engineering, environmental, and economic analyses. These procedures are inherently time-consuming and cannot be significantly streamlined without compromising their quality. While opportunities exist for the Corps to further reduce the length of its planning process, the committee found that the Corps' planning procedures are generally not excessively lengthy.

While the committee's charge was restricted to a review of domestic activities, the Corps has also worked overseas and with foreign water resources

planners, a tradition that continues today. The Corps should be encouraged to continue its cooperative efforts in international water planning, whether they involve overseas project planning or hosting foreign scientists at Corps research centers. The Corps should especially seek to apply the same high standards of project analysis in its international programs that it uses in its domestic efforts.

Although several factors made our task difficult, a number of individuals made our task easier. Ed Dickey, former Chief of Planning for the Corps, informed us, encouraged us, and at times corrected us. Bob Daniel at Corps headquarters was very helpful in providing information and arranging interactions with Corps personnel in the districts and research organizations. John D'Anello and Raleigh Leef from Corps headquarters provided important input and advice. Kyle Schilling from the Corps' Institute for Water Resources also provided guidance. We also owe our thanks to literally dozens of other Corps of Engineers employees, too numerous to mention individually, who provided presentations and logistical support at the committee's various meetings and field trips across the country. Our thanks also go to Mike Slimak from the U.S. Environmental Protection Agency, who provided a presentation to the committee at its meeting in Washington, DC in October 1997. Thanks also go to Tom MacVicar of MacVicar, Frederico, and Lamb, and Holly Stoerker of the Upper Mississippi River Basin Commission, who spoke to the committee at its West Palm Beach, FL meeting in February 1998. We also wish to thank Jack Morris, former Chief of Engineers and a current member of the Water Science and Technology Board, for attending the committee's meetings and providing valuable advice and oversight.

Our work would not have been possible without the excellent staff of the Water Science and Technology Board. Steve Parker, Director of the Board, provided logistical support and overall direction of the project. Gary Krauss gave us excellent support while he was with the Board, but the heavy duty work fell to Jeffrey Jacobs, especially during the project's final stages when we had to assemble a coherent report from disparate parts and respond to the reviewers' many insightful comments. Ellen de Guzman's assistance with logistics and her work in pulling together the various manuscripts and revising them are greatly appreciated. Our committee thanks them all for their assistance.

This report has been reviewed by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the NRC's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the authors and the NRC in making the published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The contents of the review and draft manuscripts remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their participation in the review of this report: David Kennedy, California Department of Water Resources; Carol Johnston, University of Minnesota Natural Resources Research Institute; Debra Knopman, Progressive Policy Institute; Rutherford Platt, University of Massachusetts, Amherst; Peter Rogers, Harvard University; Theodore M. Schad, consultant, Arlington, Virginia; Leonard Shabman, Virginia Polytechnical Institute; and Juan Valdés, University of Arizona.

Although the individuals listed above provided many constructive comments and suggestions, responsibility for the final content of this report rests solely with the authoring committee and the NRC.

DAVID H. MOREAU
CHAIR

Contents

Executive Summary

The U.S. Army Corps of Engineers has long been the primary federal agency responsible for developing the nation's harbors, waterways, and water resources, having planned and built structures for flood damage reduction and navigation enhancement for nearly 200 years. In its efforts to address the nation's water-related problems and to meet larger social and environmental goals, the Corps has developed a standard set of project planning procedures. Through much of its history, funding for Corps studies and projects was often entirely provided by the federal government. With passage of the federal Water Resources Development Act of 1986 (WRDA '86), however, matching funds from local sponsors were required for most Corps projects.

Planning and construction of Corps projects is complex and thus has always been lengthy. The average planning time of a Corps project today is roughly 5.6 years. When WRDA '86 mandated that local sponsors make significant monetary investments in Corps studies and projects, this increased financial stake brought a desire to see results more quickly and at a lower cost. Local project sponsors have voiced some of the stronger complaints that the Corps' planning procedures take too long.

To help streamline its planning, the Corps requested the Water Science and Technology Board of the National Research Council to form a study committee to identify ways to shorten the planning period and improve results. The committee's charge identified four broad tasks:

1. Assess the Corps' project planning process to determine if all steps are necessary and if the process can be streamlined. Is the Corps' planning effort reasonable, given the level of investment?
2. Consider the necessity for a major evaluation of the *Principles and Guidelines*. Can this process be streamlined without undue harm to land and water resources?
3. Consider how the cost-sharing requirements of the 1986 Water Resources Development Act have affected the potential development of new Corps water projects. This should address the number and size of projects, as well as effects on study duration and timing.
4. Consider how the requirement to include risk and uncertainty analysis has affected project planning, development, and the range of alternatives considered.

Various federal, state, and local laws, such as the Endangered Species Act

(ESA) and the National Environmental Policy Act (NEPA) at the federal level, and complementary acts at the state level, affect the Corps' planning process. Local sponsor plans and perceptions also influence the Corps, although these are primarily external to the Corps' internal planning procedures. This study's findings and recommendations address the task statement from two levels of analysis: issues internal to the Corps' organizational structure and issues that go beyond and are external to the Corps.

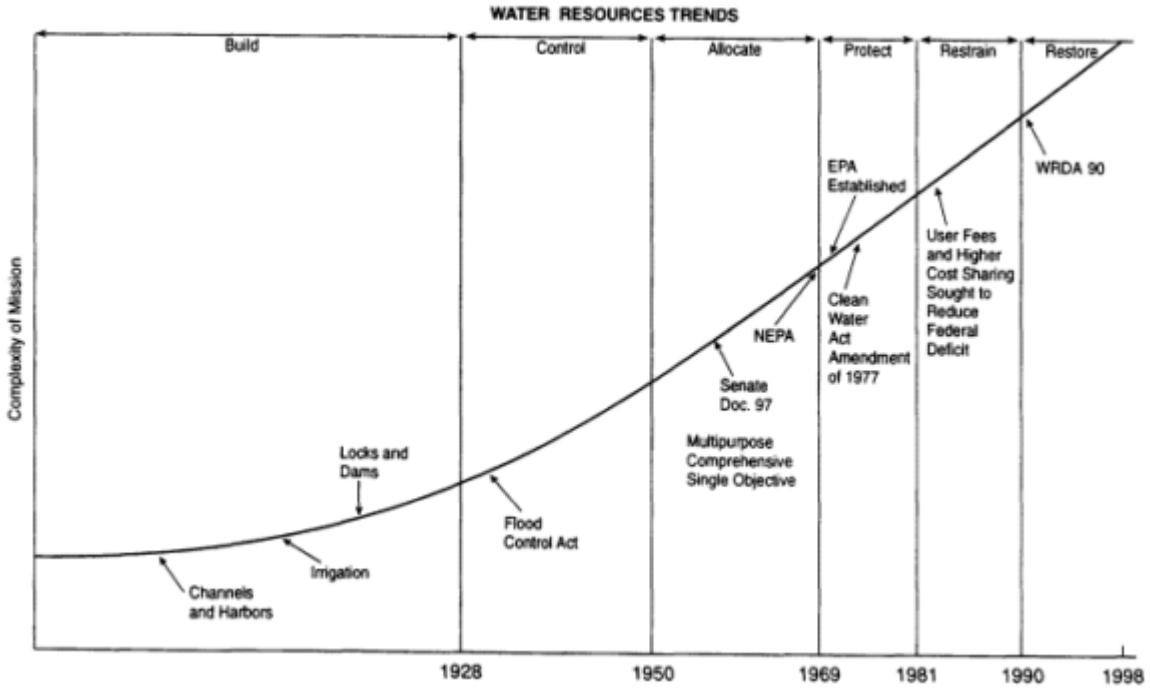
The Corps of Engineers project planning process is divided into two stages, a reconnaissance study and feasibility study, which together require an average of 5.6 years to complete. Corps reconnaissance studies, which are conducted by the Corps' district offices, are today required to be completed within 12 months. There is then often a lag between the end of project reconnaissance and the start of a feasibility study. Between 1985 and 1996, the average length of this gap was roughly one year. Feasibility studies between 1985 and 1996 averaged 3.6 years.

The committee investigated in detail the length of various components of the planning process and the means by which they might be shortened. Although the Corps recently has made considerable progress in streamlining its planning, it could take other steps. For example, the committee recommends that **when it appears to the Corps and the local sponsor that a reconnaissance study will have a favorable outcome, they should immediately begin the steps required for the next planning phase, the feasibility study. The committee also recommends that a negotiated preconstruction engineering and design (PED) cost-sharing agreement be completed at the same time as the division (chief) engineer's report is released to Corps headquarters.**

The committee generally agrees with the current requirement that the Corps consider a broad range of alternatives during project planning. **However, the Corps should develop a simple procedure that allows for the omission of analysis of expensive alternatives that are unlikely to be adopted, and stages of review for small projects for which a broad consensus exists.**

Some of this committee's suggestions for *improving* the planning process—such as greater consultation with local sponsors and more thorough analysis of complex restoration projects—will not result in *shortening* that process. Thorough, careful water resources planning is a complicated undertaking. Water projects have become more complex as our knowledge of physical and biological systems has increased, and as planning requirements (such as environmental impact statements, biological models, and consideration of basinwide biophysical impacts) have become greater (Figure ES.1). It is not unusual for private-sector water projects, such as the planning of a water supply system, to take several years. Such private-sector projects are often simpler, have more localized effects, face fewer regulatory requirements, and serve a narrower range of clients than does a Corps of Engineers project. Expectations of the Corps' ability to reduce further the time required in its planning should be realistic. While the Corps may be able to trim several months from its project planning procedures, it would be unreasonable to expect years to be trimmed from the process.

The committee was requested to consider the necessity for a review of the main document that guides federal water planning, the *Principles and Guidelines for Water and Related Land Resources Implementation Studies*, which were approved in



ES.1
Trends in the evolution of the Corps of Engineers responsibilities and approaches.
Source: Adapted from Steinberg, 1984.

1983. Often called the *P&G*, these guidelines are based on the original *Principles and Standards for Planning Water and Related Land Resources* (the *P&S*, which were approved in 1973 and repealed in 1982). The *P&G* provide comprehensive guidance on decision making and analytical procedures and are used by the Corps and three other federal agencies: the Bureau of Reclamation, the Natural Resources Conservation Service, and the Tennessee Valley Authority.

While they were in effect, the *P&S* were consistently reviewed and updated by federal and other water planning specialists. By contrast, the *P&G* have not received the same degree of attention and, as a result, do not adequately reflect contemporary water resource planning principles and practices. Although these guidelines have proven useful to the Corps since the document was developed in 1983, there have since been substantial advances in environmental evaluation methods and significant changes in the typical Corps of Engineers project. It is thus time for a comprehensive revision. Examples of specific revisions to the *P&G* which the committee recommends include:

1) movement away from consideration of the National Economic Development (NED) account as the most important concern. Today, ecological and social considerations are often of great importance in project planning and should not necessarily be considered secondary to the maximization of economic benefits. Strict adherence to the NED account may discourage consideration of innovative and nonstructural approaches to water resources planning. Furthermore, any water development alternative that does not meet environmental criteria and regulations—even though it may maximize monetary benefits—cannot be implemented.

   The notion of NED as formulated in 1983 may not fit contemporary planning and social realities. The Corps is aware of these issues, as evidenced in a recent Corps document. A Corps draft guidance dated 31 October 1997 (an updated draft version of the Corps' other key planning document, ER-1105-2-100) describes how an "NER" (national ecological restoration) account could be used, as well as an "optimum trade-off plan" designed to reasonably maximize the sum of NED and NER.
2) legislation passed after 1983 mandated new responsibilities for the Corps' in the areas of environmental improvement and restoration. Many aspects of these environmental programs are exempt from meeting some of the *P&G* requirements because they were enacted after the *P&G* were passed. The *P&G* should be updated to reflect these new and important Corps programs.
3) new techniques in risk and uncertainty analysis have been developed since 1983 and incorporated in Corps planning guidance. The *P&G* should be updated to reflect these new advances.
4) nonstructural approaches to flood damage reduction have gained much wider acceptance since 1983. The *P&G* should be updated to eliminate biases or disincentives that work against nonstructural approaches, and to ensure that the benefits of flood damages avoided by nonstructural projects are consistently and uniformly considered.

In summary, the committee recommends that **the federal *Principles and Guidelines* be thoroughly reviewed and modified to incorporate contemporary**

analytical techniques and changes in public values and federal agency programs. The executive branch, which approved the *P&G* in 1983, should take the necessary steps to update the guidelines so that they reflect contemporary planning principles and methods and address the full range of responsibilities in the Corps' work program.

The *P&G* were written by the Water Resources Council (WRC), an executive level body created in the mid-1960s to coordinate the formulation and execution of federal water policies. Today, however, the WRC lies dormant due to lack of funding and the *P&G* are currently administered by the Office of Management and Budget (OMB). Given the WRC's current status, the procedures for modifying the *P&G* are not clear. This lack of procedural clarity, however, should not be allowed to delay a review and update of the *P&G.* The executive branch should use its authority to find the means to modernize the *P&G* so that the document better reflects contemporary water planning theories and practices.

The committee was also requested to review implications of the Water Resources Development of 1986, significant for the cost-sharing criteria it enacted. Cost-sharing is not a new requirement, as some federal-nonfederal cost-sharing arrangements date back several decades. But the requirements initiated in WRDA '86 brought tremendous changes to project funding arrangements. A general result of WRDA '86 was to increase the funding responsibilities of local sponsors. With these greater financial requirements, local sponsors requested and received a greater voice in project planning and design considerations. The Corps has also become more receptive to local sponsor participation.

The emphasis on local projects and cosponsors may be pulling the Corps in opposite directions, however. On one hand, WRDA '86 mandates the Corps to work closely with local cosponsors, effectively providing a service to local communities. On the other hand, the Corps is charged to promote the national interest in its water planning activities. Promoting this national interest may require integrating plans and programs throughout a large river basin system (especially an interstate basin), which may be incompatible with providing specific water projects tailored to local—not basinwide—interests.

To promote efficient plans and projects across the nation's river basin systems, **the Corps should use the watershed or river basin, estuarial region, and coastal unit as the basic spatial units in water project planning, when and where it is appropriate and circumstances allow.** The use of such hydrologic units for planning can help account for downstream effects of flood damage reduction projects, for example, or provide a system to account for cumulative effects of Corps projects. Most of the nation's large river basins cross state lines, suggesting the need for federal involvement in data storage and management, hydrologic modeling, and analysis of systemwide impacts. The national interest in estuaries and coastlines also suggests the need for Corps planning in these systems. The Corps is a logical agency to provide these types of support: it has a long history in interstate basin planning, is currently involved in several interstate basin programs, and possesses basinwide modeling capabilities. The Corps should take the lead in improving and quantifying the basinwide implications of water projects. These activities should be coordinated with other relevant federal agencies, such as the U.S. Geological Survey and the

Environmental Protection Agency. The Corps should examine its rules and regulations and legislative mandates and recommend changes to promote long-term project planning in a spatially integrated manner.

To further help improve the planning process, **the Corps should be given more extensive authority to engage in regional planning activities that include multiple water projects,** such as in the Upper Mississippi River basin or the Everglades. Such regional activities will allow the Corps to coordinate project planning and construction more efficiently and at lower cost, schedule its contractors' resources and timetables more efficiently, and generally reduce instances of administrative duplication.

The WRDA '86 initiated a significant shift in water project financing. Though the Corps has subsequently become more attentive to the needs of project cosponsors, it is important that all parties who stand to be affected by a Corps project be kept fully informed. A poorly informed local sponsor can contribute to delays in the planning process.

To clearly delineate the respective responsibilities of the Corps and local sponsor, and to expedite planning procedures, **the Corps should provide improved guidance to local sponsors to help them identify project alternatives before a specific project is proposed. This guidance should require local sponsors to demonstrate that they have identified the alternatives proposed by all interested stakeholders before asking the Corps to begin project reconnaissance.**

The Corps is shifting an increasing portion of its resources into its restoration programs. Ecological restoration makes up about 17 percent of the Corps' current civil works budget, and this figure is likely to increase. This relatively new emphasis on restoration is appropriate, but the committee notes that Corps projects have always had environmental impacts, though the ecological implications of its past projects often were not explicitly accounted for in project planning.

Understanding and predicting the effects of interventions in ecological systems is a complicated venture, requiring expertise in ecosystem sciences. The Corps has accordingly broadened its traditional emphases in hydrology, hydraulics, and structural engineering by hiring life scientists and environmental engineers throughout the organization. **The Corps should continue to strengthen its staff expertise in the biological and ecological sciences.**

All large Corps projects should include long-term monitoring capability. To the extent that long-term monitoring is critical to a project's successful management, the costs of monitoring should be part of overall project costs. As the Corps continues to alter the nation's watersheds, estuaries, and coasts (albeit moving away from large engineering structures and toward restoring ecosystem functions), those regions will experience a variety of ecological changes. Some of these effects will become clear after a short time, whereas others may take years or decades to manifest themselves. Long-term monitoring will allow the Corps to learn more about natural systems and allow it to adjust design and management practices as understanding of these systems increases.

Contemporary concepts of "adaptive management" stress the importance of small-scale pilot projects, data gathering and monitoring of those projects, use of those data in future planning, and avoiding large, irreversible decisions. Projects are viewed not only as ends in themselves, but as carefully designed experiments in

which knowledge of project outcomes is used in future planning and decision making. As opposed to a "trial-and-error" approach, management decisions are carefully and consistently monitored. Adaptive management does not preclude initial design that utilizes all available knowledge to obtain success; it is a method of adding to that knowledge and working toward more desirable results. Adaptive management means that project planning does not end when construction is finished, but rather is an ongoing, iterative process that makes appropriate adjustments as environmental and social conditions change. **When appropriate, the Corps should adopt an adaptive management approach to project management.**

The Corps' restoration programs also represent new challenges in the economic valuation of water project outputs. Traditional Corps projects such as levees, dams, and navigation facilities typically have monetized, economic benefits that are used in a project's benefit-cost calculation. The process of identifying and quantifying the benefits and costs from such projects is complicated, and the Corps has taken its share of criticism regarding its past use of benefit-cost analysis. But the economic benefits of a habitat restoration project are even more difficult to identify and quantify. Furthermore, restoration projects may be constructed to provide benefits increasingly valued by our society, such as aesthetic values, that defy monetization. Attempts to capture these values can be made through a variety of economic techniques, such as contingent valuation methods, which, though widely used, remain controversial. **The Corps should strive to improve and further develop analytical methods for valuing the environmental benefits/detriments associated with its water projects. The committee recognizes that the tools currently available are inadequate for the Corps' purposes and that a substantial, sustained effort will be required to develop a standardized set of tools, including benefit-transfer models and programs, to help quantify environmental benefits and costs associated with its restoration, flood damage reduction, and navigation projects.**

Water management responsibilities at the federal level are greatly fragmented, with 34 federal agencies involved in some manner of water planning, development, or regulation. The relations between these agencies (including the Corps) and the states must be better defined and coordinated. When it existed, the Water Resources Council attempted to help coordinate federal-level water policies. Although the WRC was not without its problems (most of which were beyond the WRC's control), the committee concluded that implementation of coherent and effective federal water policies is severely hampered by the lack of strong involvement of an executive-level body to coordinate agency policies and programs. **This committee thus recommends the creation of a group within the Executive Office of the President to formulate national water policy and coordinate and promote interagency collaboration.** This body might start its program by promoting coordination of information and analytical techniques. The Office of Science and Technology Policy (OSTP) might, for example, be responsible for coordinating environmental and hydrological models among the various federal agencies that employ them. This body could also revise the *P&G*. This is not a call for another major federal agency, but rather a recommendation to establish some mechanism to coordinate the guidance for federal water project planning.

The committee also discussed Corps activities that could reduce economic damages in the nation's floodplains, and simultaneously preserve and enhance habitats and processes in river-floodplain ecosystems. It was particularly interested in the Corps' nonstructural approaches to reducing damages from floods, including the permanent evacuation of vulnerable structures from floodplain areas. Relocating residents and structures from frequently flooded low-lying areas permanently avoids flood damages and (expensive) disaster assistance payments. In such programs, the benefits of flood damages avoided should be explicitly accounted for in calculating project benefits. However, the *P&G* do not allow for the benefits of primary flood damages avoided to be claimed as benefits in all nonstructural projects. **The committee recommends that the benefits of flood damages avoided be included in the benefit-cost analysis of all flood damage reduction projects—including all nonstructural projects—and that these benefits be calculated in a uniform and consistent fashion.**

There appears to be a large and increasing demand for Corps-sponsored nonstructural flood damage reduction projects. The federal government, local stakeholders, many nongovernmental organizations, and the Corps itself have all promoted the economic and environmental virtues of nonstructural projects. There is an apparent mismatch, however, between this perceived demand and the federal response. The reasons for a relative lack of Corps-sponsored nonstructural projects are not clear. This may be a result of skewed benefit calculation procedures; it may be imbedded in an institutional bias against nonstructural projects; it may be that Congress and the Office of Management and Budget do not see a federal interest in local nonstructural projects. The issues are complicated, and several different avenues may be worthy of investigation. **The committee recommends a study of a representative sample of the Corps' flood damage reduction projects to determine whether nonstructural alternatives have been adequately considered, and whether there are any systematic biases in the way the Corps treats nonstructural alternatives.**

The Corps is making strong efforts to respond to conditions imposed by numerous acts of Congress. These conditions, including increased involvement with sponsors and stakeholders, overlapping agency interests, and the complexities of sound water resources planning, are the principal reasons that Corps planning studies are costly and time-consuming.

The Corps has been responsive to its local sponsors' complaints, moving to shorten the planning process in many ways, especially over the past two years. This report provides several recommendations that, taken together, should help the Corps further shorten the planning process. Beyond these recommendations, however, further reductions may be neither reasonable nor desirable. **The Corps' planning process is not significantly more time-consuming than the planning of a private-sector water project. Given the many considerations of such planning, the length and cost of the Corps planning process are generally reasonable.**

Not all of the committee's recommendations to the Corps are aimed at cutting the time and cost of planning. On the contrary, some suggestions may actually expand the process. Clearly, the Corps should not aim solely to produce planning studies and projects as cheaply and quickly as possible. Long-term project monitoring, improved analytical techniques, and studies of a project's basinwide

implications all tend to lengthen the planning process. To maintain the high quality of its planning studies, the Corps must stay abreast of and use contemporary planning theories and methods, even if these add time to the planning process.

As a federal steward of the nation's water resources, the Corps promotes projects in the national interest and constructs projects consistent with the nation's economic and environmental statutes and goals. Not only does this require thorough and sometimes lengthy studies, but these larger concerns may conflict with local plans and projects. This clearly represents a conundrum for the Corps: to protect the federal interests or to promote local interests? Maintaining a responsiveness to local sponsor concerns and desires—which are often justified and understandable—while assuring that those local concerns are consistent with federal and basinwide goals, will present a great challenge to the U.S. Army Corps of Engineers in the early 21st century.

1

Evolution of Corps Programs and Federal Water Policies

The Corps of Engineers has played several important roles in shaping America's water resource systems and policies. The Corps has been central to many important trends and events within the federal government's water management programs, from the "levees-only" debate along the Mississippi River in the 1850s, to federal river basin committees in the mid-20th century, to the environmental movement of the late 1960s and 1970s. Although other federal water planning agencies, such as the U.S. Bureau of Reclamation in the western states and the Tennessee Valley Authority in the southeastern United States, have been influential, the Corps predates them all and has sponsored projects and programs in all 50 states. This chapter describes the evolution of the Corps' programs and federal water policies, to set the stage for later detailed discussions of how the Corps' planning procedures might be changed. Readers familiar with these topics may wish to proceed directly to the discussion in Chapter 2 on the implications of the Water Resources Development Act of 1986 and other legislative and administrative initiatives for Corps policies and planning.

EARLY CORPS ACTIVITIES IN THE NATION'S RIVER BASINS

The Corps' origins can be traced back to the U.S. Military Academy in West Point, New York, where an engineering school was established in 1802. West Point trained its officers in drafting, mathematics, surveying, and hydraulics, and served as the nation's primary engineering school well into the 19th century.

The early 1800s saw lengthy and heated debates regarding federal involvement in regional water resource development. The debate culminated in the 1824 *Gibbons v. Ogden* Supreme Court decision, which was strongly profederal. In this historic ruling, Chief Justice John Marshall's majority opinion declared that federal power to regulate interstate commerce carried with it a similar federal authority over navigation (Rogers, 1993), providing entry for the Corps into a variety of programs for the nation's waterways.

In 1850 the U.S. Congress directed the Corps to engage in its first planning exercise. The Corps was authorized to "determine the most practical plan" to control flooding along the lower Mississippi River (Clarke and McCool, 1996). Two strongly diverging reports were produced. A report by Captain Andrew Humphreys promoted a levees-only strategy, focused on completing a levee system along the lower river to the exclusion of other tactics. The other report, by the respected civil

engineer Charles Ellet, backed a more comprehensive strategy of strengthening downstream levees along with upstream storage reservoirs and enlarged river outlets. In 1861, the Corps finally decided in favor of Humphreys' levees-only strategy.

The 1899 River and Harbor Act

The 1899 River and Harbor Act gave the Corps its first direct regulatory mission, by authorizing it to monitor, control, and/or prohibit the dumping of dredged material and other debris into the nation's navigable waters.

Other important legislation was enacted during this period. The Reclamation Act of 1902 created the Reclamation Service (renamed the Bureau of Reclamation in 1923), the federal agency responsible for irrigation and hydropower development in the western United States, that eventually grew in size and power to rival the Corps during the 1940s and 1950s. President Theodore Roosevelt established the Inland Waterways Commission (IWC) in 1906, and in 1909 the River and Harbor Act authorized the Corps and the Reclamation Service to consider hydroelectric power development in their project planning. Traces of the idea of basinwide planning are to be seen in this era and President Roosevelt himself advocated cooperative planning in the nation's river basins, stating that "each river system, from its headwaters in the forest to its mouth on the coast, is a unit and should be treated as such" (Inland Waterways Commission, 1908).

The Federal Water Power Act of 1920

The Federal Water Power Act of 1920 established a uniform process for the licensing of private hydroelectric power projects, but Congress initially neglected to give the Federal Power Commission (FPC) the necessary funds for planning. This was resolved in the River and Harbor Act of 1925. This act requested the Corps and the FPC to estimate the costs of appraising the feasibility of hydropower development, in combination with improvements in navigation, flood control, and irrigation on the "navigable streams of the United States and their territories . . . " (U.S. Congress, 1925). In the River and Harbor Act of 1927, Congress authorized the Corps to undertake comprehensive surveys to formulate "general plans for the most effective improvement of [navigable streams and their tributaries] for the purposes of navigation and the prosecution of such improvement in combination with the most efficient development of the potential water power, the control of floods, and the needs of irrigation" (White, 1957). The surveys came to be called "308 reports," after House Document number 308, which listed the basins recommended for more complete studies. The reports established "the first comprehensive river-basin development plans for the nation" (Moreau, 1996).

New Deal Planning

The 308 plan for the Tennessee River Basin provided the basis for the Tennessee Valley Authority (TVA), a hallmark of New Deal resource planning. Even before his inauguration, President Franklin Roosevelt promised the people of the impoverished Tennessee River region that the TVA would serve as an example of planning "for generations to come, tying in industry and agriculture and forestry and flood prevention, tying them all into a unified whole over a distance of a thousand miles so that we can afford better opportunities and better places for millions of yet unborn to live in the days to come" (Freidel, 1990).

The Tennessee Valley Act of 1933 marked an era of great confidence in the potential for similar valley authorities to promote water and related land development, with the ends of social and economic improvement. In the 74th Congress alone, more than a dozen bills were introduced that called for valley authorities in the upper Mississippi, Arkansas, Cumberland, Wabash, Columbia, Sacramento-San Joaquin, Missouri, Tombigbee, Connecticut, and Merrimack basins (Rieke and Kenney, 1997).

Executive-level interest in resource planning was reflected in a series of national boards and commissions: the National Planning Board (1933-1934), the National Resources Board (1934-1935), the National Resources Committee (1935-1939), the National Power Policy Committee, and the National Resources Planning Board (1939-1943).

The Flood Control Act of 1936

It was also during the 1930s that the Corps developed its benefit-cost procedures. Section I of the Flood Control Act of 1936 specified the circumstances for federal involvement in improvements for flood control: "the federal government should improve or participate in the improvement of navigable waters or their tributaries, including watersheds thereof, for flood control purposes if the benefits to whomsoever they may accrue are in excess of the estimated costs, and if the lives and social security of people are otherwise adversely affected" This effectively subjected all of the Corps' future flood control projects to a benefit-cost test (Kneese, 1993).

Although this idea came from Congress, it had been contemplated for a long time. In 1808 Treasury Secretary Gallatin issued a report calling for analysis of the benefits and costs of proposed waterway improvements. It also appeared, in some form, in the 1902 Reclamation Act, and comparisons of benefits and costs were routinely included in the 308 reports (for example, see House Document 500, 72nd Congress, "Improvement and Development of Neuse River, NC"). The most direct congressional mandate was in the 1936 act: "Whether the legislators who framed and enacted this statute knew it or not, with this provision they enshrined the "Kaldor-Hicks" potential compensation criterion in federal law. This criterion says that a project is economically justified if the beneficiaries could compensate the losers, whether they do so or not" (Kneese, 1993).

The act also elevated the Corps' flood control activities to the same level as

its navigation enhancement programs. Over the next 60 years, the Corps increasingly refined its benefit-cost analysis, becoming one of the primary federal agencies to apply this decision making technique, although the Corps' applications of benefit-cost analysis have drawn several criticisms (Krutilla, 1966; Reisner, 1986).

The Federal Interagency River Basin Committee

President Roosevelt established the Federal Interagency River Basin Committee (FIARBC) in 1943, at the same time Congress moved to abolish the National Resources Planning Board (NRPB) (Moore and Moore, 1989). The first regional river basin committee under the FIARBC, the Missouri Basin Interagency Committee (MBIAC), was created in 1945 to implement the Pick-Sloan Plan (adopted in the 1944 Flood Control Act). Pick-Sloan was forwarded to resolve the competition in the Missouri River basin between the Corps and the Bureau of Reclamation, both of which vied for supremacy over western U.S. water development in the post-World War II era. According to Pick-Sloan, the Corps was to develop flood control and navigation improvements for the Missouri River, while the Bureau of Reclamation was to develop irrigated agriculture in the Missouri basin (Rieke and Kenney, 1997). By 1950, other FIARBC committees had been established in the Columbia, Pacific Southwest, Arkansas-White-Red, and New York-New England basins. Much has been written about the FIARBC committees, most of it "uniformly critical of this institutional arrangement" (Rieke and Kenney, 1997). The FIARBC committees were eventually replaced by the Interagency Committee on Water Resources (ICWR) during President Eisenhower's administration.

FEDERAL WATER RESOURCES PLANNING AT MID-CENTURY

The Cooke Commission

A series of water resource investigations at the federal level were initiated in the 1950s and 1960s, starting with the President's Water Resources Policy Commission, established by executive order in January 1950 (Rogers, 1993). The panel was known as the Cooke Commission, as it was chaired by Morris Cooke, a well-known management consultant and administrator of the Rural Electric Authority and other federal agencies. The commission produced a substantive three-volume report in 1950. Volume 1, *A Water Policy for the American People*, made several recommendations for federal water planning, including a call for separate commissions for the nation's major river basins (even though the previous FIARBC river basin committees were deemed mainly ineffective). Volume II, *Ten Rivers in America's Future*, identified several programs for more effective planning, including standards for data collection (Wescoat, 1998). The Commission's findings also led the Bureau of the Budget to issue a manual—Circular A-47—which identified

standards to be used by all federal agencies in water project evaluation.

The Green Book

In 1950 a subcommittee of the FIARBC presented the classic economic efficiency model as the standard for analysis, in a report known as the Green Book (the document was revised and published in 1958 as *Proposed Practices for Economic Analysis of River Basin Project*). The report covered the basic concepts of benefit-cost analysis; principles and procedures for project and program formulation; standards, problems and procedures in benefit and cost measurement; analysis of various project purposes; and cost allocation (Yoe and Orth, 1996). Although the professional staffs of the federal agencies agreed on many of the document's economic principles, the FIARBC never officially adopted the report. Much of its content, however, found its way into Circular A-47.

Circular A-47

Enacted by President Truman on December 31, 1952, just as he was leaving office, Circular A-47 imposed rigorous new standards for water project evaluation by the federal agencies. Congress did not approve of the circular but could not agree on an alternative. It thus remained a directive that Congress routinely circumvented in its authorization and appropriation processes. The Bureau of the Budget's Circular A-47, entitled *Reports and Budget Estimates Relating to Federal Programs and Projects for Conservation, Development, or Use of Water and Related Land Resources*, was intended to provide uniform standards and criteria to be used by the Executive Office of the President (EOP) in reviewing reports and budget requests of the various water resources agencies. According to its key directives (Moore and Moore, 1989):

- the project's total benefits had to exceed its costs;
- the benefits of each purpose of a multiple-purpose project had to exceed the costs;
- where permitted by enabling legislation, local interests should contribute one-half of the land enhancement value of flood protection;
- project costs should include an estimate of the taxes foregone; and
- 50-year maximum period should be set for repayment of the federal interest.

Circular A-47 also laid the groundwork for nonstructural solutions to flood problems, either as supplements to or substitutes for traditional structural approaches.

But the Corps did not widely use such executive branch guidance in formulating projects during the 1950s. One reason was that the Corps had become closely identified with congressional interests. According to Arthur Maass, who studied the role of the Corps in the U.S. governmental system and its relations with local constituents, the agency operated as the construction and engineering arm of the

U.S. Congress during the years between the two world wars, calling itself the U.S. Engineering Department (Maass, 1951). Maass noted a complex, highly structured planning process within the organization, the purpose of which was to allow local participation in plan formulation: "A recapitulation of the process . . . reveals a minimum of thirty-two stages at which interest groups may be able to present their views to the Corps and Congress. Of these thirty-two stages, fifteen may involve contacts between interest groups and the Engineering Department" (Maass, 1951).

Senate Document 97

In 1962 the U.S. Senate published a report prepared by the Interagency Committee on Water Resources which was transmitted to the Congress by President Kennedy. The report significantly impacted the planning processes of federal water agencies. Known as Senate Document 97, it laid out new policies, standards, and procedures to be used in the formulation, evaluation, and review of agency plans. The objectives of flood control were left essentially unchanged: flood control and prevention benefits were to consist of a reduction in damages from inundation, plus increases in the net return from higher property value made possible as a result of lowering the flood hazards. However, Senate Document 97 also established a general planning milieu based on "the expectation of an expanding national economy in which increasing amounts of goods and services are likely to be required to meet the needs of a growing population, higher levels of living, international commitments and continuing economic growth" (Rogers, 1993).

THE U.S. WATER RESOURCES COUNCIL AND TITLE II RIVER BASIN COMMISSIONS

The Water Resources Council

The 1965 Water Resources Planning Act was passed as part of a continuing effort by the administrations of John F. Kennedy and Lyndon Johnson to coordinate and centralize federal water resources planning and policy formulation. The act marked the culmination of decades of efforts toward a more centralized approach to water resources planning (Wescoat, 1998). In terms of federal water policy, the act had two key components: Title I created the executive-level Water Resources Council (WRC); Title II provided the framework for the establishment of interagency-interstate commissions (Rieke and Kenney, 1997). It also required the establishment of "principles, standards, and procedures for Federal participation in the preparation of comprehensive regional river basin plans and for the formulation and evaluation of Federal water and related land resources projects" (42 U.S.C. 1962a-2).

The WRC initially consisted of seven cabinet-level departments: Agriculture, Army (including the Corps), Commerce, Energy, Housing and Urban

Development, Interior, and Transportation. The Environmental Protection Agency (EPA) was added in 1970 when it was created by executive order. The WRC was chaired by the Secretary of the Interior, who was assisted by an executive director and a small staff. The level of representation within the WRC varied considerably. The secretaries of each department and the EPA administrator were the actual council members. But because they often did not have time for the council's day-to-day operations, their responsibilities were delegated to assistants.

Among the WRC's more important programs were the development in 1973 of the *Principles and Standards for Planning Water and Related Land Resources*, national assessments of the nation's water resources (issued in 1968 and 1978), and a state-level planning program. According to Moore and Moore (1989): "Key provisions of the new *P&S* made capital-intensive water projects harder to justify. Environmentalists and the budget-conscious were pleased with the restrictions, but construction agencies wanted more liberal evaluation criteria. Concerned that the P&S did not give equal priority to economic development and social well being, in Section 80C of WRDA '74, Congress directed a second study that was published in 1975. This study noted inconsistencies in agency cost-sharing practices and left final decisions for correcting the problems to Congress."

The new *P&S*, along with the National Environmental Policy Act of 1969 (which mandated preparation of an environmental impact statement as part of federal water project planning) lengthened the Corps' planning process (Mazmanian and Nienaber, 1979). According to Moore and Moore (1989), "By 1971, the Corps estimated the time between passage of a congressional resolution authorizing a study and the initiation of construction at 15 years. In 1981, Congress estimated an average of 26 years from authorization to construction."

In 1983, the *Principles and Standards* were repealed by the WRC and replaced by the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*, commonly called the *P&G*. They were removed from the "Rules" section of the Federal Register and placed in the "Notice" section, thus becoming guidelines rather than rules for federal agency planning.

The WRC was the product of an era of pronounced national interest in river basin development, which began in the 1930s and ran through the 1960s. The WRC presided during a period of ambitious water resources planning (including its 1968 and 1978 national water assessments). President Carter's suggestion that the WRC have an expanded role, with greater regulatory and projects review authority, was not well received. The WRC, criticized over previous modest interventions in the planning process, came under a torrent of complaints regarding excessive costs, permits, and denials (Wescoat, 1998). The Reagan administration moved quickly to phase out the WRC, zero-funding the organization in 1981.

Title II River Basin Commissions

Several river basin commissions were established under Title II of the 1965 Water Resources Planning Act, including ones for New England, the Ohio River basin, the Missouri River basin, the Pacific Northwest, the Great Lakes, and the

Souris-Red-Rainy region. The Upper Mississippi Title II Commission was added in 1971 and was incorporated into the Souris-Red-Rainy Commission (Rieke and Kenney, 1997). No Title II commissions were created in basins where waters had been allocated according to Supreme Court decisions or by compacts (such as on the Colorado River).

The Title II commissions were formed to promote the coordination of federal and, to a lesser extent, state water management agencies. The commissions' activities varied greatly, depending on basin histories and geographical circumstances, and they were viewed as moderately successful, at best. Only the New England River Basins Commission was generally seen as effective. This was due largely to the strong conservation ethic of its chairman, Frank Gregg; a modest influence of federal development agencies in the region; and a strong regional orientation and tradition of interstate cooperation (Rieke and Kenney, 1997).

PROGRAM REDUCTION, 1970-1985

The period 1970 to 1985 marked a significant departure from the previous decades of Corps program growth, as Congress authorized no major water projects. For several well-documented reasons, public environmental perceptions and values began to change in the 1960s (Caulfield, 1977; Hays, 1987; Nash, 1990). Consequently, Congress passed several statutes that had considerable influence on the Corps' (and other federal agencies') planning processes, and the presidents during this time issued several important executive orders relating to natural resources policy and planning. These statutes and executive orders included:

- the 1969 National Environmental Policy Act;
- President Nixon's July 1970 executive order creating the EPA;
- the Federal Water Pollution Control Act of 1972, especially Section 404 relating to wetlands protection;
- the Endangered Species Act of 1973; and
- President Carter's 1977 Executive Order 11988 on floodplain management and 11990 on wetlands protection, which united the previously separate goals of reducing flood losses and environmental damage by recognizing the beneficial values associated with wetlands (Moore and Moore, 1989).

Although the Corps' planning processes had always been relatively elaborate, these new authorities raised that complexity to a higher level. The new policies and statutes resulted in more extensive interagency programs with the EPA, the Fish and Wildlife Service, the Federal Emergency Management Agency (FEMA), the Council on Environmental Quality (CEQ), and the Office of Management and Budget (OMB). Private-sector, nonprofit environmental organizations also stepped up their participation in Corps planning. Most of the cooperation and coordination initiated in the 1970s continues today and in some cases—such as coordination with the Fish and Wildlife Service regarding the Endangered Species Act—has been expanded.

Higher discount rates that disfavored project economic justification (Moore and Moore, 1989), coupled with the Office of Management and Budget's general lack of enthusiasm for water projects (Caulfield, 1977), resulted in decreased funding. Federal outlays for water projects dropped by almost 80 percent, from $6 billion per year in 1968 to $1.3 billion in fiscal 1984, and from 1977 to 1983 more Corps civil works projects were canceled than were authorized (Moore and Moore, 1989). The Reagan administration's emphasis on cost sharing further reduced federal support for large-scale water development.

Most of the nation's main rivers and tributaries had already been dammed by the late 1960s, also decreasing the possibility of more federally funded water projects. The mainstreams of the Columbia, Missouri, Mississippi, Colorado, Tennessee, Ohio, and Rio Grande had been nearly fully developed. The need for large-scale water resources engineering and construction had simply declined.

By the end of the 1970s, these factors, along with heightened environmental awareness, necessitated changes to the Corps' project planning. The Chief of Engineers enunciated new, agency-wide environmental objectives; public involvement was expanded; new environmental resources units were established at the district, division, and headquarters levels; and the Corps hired personnel with expertise in the biological and social sciences to augment the agency's environmental programs.

"Fishbowl planning"—public participation in all steps of the planning process—was conceived and implemented by the Corps' Seattle district. It represented the most extensive effort to incorporate the myriad changes and directives into the agency's traditional planning process (Mazmanian and Nienaber, 1979). Used for several projects in the Pacific Northwest, including a flood damage reduction project on the Middle Fork of the Snoqualmie River, this new planning model (originally mandated by NEPA and the EIS requirements) resulted in a longer and costlier process.

Although popular with the general public, the Corps eventually scaled back public participation because it was not considered to be cost-effective. For instance, in the case of the Snoqualmie River, the original congressional authorization for a flood damage reduction study was passed in 1960, but the agency's final study was not scheduled for completion until 1981 (Mazmanian and Nienaber, 1979). Other examples where public participation programs were reduced include the Meramec Lake Project (St. Louis district) and the Little Calumet River Project (Chicago district).

This attenuated planning process, new environmental legislation, and the precipitous decline in new starts in the 1970s caused the Corps to reconsider its entire planning process. In addition, Congress was soon to change the context and ground rules for federal water projects and planning. The changes enacted in the federal Water Resources Development Act of 1986 (WRDA '86) and the following years are reviewed in detail in Chapter 2.

2

The Water Resources Development Act of 1986 and Other Legislative and Administrative Initiatives

IMPLICATIONS OF WRDA '86 AND OTHER WRDAS

The Water Resources Development Act of 1986 (WRDA '86) and other "WRDAs" are omnibus water bills which provide congressional authorization for Corps of Engineers projects across the nation. The first WRDA was passed in 1974. Prior to 1974, Congress authorized the Corps' flood damage reduction and navigation enhancement projects in the same bill but under different titles, River and Harbor, and Flood Control Acts, respectively. Since the 1974 bill, WRDAs have been passed in even-numbered years, though not necessarily every even-numbered year (there was no WRDA in 1998, for example). WRDA '86 was significant in that it released several years of pent-up demand and significantly changed the relationship between the Corps and local project interests. In particular, it called for significant changes in water project cost-sharing arrangements, resulting in greater financial and decision making roles for local stakeholders. Its centerpiece was a set of cost-sharing provisions that placed greater economic responsibility on nonfederal interests. This was not the first time Congress mandated cost sharing between the federal government and local sponsors. The 1936 Flood Control Act, for example, required nonfederal sponsors to provide land easements for some flood damage reduction projects, and other cost-sharing arrangements date back even further (e.g., to the 1920s for projects along the Lower Mississippi River). But the cost-sharing regulations in RDA '86 for the first time stipulated actual cash contributions for most types of projects. Prior to WRDA '86, neither flood control costs for reservoirs nor harbor navigation projects had any cost-sharing arrangements; with the passage of WRDA '86, local sponsors had to provide cash contributions for these projects.

Advocates of these new cost-sharing rules promised that the allocation of federal funds to Corps projects would result in more efficient use of tax dollars because water projects would have to meet the test of the market. They reasoned that if a local project sponsor was neither capable nor willing to share the costs of a project, it was not worth building and that only truly good projects would receive local financial backing and be constructed. Advocates also argued that the legislation would spread a limited construction budget across a greater number of projects.

WRDA '86 greatly changed the way new projects would be studied and evaluated and it established a framework that promoted federal-nonfederal partnerships. Local sponsors were given a greater role in project planning and became more cost-conscious. Subsequent federal Water Resource Development

Acts further encouraged local interests to become more active stakeholders. As a result, nonfederal sponsors, having made substantial investments in project studies, have tended to become impatient with the Corps' planning process.

Cost-Sharing Provisions of WRDA '86

WRDA '86 initiated the sharing of construction costs of virtually all types of civil works projects. The cost-sharing requirements for the nonfederal sponsors developed in WRDA '86 are summarized in Table 2.1, and an example of the implications of these new arrangements is provided in Box 2.1, which compares cost-sharing arrangements before and after WRDA '86. Changes initiated by WRDA '96 are not included in either. The committee was especially interested in determining if these cost-sharing criteria contained any biases against nonstructural flood damage reduction projects. As described in Box 2.1, the committee found that no such biases were intended to result from the WRDA '86 cost-sharing criteria.

Table 2.1 lists cost-sharing criteria for structural and nonstructural projects; the distinction between the two is important. In Corps terminology, a nonstructural project is one that does not store or divert flood flows away from an inhabited area, whereas a structural project uses dams or levees to keep flood waters away from buildings and other infrastructure. A nonstructural project might include raising buildings above the high-water mark, relocating a community, or taking some other action that does not alter high flows. A structural project includes any structure designed to keep water away from an inhabited area.

Broadening the Scope of Corps Water Planning

Since the mid-1980s, legislation has expanded the types of studies and projects the Corps is allowed to undertake, especially when environmental outputs are a main objective. In WRDA '96, many programs authorized between WRDA '86 and WRDA '92 were enlarged and broadened. Several of the major changes are summarized in Table 2.2.

In addition, many new environmental programs and projects were authorized in WRDA '96 (Table 2.3). It should be noted that no further congressional authorization is generally needed to implement the recommendations, although modifications to broaden or increase the appropriations ceilings specified are likely to be necessary. The basic difference in the traditional study-to-construction process is that no further authorization is required for those programs authorized for construction. These tables suggest that the Corps is looking for innovative, cost-effective and technically sound solutions to a variety of water-related environmental problems.

RISK AND UNCERTAINTY ISSUES

Treatment of risk and uncertainty in the planning of Corps of Engineers projects has been among the organization's critical planning issues in the 1990s. The

BOX 2.1

THE EFFECTS OF COST-SHARING ARRANGEMENTS ON FLOOD DAMAGE REDUCTION ALTERNATIVES

The committee reviewed the changes in cost-sharing criteria contained in WRDA '86 with an eye toward understanding any biases that might exist either in favor of or against nonstructural projects. The committee was particularly interested in examining the argument that because nonfederal sponsors were required to provide lands, easements, rights of way, relocations, and disposal areas (LERRDs) for nonstructural projects, they would tend to reject nonstructural, land-intensive alternatives.

The structural-nonstructural dichotomy is somewhat misleading. Nonstructural alternatives may include large amounts of structural modifications to properties at risk. The term "structural" usually refers to projects that include dams, dikes, levees, and diversions to modify the flow of flood waters. "Nonstructural" usually refers to projects that involve modifications to properties to reduce their susceptibility to flood damage, but a nonstructural alternative may result in a substantial cost to modify residential, commercial, industrial, or publicly owned structures. Relocation or flood-proofing of housing and buildings at risk to floods would be considered a nonstructural option involving costs to move or flood-proof large numbers of structures.

The following table provides an example of nonfederal shares of costs for flood damage reduction projects with various mixes of land and construction costs. The figures for LERRDs and construction costs are based upon WRDA '86, which established the following cost-sharing criteria: for structural projects, the local sponsor is responsible for LERRDs plus a minimum 5 percent cash contribution, ranging from a minimum of 25 percent to a maximum of 50 percent of total costs; in nonstructural projects, the local sponsor is responsible for 25 percent of total project costs.

In searching for possible biases contained within cost-sharing requirements, five hypothetical flood damage reduction projects are described, all costing $80 million. They range from a project with a high amount of construction costs and low land acquisition costs (Project A: $75 million construction, $5 million LERRDs), to a project with low construction costs and high land acquisition costs (Project E: $15 million construction, $65 million LERRDs).

With the passage of WRDA '86, the nonfederal share of nonstructural projects was set at 25 percent ($20 million in each of the table's nonstructural projects). The nonfederal share of structural projects ranged between a minimum of 25 percent (Project A) and a maximum of 50% (Projects D and E). In the example of post-WRDA '86 Projects A and B, the local sponsor would be indifferent toward a structural vs. nonstructural project (both at 25 percent of total cost, or $20 million). However, as LERRDs increase, the nonstructural projects are more economically attractive to the local sponsor; they are capped at 25 percent, whereas the share for structural projects ranges up to 50 percent All other things (than the cost-sharing requirements) being equal, local sponsors will favor nonstructural alternatives in more land-intensive projects.

The issues related to selection of a preferred project alternative are very complicated and deserve greater attention by the Corps. Cost-sharing considerations, though important, are not the sole criteria upon which project selection is based Benefit-cost analysis has always been complex and controversial, and the Corps may have inherent institutional biases as an engineering organization that favors structural alternatives.

Based upon the cost-sharing criteria within WRDA '86, it is clearly not intended that the nonfederal share of a nonstructural alternative be more expensive than the structural option of comparable total costs. There was a change in the cost-sharing formula of flood damage reduction projects authorized after WRDA '96: the local sponsor's share of the cost of nonstructural projects was raised from 25 percent to 35 percent, and the minimum share of a structural project has also been raised from 25 percent to 35 percent. The upshot is that in many projects the cost to the local sponsor of a nonstructural and structural project will be identical. A nonstructural project will represent the cheaper option only when it has a large portion of costs in LERRDs. Although biases for structural projects may exist within the Corps (or with the local sponsor), they do not appear to be inherent in cost-sharing arrangements.

		Nonfederal Share	
Project	Cost	Structural	Nonstructural
Project A			
LERRDs	5	5	5
Construction	75	15	15
Total	80	20	20
Project B			
LERRDs	15	15	15
Construction	65	5	5
Total	80	20	20
Project C			
LERRDs	30	30	20
Construction	50	4	0
Total	80	34	20
Project D			
LERRDs	40	36	20
Construction	40	4	0
Total	80	40	20
Project E			
LERRDs	65	36	20
Construction	15	4	0
Total	80	40	20

NOTES: Prior to WRDA '86, structural nonfederal cost sharing consists of LERRDs only with the maximum contribution of 50% of total costs. Between WRDA '86 and WRDA '96, structural, nonfederal cost sharing consists of LERRDs and a minimum 5% cash contribution. The range of the total nonfederal share is between 25% and 50%. Prior to WRDA '86 (commencing with the Flood Control Act of 1974), the nonstructural, nonfederal cost sharing consists of 20% (whether LERRDs or cash). Between WRDA '86 and WRDA '96, nonstructural, nonfederal cost sharing consists of 25% (whether LERRDs or cash).

Table 2.1 Corps of Engineers Civil Works Projects Cost Sharing Formulas

	Federal/Nonfederal Construction Cost Sharing		Federal/Nonfederal O&M	
Project Purpose	Pre-WRDA '86	Post-WRDA '86	Pre-WRDA '86	Post-WRDA '86
I. Navigation				
Harbor projects				
LERRDs	Generally 100% nonfederal.	LERRs are 100% nonfederal dredged material disposal areas are cost-shared as a GNF.	Generally 100%.	
General navigation Features	100% federal	Nonfederal 10% for depths < 20 ft + 25% for depths >20 ft<45 ft. 50% for depths >45 ft.	Generally 100% federal.	Generally 100% federal.
Inland waterways				
LERRDs	Varies between 100% federal to 100% nonfederal.	Replacement locks generally 100% federal.		
Construction	100% federal.	100% federal, of which 50% of the costs of projects authorized to be funded in part of IWWTF is derived through fuel taxes paid into the fund.	General 100% federal.	Generally 100% federal.
II. Flood Control				
Structural				
LERRDs	100% federal for reservoir projects; 100% nonfederal for local protection projects.	100% nonfederal for all structural projects.	100% federal for reservoir projects; 100% nonfederal for local protection projects.	100% nonfederal for all structural projects
Construction	Generally 100% federal.	Minimum of 25% nonfederal and a maximum of 50% (to include the value of LERRDs). A minimum of 5% of the nonfederal share must be cash. For projects authorized after WRDA '96, the minimum nonfederal share is 35%.	(1) 100% federal for reservoir projects (2) 100% nonfederal for local protection projects.	100% nonfederal for all structural projects.

	Federal/Nonfederal Construction Cost-Sharing		Federal/Nonfederal O&M	
Project Purpose	Pre-WRDA '86	Post-WRDA '86	Pre-WRDA '86	Post-WRDA '86
Nonstructural				
LERRDs	100% nonfederal except that it shall not exceed 20% of project costs.	100% nonfederal except that it shall not exceed 25% of project costs (raised to 35% for projects authorized after WRDA '96).	100% nonfederal.	100% nonfederal.
Construction	20% nonfederal; the value of LERRDs counts against this percentage.	25% nonfederal (or 35% for projects authorized after WRDA '96). The value of LERRDs counts against this percentage.	100% nonfederal.	100% nonfederal.
III. Hurricane and storm damage reduction				
Beach-type projects				
LERRDs	100% nonfederal.	100% nonfederal.	100% nonfederal.	100% nonfederal.
Construction (including periodic nourishment)	Generally 50% nonfederal based on recreation cost sharing.	35% nonfederal, including credit for the value of LERRDs.	100% nonfederal.	100% nonfederal.
Hurricane walls/levees				
LERRDs	100% nonfederal.	100% nonfederal.	100% nonfederal.	100% nonfederal.
Construction	Generally 35% nonfederal.	35% nonfederal.	100% nonfederal.	100% nonfederal.
IV. Improvement of the environment				
Project modifications	Not generally considered for implementation prior to WRDA'86.	25% nonfederal; additional LERRDs required count toward this percentage.	Did not exist.	100% nonfederal.
Aquatic ecosystem restoration	Not generally considered for implementation prior to WRDA '86.	35% nonfederal; LERRDs count toward this percentage.	Did not exist.	100% nonfederal.

	Federal/Nonfederal Construction Cost Sharing		Federal/Nonfederal O&M	
Project Purpose	Pre-WRDA '86	Post-WRDA '86	Pre-WRDA '86	Post-WRDA '86
V. Other project purposes				
Recreation				
Reservoir projects	50% of separable costs nonfederal from 1965 to 1986. Prior to PED in 1965, 100% federal.	50% of separable costs nonfederal.	100% federal prior to PED in 1965. Thereafter, 100% nonfederal.	100% nonfederal.
Local production projects (flood control)	50% of joint and separable costs nonfederal.	50% of joint and separable costs nonfederal.	100% federal prior to PED in 1965. Thereafter, 100% nonfederal.	100% nonfederal.
Navigation projects (Deep Draft, Shallow draft and Inland	50% of joint and separable costs nonfederal.	50% of joint and separable costs nonfederal.	100% federal prior to PED in 1965. Thereafter, 100% nonfederal.	100% nonfederal.
Municipal and industrial water supply	100% nonfederal.	100% nonfederal.	100% nonfederal.	100% nonfederal.
Agricultural water supply	?????	35% nonfederal. The value of LERRDs counts against that percentage.	100% nonfederal.	100% nonfederal.

Table 2.2 WRDA'96 Modification of Prior Environmental Programs

Section in WRDA'96	Modified Section		
	Prior Authorization	Overall Description of Currently Authorized Programs	Comments
204	1135 WRDA'86	Restoration of Environmental Quality: Program for modification of existing Corps projects. Focus is on environmental improvement.	WRDA'96 broadened Section 1135 Demonstration Program. $5 million federal limit per project with $25 million annual limit. Guidance to Field in EC1105-2-214 September 1997.
205	312 WRDA'90	Environmental Dredging: Permits use of O&M funds to remove contaminated sediments outside of the boundaries of and adjacent to the navigation channel to comply with Federal Water Pollution Control Act. Work also allowed in navigable waters of the United States, with 50% cost-sharing.	$20 million federal limit per year priority projects identified in modified Section 205.
207	204 WRDA'92	Beneficial Uses of Dredged Material: Authorizes a program for carrying out projects for the protection, restoration, and creation of aquatic and ecologically related habitats including wetlands. Must be linked to dredging.	Requires 25% nonfederal cost sharing and 100% nonfederal O&M; $15 million annual limit.
210	103 WRDA'86	Cost Sharing for Environmental Projects: New cost-sharing category: 35% nonfederal share.	PGL No. 48, dated July 21, 199_ clarifies cost sharing for environmental projects. It distinguishes between F&WL mitigation and ecosystem restoration when different cost sharing is appropriate.
504	219 WRDA'92	Environmental Infrastructure: 18 projects identified as eligible for Corps assistance for carrying out water-related environmental infrastructure and resource protection and development projects.	WRDA'96 mod. authorized construction for six of the projects with varying authorization of appropriations amounts. Some funds have been provided in recent appropriations acts.

Table 2.3 WRDA'96 New Environmental Programs

Section in WRDA'96	Description of Authorized Programs	Comments
206	Aquatic Ecosystem Restoration: A new continuing authority with approval of projects delegated to the secretary. If it is determined that the project (1) will improve the quality of the environment and is in the public interest and (2) is cost effective.	$5 million federal limit per locality; $25 million maximum per FY; $6 million appropriated in FY 1998 (first year).
503	Watershed Management, Restoration, and Development: Section may provide technical, planning and design assistance to non-Federal interests for carrying out watershed management projects to include environmental restoration and demonstration of technologies for nonstructural measures to reduce flooding impacts.	$15 million appropriation authorization; Non-Federal share is 50%; 13 project locations identified.
510	Chesapeake Bay Environmental Restoration and Protection Program: Authorizes a pilot program for environmental assistance to nonfederal interest for design and construction of water-related environmental projects.	$10 million appropriation authorization; 25% nonfederal share; $1 million appropriated in FY 1998.
511	Research and Development Program to Improve Salmon Survival: Authorizes acceleration of ongoing R&D, especially in the Columbia River basin.	$10 million appropriation authorization for salmon R&D. $12 million authorized for "fish-friendly" turbine development efforts.
528	Everglades and South Florida Ecosystem Restoration: Authorizes a community plan for restoring, preserving, and protecting the South Florida ecosystem. Also calls for accelerating project implementation if otherwise authorized or if consistent with Section 528.	$75 million appropriation authorization for FY 1997-1999. Individual Federal project limit is $25 million. 50% is nonfederal cost sharing, except as otherwise noted.
539	Restoration Projects for Maryland, Pennsylvania, and West Virginia: Authorizes technical assistance to nonfederal interests for the purpose of abating and mitigating surface water-quality degradation cause by abandoned mines. Two river watersheds were identified.	$1.5 million appropriation authorization for each of the two projects; 50% nonfederal cost sharing.

Corps (and other water resource planners) have recognized for decades the problems associated with uncertainty. Water resource engineers and planning agencies have historically designed dams and other flood damage reduction structures according to a standard "base flood", such as the 100-year flood or the probable maximum flood (PMF). During the 1990s, the Corps began to move away from designing projects around such parameters, and toward the use of risk-based analyses for flood damage reduction. An important policy document in the Corps' move toward the use of risk-based analysis was the Corps' Engineering Regulation, "Risk-Based Analyses for Evaluation of Hydrology/ Hydraulics, Geotechnical Stability, and Economics in Flood Damage Reduction Studies", ER 1105-2-101 (USACE, 1996a). One consideration which led the Corps to embrace the use of risk-based techniques was that the Corps' previous approaches in dealing with risk may have resulted in projects larger than necessary (NRC, 1985).

The Corps' Past Treatment of Risk and Uncertainty

The Interagency Committee on Water Resources treated risk and uncertainty as components of the discount rate in its *Proposed Practices for Economic Analysis of River Basin Projects* (1950). It directed that adjustments be made to the discount rate to account for uncertainties that arise between the times when resources are committed to a project and when benefits accrue. The report adopted from the economics literature the classical distinction between two forms of risk. One type, such as droughts and floods, is predictable in that it can be assigned a probability. The other type includes shifts in the economy, technological changes, and other unforeseeable events to which probabilities cannot be assigned using relative frequencies from historical records. Other methods for addressing uncertainty involve the shortening of economic lives of projects, conservative estimates of benefits, and safety margins.

That distinction between risk and uncertainty was carried over in the Water Resources Council's *Principles and Standards*. Risk was characterized as being reasonably predictable on the basis of probabilities assignable to events for which relative frequency information is available. Probabilities are then used to calculate average values of losses from fires, floods, and other uncertain events, thereby establishing certainty equivalents. Uncertainty was characterized by the absence of a basis for assigning probabilities, and the same references to economic and technological change were cited as examples. Treatment of uncertainty was considered a matter of judgment to be discussed in planning reports and incorporated into specific strategies such as flexibility in project designs. Sensitivity analysis was also suggested as an analytical approach to uncertainty.

Current Corps Policies

Specific guidance for the Corps' use of risk-based analysis is provided in several engineering circulars, regulations, and manuals. Guidelines developed by the

Corps Institute for Water Resources (IWR) offer many examples for each of several project purposes that may be included in the analysis of Corps projects. Risk-based analyses are used to quantify uncertainties in discharge-exceedance probability, stage-discharge, and damage-stage relationships, and to incorporate these into economic and performance analyses of alternatives. The process applies Monte Carlo simulation, a numerical analysis procedure that computes the expected value of damage reduced while explicitly accounting for the uncertainty in basic functions (USACE, 1997a).

The Corps' 1996 Engineering Regulation on Risk-Based Analysis, ER 1105-2-101 (USACE, 1996a), mandates two kinds of risk analysis for flood damage reduction studies, one applied to flood events and the other to economic and hydraulic variables. For flood events, regulations state that when standard freeboard (vertical levee height added to the design flood stage level) assumptions or over-engineering standards are applied to project design, performance is to be reported in at least four ways: (1) the annual probability that standards will be exceeded; (2) risks of exceedances over 10-, 20-, and 50- years using the binomial formula; (3) conditional probabilities of non-exceedance of specified events; and (4) percent chance of containing a specified historic event.

The regulations also require risk-based analysis for all key economic and hydraulic variables. Whenever possible, probabilities are to be applied to each of the key variables, and benefits and costs, as well as the expected value, are to be estimated on a probability basis.

Regulations for analysis of deep draft navigation studies have similar requirements. Risk analysis is to be applied to vessel operating costs, fleet distributions, commodity forecasts, shoaling/sedimentation rates, unit costs of dredging, and unit costs for disposal. Risk analysis must also be applied to commodity forecasts and unplanned closures and estimates of costs due to delays, system capacity, fleet characteristics, foundation conditions, cross-currents in approach channels, filling areas, climatic conditions, competing uses, and high/low flows.

In all of these regulations, Corps planners are advised to assign probabilities to each of the listed variables, recalculate all benefits and costs for a large number of combinations of values of those variables, and state those benefits and costs in probability terms. Procedures are suggested for assigning those probabilities in cases where relative frequency data are not available. This approach is generally referred to as Monte Carlo simulation.

Use of Risk Analysis

The Corps has used RBA techniques for decades, and concepts of risk and risk reduction have long been central to the Corps' flood damage reduction programs. In the early 1990s, the Corps began to pursue expanded applications of RBA techniques. At a Corps-sponsored workshop on *Riverine Levee Freeboard* in Monticello, MN, in 1991, a basic proposal for the inclusion of risk-based analyses in flood damage reduction studies was offered. Since then, the Corps has steadily

solidified its commitment to the use of RBA techniques through a series of Engineering Circulars (EC) and Engineering Regulations (ER). These expanded applications have proceeded in parallel with encouragement from the Office of Management and Budget (OMB) to adopt risk-based analyses in planning studies.

While there have been criticisms of RBA (e.g., difficult to communicate RBA concepts to the public), such criticisms often attend the adoption of new planning approaches, and generally subside as practitioners gain experience with risk-based techniques. Furthermore, the use of previous design standards also had limitations. Contemporary Corps of Engineers practices generally recognize that no structure can provide absolute protection, and that all structures have a point at which they will fail. Risk-based analyses represent a more sophisticated approach than a single standard to cope with uncertainties, and attempt to find appropriate levels at which to design water control structures in different geographical and hydrological settings.

A unique case of the application of risk-based techniques was examined in detail by a committee of the National Research Council (NRC, 1995), which was charged to examine flood risk management by the Corps in the American River basin in California. Of particular concern was the estimation of the probability that a flood would exceed a given value at which a protective levee would be overtopped. The city of Sacramento, which lies behind these levees, is considered by many to constitute the greatest potential flood hazard in America. The committee demonstrated that classical statistical approaches to the estimation problem led to biased estimators of exceedance probabilities and estimates of damages. To avoid biases introduced by adjustments to parameter models, the committee recommended that the economic assessment and probability of flooding be based on best estimates of parameters in models with supplementary information about their accuracy derived from Monte Carlo simulations and other methods.

The Corps' use of RBA has also attracted congressional attention. Public Law 104-303 (part of WRDA '96), passed on October 12, 1996, directed the U.S. Army to enter into an agreement with the National Academy of Sciences (NAS) to conduct a broader investigation of the Corps' use of RBA in flood damage reduction studies. That investigation is to evaluate the Corps' use of RBA methodology and its implications regarding project formulation, economic justification, value added, and engineering and safety implications. It will also investigate the scientific validity of the Corps' practices. That committee has started its work and is scheduled to complete the study in 2000.

Environmental Risk Assessment and Restoration Projects

An emerging challenge to Corps planning is the use of environmental risk assessment, especially as it relates to environmental restoration projects. The Corps has a substantial history of evaluating the environmental impacts of water projects. A multiple objective planning model that included environmental quality as well as economic development was set forth by the WRC, which incorporated a more complete version of that model in the *P&S*. The *P&S* were influenced by the National Environmental Policy Act (NEPA), and the *P&S* and NEPA requirements

for environmental impact statements put the Corps at the forefront of environmental analysis.

Reducing uncertainty in ecological analysis continues to be a challenge. Earlier NRC committees have expressed concern that the scale of ecosystems is sufficiently large to make scientifically sound sampling very difficult, and that predictive ecological models need to be improved (NRC, 1993). The American River study committee concluded that ecological analysis was too "embryonic" to evaluate (NRC, 1995). Further discussion of the Corps' environmental restoration programs is included in Chapter 5.

Adaptive Environmental Assessment and Management

The concept of adaptive management has been promoted as a useful approach to natural resource management (water, forests, wetlands) in contexts with high degrees of uncertainty. Adaptive environmental assessment and management (AEAM) emphasizes the use the results of scientific experiments to help adjust and refine future policy decisions. AEAM is codified in a series of case histories, papers, and books by its advocates and practitioners (Gunderson et al., 1995; Holling, 1978; Lee, 1993; Walters, 1986). Many of the case histories involve large sites and resource extraction (fisheries, timber, water supply, hydroelectric dams), but the same approach also applies to smaller sites and to environmental restoration. AEAM incorporates many elements (modeling, risk analysis) that have a long history in natural resources planning and engineering and, more specifically, in well-developed engineering theories of adaptive control processes (Bellman, 1961; Holling, 1978).

The treatment of uncertainty within adaptive planning and management is based upon two key concepts. The first is that projects are viewed as a sequence of experimental designs, with results used in an iterative learning process to improve subsequent designs. The second follows from the first: monitoring, assessment, feedback, and adjustments are integral parts of the process and should be included in program design and funding decisions.

Although an attractive approach to coping with the uncertainties in environmental restoration, adaptive management does not provide a framework for guiding investment decisions. When the Corps (or any other public or private investor) considers an expensive ecosystem restoration project in which the outcomes are subject to considerable uncertainty, the range of possible investment outcomes, and the likelihood of each outcome, should be considered. Adaptive management suggests a sequential decision making process in which outcomes from one stage can be used to modify subsequent decisions. However, this does not avoid the necessity of judging whether a project should even be initiated, and, given prior outcomes at any given project stage, whether subsequent investments should be made. Because some restoration projects being considered by the Corps involve large expenditures, is it imperative that the Corps develops investment evaluation methods that explicitly account for uncertainties associated with these projects.

Treatment of uncertainties in ecological restoration projects is very different from uncertainties in flood damage reduction projects. Hydrologic uncertainty of

flood events can be represented by probability distributions based on relative frequency of events in historical records. By contrast, there are very few historical records of environmental restoration projects in particular ecological settings. Decision analysis is one approach that offers at least a conceptual framework for such an analysis. Decision trees can be used to map the various pathways to which sequences of decisions and their outcomes could lead. A combination of objective and subjective probabilities of following each path can be assessed. Physical, chemical, biological, and economic consequences are then predictable in quantitative and probabilistic terms, and strategies may be devised to cope with those uncertainties. Applications of this type of decision analysis would require research, development, testing, and evaluation. A critical issue is the process by which subjective probabilities would be assigned.

Climate Change

The climate change issue strongly relates to risk-based analysis. Extreme climate events and changes in variability can skew the hydrologic parameters upon which Corps projects are based. These changes, in turn, can change the reliability of Corps projects. For example, the degree of protection afforded by a Corps flood damage reduction project can change if flood events occur more or less frequently in the future.

While the specter of climate change hangs over many of the Corps' planning and management activities, it is not known how climate might change in the future. The available evidence suggests that 20th century global mean temperature, which has increased between 0.3°C and 0.6°C since the late 19th century (Houghton et al., 1996) is at least as warm as any century since 1400 A.D. The climate record also shows that three years in the 1990s—1990, 1995, and 1997—were warmer than any other year since (at least) 1400 A.D. (Mann et al., 1998).

It is difficult to prepare for possible future changes in climate, the direction and magnitude of which are not known. However, the possible consequences of dramatic shifts in climate, especially extreme weather events, suggest that the issue be taken seriously. The Corps has been studying the climate change issue extensively for years and continues to keep current with changes and advances in global warming research (e.g., Stakhiv, 1998). The Corps should remain abreast of research on climate change and variability issues, such as El Niño-Southern Oscillation, and their implications for hydrology and water management. Federal agencies such as the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Geological Survey are among the organizations the Corps can call upon to help stay well informed.

3

Assessment of the Corps' Planning Processes

THE CORPS PLANNING PROCESS

The U.S. Army Corps of Engineers plans, constructs, and operates water resource projects for a variety of purposes. The Corps' main water planning and development activities include flood damage reduction, navigation enhancement, aquatic ecosystem restoration, hurricane damage prevention, and beach protection. The Corps' water resources project planning procedures consist of two planning phases: a reconnaissance study and a feasibility study. This two-phase planning process was formalized with the enactment of the federal Water Resources Development Act of 1986 (WRDA '86). According to a special Corps task force that reviewed the planning process, "The fundamental purpose of the Corps process is to provide enough information to federal and nonfederal decision makers to determine that implementation of a proposed action is a wise investment decision" (USACE, 1996b).

Corps planning guidance comes from several sources. The two most important are the federal *Principles and Guidelines for Water and Related Land Resources Implementation Studies*, and the Corps document "Guidance for Conducting Civil Works Planning Studies," also known as Engineering Regulation (ER) 1105-2-100 (USACE, 1990). This document contains the *P&G* and provides advice on how they are to be used. The *P&G* provide planning guidelines for the Corps and three other federal water-planning agencies (the Bureau of Reclamation, the Natural Resource Conservation Service (NRCS), and the Tennessee Valley Authority), whereas ER 1105-2-100 is specific to the Corps. Additional guidance is provided by the *Digest of Water Resources Policies and Authorities* , guidance letters, and a series of engineering regulations (ERs) and engineering circulars (ECs).

The *Principles and Guidelines* were approved in 1983 and enacted via the Water Resources Council (WRC). The *P&G* replaced the *Principles and Standards for Planning Water and Related Land Resources*, which were adopted in 1972. Like the *P&G*, the *Principles and Standards* were enacted to provide a comprehensive framework for analyzing water development alternatives and were intended to be used consistently across federal water agencies.

There are several important differences between these two documents. The *P&S* framework included four sets of objectives: (1) national economic development (NED); (2) environmental quality (EQ); (3) regional economic development (RED); (4) other social effects (OSE). These four accounts encompass the significant effects of a water development project according to the National Environmental Policy Act

(NEPA) of 1969. The *P&S* required water project alternatives to be evaluated in relation to their impacts on the two principal planning objectives, NED and EQ. The other two objectives could also be assessed but were not required for all projects.

The *P&G* represented an important departure from the *P&S* in that they required only one alternative to be developed during project planning, the NED option. Other alternatives may be developed but are not required. The NED account is the water development alternative designed to maximize a project's marginal benefits and is to be "consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements" (U.S. Water Resources Council, 1983). Details of how the NED plan is to be calculated are provided within the *P&G*. The other critical difference between the two planning documents is that the *P&G* serve merely as **recommended guidance** that has no legal force, whereas the *P&S* constituted **requirements.**

The *P&G* define a six-step planning process, which guides both the reconnaissance and feasibility planning stages. Those six steps are:

1. Specify problems and opportunities.
2. Inventory and forecast conditions.
3. Formulate alternative plans.
4. Evaluate effects of alternative plans.
5. Compare alternative plans
6. Select recommended plan

These six steps are not necessarily applied sequentially in Corps planning; rather, the activities of problem definition, goal setting, and comparing project alternatives can be conducted simultaneously and recur throughout project planning.

The concept of "planning" defies exact description but is explained in a Corps Institute for Water Resources (IWR) document (Yoe and Orth, 1996) as: " . . . the deliberate social or organizational activity of developing an optimal strategy for solving problems and achieving a desired set of objectives." Although technical analyses are part of the planning process, the Corps' notion of planning extends beyond technical activities such as siting and design. The Corps seeks to solve water related problems through a structured, rational planning approach.

The Corps' studies and projects typically originate with a request for assistance from a community with a water resource problem beyond its means to address. They can also originate within the Corps, which may identify a water resource problem or opportunity. Before the Corps can get involved, it needs two types of authority from the Congress: study authority and budget authority. A study authority allows the Corps to investigate the problem. Once this is granted, the budget authority to spend federal funds can be provided in an annual appropriations act passed by Congress.

If there is no authority for the Corps to study the problem, a congressional member may request a study authority from the Senate (Committee on Environment and Public Works, Subcommittee on Transportation and Infrastructure) or the House of Representatives (Committee on Transportation and Infrastructure, Subcommittee on Water Resources and Environment). Once congressional approval is obtained, the

study is assigned to one of Corps' 36 local district offices. The district may then request funds through the federal budget process to conduct the study's first phase, the reconnaissance study. Once those funds are apportioned by the Office of Management and Budget (OMB), the district office may begin the study of the particular water resource problem.

As of 1996, it took the Corps an average of 1.5 years to conduct reconnaissance studies, and 3.4 years for feasibility studies (USACE, 1996b), plus roughly a one year gap in between. Figure 3.1 is an idealized timeline, according to this committee, of the Corps' two-stage planning process, the reconnaissance and feasibility stages.

The Reconnaissance Phase

The reconnaissance phase of a Corps study is used to better understand the nature of a water resource problem and to determine the likelihood of a plan the Corps can eventually implement. Reconnaissance studies are fully funded by the federal government. The reconnaissance study provides a recommendation either to proceed to the feasibility study or halt the planning efforts. Today the Corps' reconnaissance phase is to be completed in no more than one year and is to cost no more than $100,000.

Conducted by a Corps district office (Figure 3.2), the reconnaissance study also examines the likelihood of enlisting local sponsorship. Upon completion of the reconnaissance report, the Corps and local sponsor negotiate a project study plan (PSP) and a feasibility cost-sharing arrangement (FCSA). These are part of the same process, as the FCSA reflects the terms agreed to by the Corps and local sponsor in the PSP.

The PSP includes specific engineering and scientific studies and management activities that need to be conducted. Although the specifics vary from study to study, the Corps and local sponsor must agree on the following terms:

- task descriptions: what needs to be done and at what level of detail and effort?
- task responsibilities: who will pay for each task?
- task milestones: how long will each task take, and when will they be completed?

The Corps and a local sponsor—usually a nonfederal agency that signs a feasibility cost-sharing agreement and/or the project cooperation agreement (PCA) with the Corps—negotiate several other points, including study schedule, study cost, mix and value of cash and in-kind products and services, and the review of the work. Local sponsors are part of a broader category of "local interests," which refers to a broad group of people and organizations with interests in a Corps project, some of whom may oppose the project.

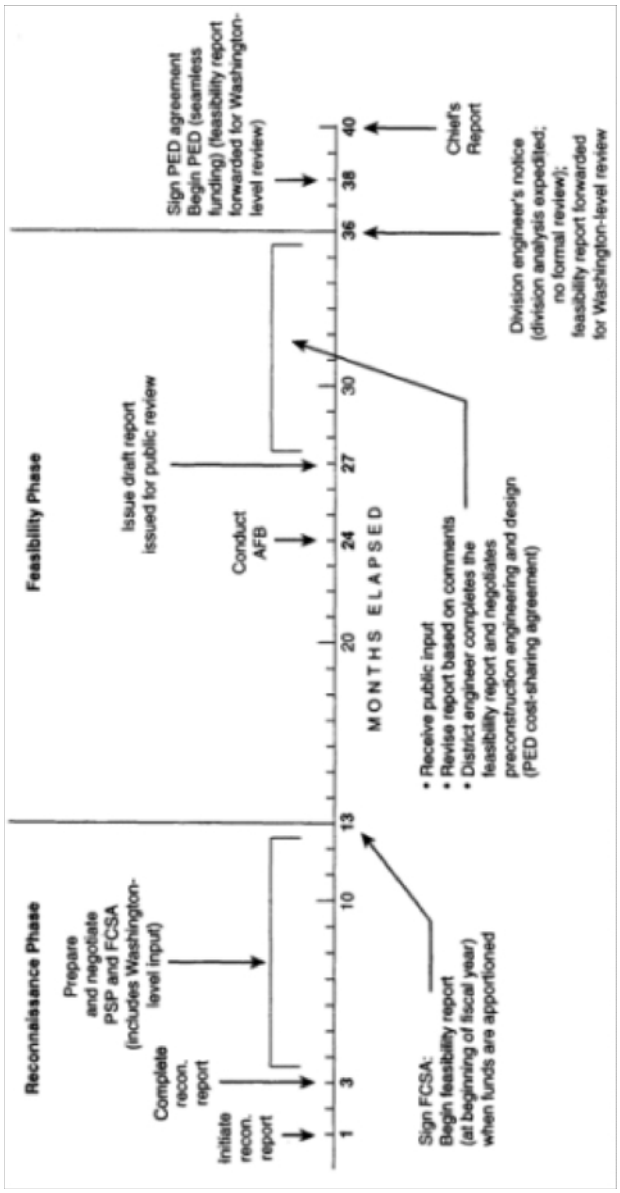


Figure 3.1
Recommended Corps planning study timeline.

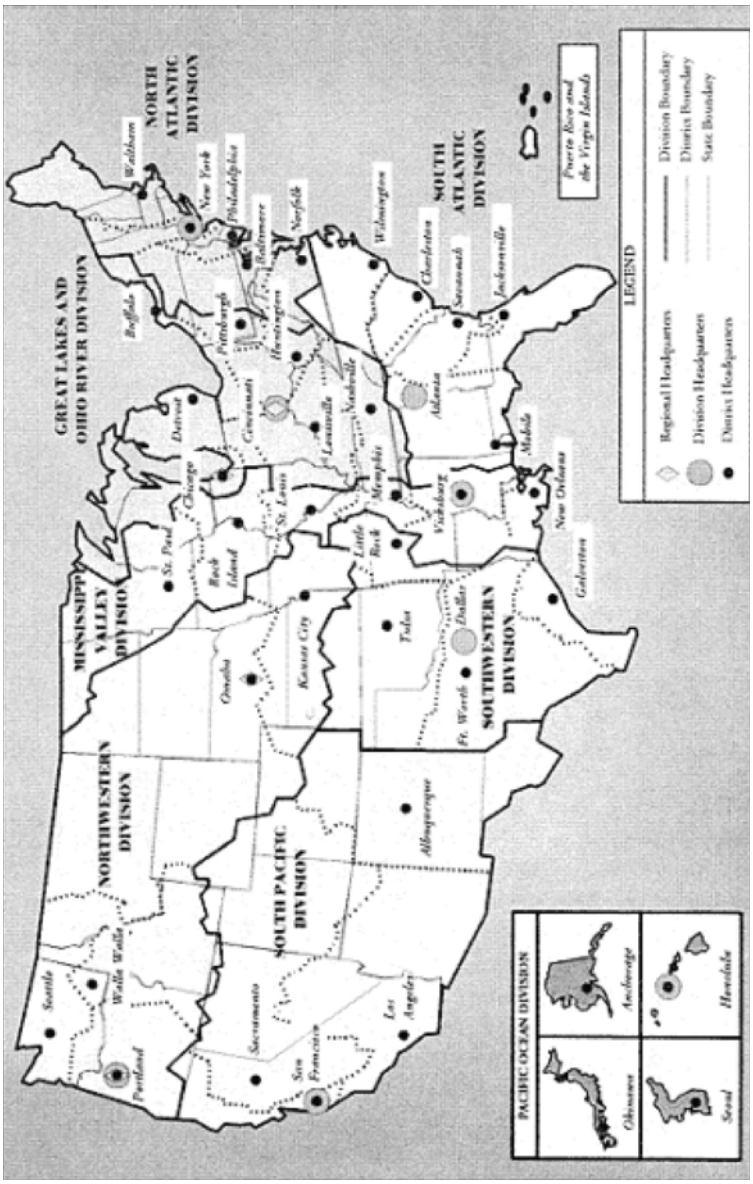


Figure 3.2
Division and districts of the U.S. Army Corps of Engineers.
Source: http://www.usace.army.mil.

Many terms of the FCSA are non-negotiable. For example, cost-sharing arrangements of the feasibility study are mandated by WRDA '86, calling for a 50-50 split between the Corps and local sponsor. In addition, the local sponsor can contribute a maximum of 25 percent of the total study costs through in-kind products and services (50 percent of their 50 percent contribution).

The FCSA negotiations may require up to nine months, but the FCSA should be signed about one year after the beginning of the reconnaissance phase, assuming feasibility study funds are appropriated. Throughout the course of the FCSA, the Corps may receive input from Corps headquarters in Washington, D.C., and also receives public input through a variety of means. The FCSA is signed when the sponsor and Corps reach agreement on the negotiable terms and Congress appropriates feasibility study funding.

The Feasibility Phase

Soon after the FCSA is signed, the Corps announces the project's feasibility study and holds a public workshop. The first several months of the feasibility stage are spent formulating alternative plans. For example, in addressing a flood problem the Corps might consider a range of strategies, including construction of a dam or levees, channel improvements, nonstructural techniques, or combinations of approaches. They would also examine the appropriate design characteristics revealed in preliminary studies (e.g., the level of flood protection—50 years, 100 years, 200 years, or greater). During this stage the Corps conducts project design analyses (including engineering and hydrologic studies), project costs estimates, and benefit-cost estimates in accord with the *P&G* and the "Guidance for Conducting Civil Works Planning Studies" (ER 1105-2-100). Although the Corps does not conduct a highly detailed investigation for every project alternative, these studies are inherently intensive and time-consuming. Reducing the time spent on these studies may be possible but may also compromise their quality.

Among these alternative plans (formulated by the Corps district office in collaboration with the sponsor, the stakeholders, and Corps headquarters), the Corps must identify the NED alternative. Although it represents the optimal national economic alternative, the NED plan may not be the preferred alternative. For example, the NED plan may offer protection to the 100-year flood level, but the local sponsor may desire protection against a 200-year flood. The Corps may eventually construct a project that goes beyond the NED plan, provided the sponsor is willing to bear some portion of the additional costs.

An alternative formulation briefing (AFB) is held when the Corps district office is prepared to present the alternative plans, the NED plan, and the tentatively selected plan. Though the AFB is not mandatory, the Corps district office is strongly encouraged to convene the briefing to prevent problems from arising later in the study. At the AFB, the Corps district office addresses policy issues identified by the division, district, or Corps headquarters. Sponsors are strongly encouraged to attend the AFB discussions, especially technical and other experts of sponsor groups. The Corps clearly feels that local sponsor participation is essential for a successful briefing.

Following the AFB, the district completes the draft feasibility report (as well as an environmental impact statement, or EIS). The draft feasibility report is distributed for a 45-day public review and sent to Corps headquarters for Washington-level review (i.e., the Corps, the Secretary of the Army, the states, other relevant federal agencies, and the OMB). The Corps then holds another public meeting (roughly six months after the AFB) and incorporates comments from the public and headquarters into a revised feasibility report.

When the project sponsor and the Corps agree on a final plan, the feasibility study ends with the signing of the division engineer's notice, which represents a public announcement that the top Corps-level field official recommends approval of the project and allows the final feasibility report to be sent to Corps headquarters for review.

Preconstruction Engineering and Design and the Chief's Report

The preconstruction engineering and design (PED) phase begins soon after the division engineer's notice. The Corps district office conducts the PED phase, which includes the first set of specifications and a clear identification of the lands, easements, rights of way, relocations, and disposal areas (LERRDs) required. PED often takes two years or longer.

The planning process is completed with the signing of the final report by the chief of engineers. This is typically a short (five- to six-page) letter addressed to the Secretary of the Army, in which the Chief of Engineers recommends approval of the project.

TYPES, LENGTH, AND COSTS OF CORPS PLANNING STUDIES

Since WRDA '86, the Corps has initiated about 50 reconnaissance studies a year. As shown in Table 3.1, 51 percent of those projects were for flood damage reduction, with navigation projects accounting for 17.5 percent. Nine percent of the projects were for environmental restoration, and roughly 9 percent were for hurricane damage prevention (4.4 percent) and shoreline and beach protection (4.4 percent).

Of the 566 reconnaissance studies started in 1986-1996 (Table 3.1), 525 were actually completed. Of those 525, feasibility studies were initiated on 163 projects, or 31 percent of the projects conceived at the reconnaissance stage. The data in Table 3.1 are for the 82 feasibility studies completed by 1996.

Regardless of purpose, projects have about an equal chance of progressing to the feasibility stage. For example, Table 3.1 indicates that 51.2 percent of the feasibility studies were for flood damage reduction, nearly the identical percentage that flood damage reduction studies represent at the reconnaissance stage. An exception may be the Corps' environmental projects. Although the statistical sample that the committee evaluated was relatively small, environmental projects were only half as likely to proceed to the feasibility stage.

Table 3.1 Profile of Corps Studies, 1986-1996

	Reconnaissance Studies		Feasibility Studies	
Project Type	Number	Percentage	Number	Percentage
Flood damage prevention	288	50.9	42	51.2
Navigation	99	17.4	22	26.8
Hurricane damage prevention	25	4.4	6	7.3
Shoreline/beach protection	25	4.4	4	4.9
Environmental	51	9.0	4	4.9
Water supply	22	3.9	3	3.7
Other	56	10.0	1	1.2
Total	566	100.0	82	100.0

Source: USACE, 1997.

Length of Corps Planning Studies

Since 1990, the average reconnaissance study has taken about 13.5 months to complete. Tables 3.2 and 3.3 show elapsed planning time for select Corps reconnaissance studies (495 studies), and Corps reconnaissance and feasibility studies (54 studies), respectively. The data indicate that the average time to complete both the reconnaissance and feasibility studies is approximately 5.6 years, roughly the same as those reported in 1996 by a special Corps task force on shortening the planning and design process (USACE, 1996b).

Costs of Corps Planning Studies

Table 3.4 provides detailed cost information on 495 of the reconnaissance studies initiated from 1985 to 1996. The data are arranged on the basis of calendar years and assigned total reconnaissance planning costs for each project the year it was started, regardless of whether the document was finished that year. Reconnaissance studies have become more expensive in current dollars, but have remained constant in real terms. The average study started between 1985 and 1990 cost roughly $320,000, whereas the average study between 1991 and 1996 cost roughly $410,000 (which includes labor, travel, consultant fees when necessary, and internal overhead costs when appropriate). These costs have increased at roughly the rate of inflation.

As noted in the previous section, less than a third of the reconnaissance studies progressed to the feasibility stage. The final column of Table 3.4 shows total expenditures on reconnaissance studies that did not result in a feasibility report. In fact, for all studies initiated in the years 1985-1993, 63.9 percent of the dollars budgeted for reconnaissance studies were spent without further expenditures for a feasibility study. This amounts to over $79 million during that period to determine that there was either no federal interest or that the local sponsor was unable or unwilling to share the costs of further evaluation.

A 1996 initiative by Corps Headquarters (HQUSACE) mandating the $100,000 limit on the cost of reconnaissance studies will have a significant impact on the planning process, as more than 90 percent of the studies conducted in 1985-1996 exceeded the limit. Complete reconnaissance and feasibility cost data were available for a subset of 54 of the 588 projects that the committee reviewed. Average costs are presented in Appendix B.

FEDERAL BUDGETING AND AUTHORIZATION

Before 1986, nonfederal sponsors were far less involved in arranging project financing, as all funding for reconnaissance and feasibility studies was provided by the federal government. Nonfederal sponsors today must budget funds and other assets for planning activities, design, and construction in a more timely manner and in concert with federal budgeteers. Longer lead times, variable outcomes of federal

budgeting processes, and unforeseen costs and cost overruns all increase uncertainty for nonfederal partners. Some projects in the federal interest may not have been undertaken because the Corps could not adequately assure that studies would be completed on time and within budget.

Table 3.2 Elapsed Time of Corps Reconnaissance Studies, 1985-1996

Year Study Initiated	Number of Reconnaissance Reports That Year	Average Time to Complete (months)	Range of Time to Complete (months)
1985	18	22.5	12-39
1986	28	12.7	1-26
1987	11	16.2	11-34
1988	77	14.8	7-24
1989	35	14.7	12-24
1990	42	13.1	5-19
1991	71	14.0	8-20
1992	29	13.8	9-22
1993	43	13.7	6-19
1994	69	13.0	4-21
1995	34	13.7	11-19
1996	38	-	-

The Corps' budgeting process is lengthy, taking up to two years lead time. The administration's budgeting process takes roughly one year, plus a minimum of nine additional months for the congressional process. After receiving guidance from the OMB for the impending budget cycle, Corps districts send proposed budgets to Corps divisions, which then send the requests to Corps headquarters. Annual budget requests generated through this process consist of individual amounts for well over a thousand studies, projects, and programs, including reconnaissance studies, feasibility studies, PED, construction projects, and operation and management (O&M) projects and programs. Headquarters then assembles its request (usually in

July or August) for submission to OMB, through the Assistant Secretary of the Army for Civil Works. The request is then reviewed for two to three months (September or October to December). All of this must occur before the president's budget is presented in January or February of the following year. Congress then has until October 1 to enact an appropriations bill.

Table 3.3 Duration of Selected Studies (54 Projects)

	Average Elapsed Time (months)			
Project Purpose	Reconnaissance	Between	Feasibility	Total Elapsed Time
Shoreline beach protection (2)	12.00	21.50	47.00	80.5
Navigation/shallow draft (5)	12.40	8.60	32.80	53.8
Navigation/inland waterways (3)	12.00	7.33	40.67	60.0
Navigation/deep draft (10)	11.70	9.50	44.50	65.7
Navigation/other(1)	16.00	6.00	59.00	81.0
Hurricane damage protection (4)	15.25	15.50	38.75	69.5
Flood damage protection (27)	13.11	11.44	43.85	68.4
Environmental (2)	12.00	13.50	31.50	57.0
Average (54)	12.85	11.24	43.33	67.42

Because the total amounts requested by Corps districts may exceed what the president's budget includes, congressional committees may require the Corps to determine its "capability" during the fiscal year: its capacity to process projects and studies, considering not only budgetary but also personnel constraints, sound engineering practices, and the timing of available funds.

Each Corps study and project is required to be appropriately authorized. The Corps undertakes civil works studies in response to authorizations from Congress. Committee resolutions are the most common authorization vehicles for studies. As mentioned earlier, authorizations may be contained in public laws and resolutions of either the Senate or House. This is especially the case when a study's scope involves a review of a basin or navigation report previously studied by the Corps.

STREAMLINING THE PLANNING PROCESS

In 1996 the Assistant Secretary of the Army for Civil Works ordered the planning process to be shortened (Corps Planning Guidance letter 97-10, 1997; see Appendix A). In response, the Corps appointed a special task force on shortening the planning process, which began its study with the following premises: local sponsors often feel strongly that the Corps' planning and design process is too long; it is important to understand the impacts of any changes in the Corps process on the quality of planning; and there are no constraints on the alternatives to be developed.

The task force recommended the following changes for shortening the planning process, which the Corps adopted:

Table 3.4 Cost Analysis of Reconnaissance Studies 1985-1996

Year Reconnaissance Study was Initiated	Number of Reconnaissance Studies	Average Cost of Study ($1,000)	Range of Cost for Studies Initiated ($1,000)	Total Cost of Reconnaissance Studies ($1,000)	Total Reconnaissance Expenditures That Did Not Result in a Feasibility Study ($1,000)
1985	18	243.3	46-558	4380	3245
1986	28	210.7	43-775	5900	3650
1987	11	396.5	50-1424	3965	2897
1988	77	296.9	50-810	22,859	16,623
1989	35	400.7	100-1178	14,023	8381
1990	42	334.3	50-4380	16,141	7367
1991	71	390.3	20-1320	27,712	17,655
1992	29	349.1	98-1080	10,123	7195
1993	43	456.2	25-1000	19,616	12,705
1994	69	422.3	30-1225	29,138	24,304
1995	34	405.3	100-750	13,780	13,230
1996	38	428.3	55-1000	16,277	-

Source: Corps data.

- procedural changes that provide for each feasibility study to be focused and tailored to meet specific needs and objectives;
- policy changes that, in certain cases, provide for categorical exemptions from requirements to develop and recommend the NED plan; and
- use of flexible federal-nonfederal cost-sharing of feasibility studies.

Two other significant task force recommendations that the Corps has implemented are:

- elimination of the review by the division engineers; and
- significant shortening of the reconnaissance study phase.

Funds for reconnaissance and feasibility studies are generally not appropriated in the same year. However, the Corps intends to be ready to initiate the feasibility report at the start of the second year, rather than the latter part of the second year or even the third year (which was often previously the case). In addition, Congress introduced the use of the conditional authorization in WRDA '96, which is essentially an extension of the deadline by which a chiefs report must be signed prior to congressional action. It enabled 13 projects with favorable recommendations from district engineers to be authorized, even though they did not have the chiefs reports when WRDA '96 was signed into law on October 12, 1996 (these 13 projects are listed in Appendix C).

WRDA '86 included a requirement that feasibility studies would be cost-shared on a 50-50 basis, with a maximum of 50 percent of the nonfederal share to be provided as in-kind services. Since 1986, the Corps has on several occasions increased the feasibility study costs after the signing of the feasibility cost-sharing agreement. Such cost increases can place nonfederal sponsors in an awkward position. For example, the local sponsor may prefer to continue the study but cannot provide its 50 percent of the additional costs in a timely manner. WRDA '96 (Section 203) allows the Corps to finance study cost overruns, given that they do not violate federal laws or change the scope of the study requested by the nonfederal interests. The nonfederal sponsor must agree to repay its share of the excess amount when the project goes to construction (i.e., on the date the PCA is signed). This provision should reduce instances in which feasibility cost overruns delay continuation of studies.

COMMITTEE RECOMMENDATIONS

The committee recommends the Corps implement the following to further shorten the planning process:

1. The Corps should use "seamless funding" between reconnaissance and feasibility, and between feasibility and PED, which may potentially help avoid unnecessary delays. Seamless funding refers to funding available without interruption between two different study/PED phases. For example, once a feasibility

study is complete (and funds exhausted), funds for PED are made available in the same fiscal year. There is no need to wait until the start of the next fiscal year to obtain funds for PED, thus allowing a smooth transition between stages. However, if these funds (from two different pools) are not on hand during the same year, the planning or design process can stall.

There is often a six to twelve month gap between completion of the reconnaissance phase and initiation of a feasibility study—even though funds are available immediately in the year following completion of reconnaissance. However, since the abbreviated reconnaissance reports (905(b) analyses) are only a few pages long and take roughly three months to complete, the balance of that fiscal year should be spent preparing the PSP and the FCSA and discussing it with the nonfederal sponsor. This should allow for the cost-sharing agreement to be ready for signing at the start of year following funding of the reconnaissance study.

Until fiscal year 1997, moving from feasibility to initiation of PED was essentially seamless once the division engineer's notice was issued. In 1997, it was decided to obtain more nonfederal funds prior to initiating PED. The new policy (although not based on any new law) results in a delay in the initiation of PED until a cost-sharing agreement is consummated. The negotiation of this agreement adds as much as six to nine months to most new PED studies. Once again, seamless federal funding is available, but internal institutional requirements (primarily the processing of cost-sharing agreements) now delay part of the process that worked well in the past. The Corps should strive to reduce any gaps between completion of the district's reconnaissance report and initiation of the feasibility report, as well as between the division engineer's notice and the initiation of PED.

2. The Corps should proceed with PED even while the feasibility report is undergoing final processing at headquarters for authorization. Assuming PED funds are available for a project awaiting authorization (which is often the case), there are opportunities in each budget cycle to receive a federal construction appropriation. For example, the initial construction funds can be included in the president's budget.
3. Processing of the chiefs report should be shortened by 60 days, from six months to four months. The final review by states and agencies (primarily the Department of Interior and EPA) has been shortened in law from 90 days to 30 days. This shorter review period was implemented as part of WRDA '96 (Section 223) and was instrumental in completing the review process and obtaining chiefs reports on several conditional project authorizations contained in WRDA '96 (Section 101(b)). Despite the shorter review mandated for states, the Corps has yet to shorten the processing of Chief of Engineers' reports, thereby delaying the approval process for many water projects.
4. The Corps should provide broader authority for the field (district-level offices) to approve FCSAs when the model FCSA is closely followed. Delays in moving from reconnaissance to the feasibility phase often result from an inability to reach timely agreements with the local sponsor on provisions contained within the FCSA and/or the PSP. WRDA '86 provides that feasibility studies may not be initiated "until appropriate nonfederal interests agree, by contract, to contribute 50%

of the cost for such study during the period of such study. Not more than one-half of such nonfederal contribution may be made by the provision of services, materials, supplies, or other in-kind services necessary to prepare the feasibility report" (from WRDA '86, Section 105). The Corps has developed a model agreement, used in negotiating a final executed agreement prior to the initiation of each feasibility report (except for inland waterway navigation studies). By granting the district-level offices the authority to approve FCSAs that adhere to the model, significant time savings should result.

5. The Corps' district-level offices should strive to complete feasibility reports in two years rather than three, subject to the availability of federal and nonfederal funds. This could be accomplished by starting the feasibility study early in the year that initial funds are apportioned, waiving certain reviews, and implementing the committee's other recommendations.
6. The Corps should continue to seek conditional authorizations in Water Resources Development Acts. As mentioned, conditional authorization allows for the authorization of projects that just miss the final date for the signing of a chiefs report, preventing delays of up to two years (the time projects would normally have to wait for subsequent authorization under the next Water Resources Development Act).

It remains to be seen whether the final Washington-level review can be shortened in accord with the streamlining efforts mentioned above. At this point, there are insufficient data upon which to make an assessment. A clearer notion of these initiatives on the length of the planning process will emerge over the next two years.

COMMENTARY

The expedited reconnaissance stage has resulted in severely constrained analysis in the first stage of the planning process. With only $100,000 and 12 months to complete the study, much of which is devoted to preparing the project study plan, the Corps must rely on numerous assumptions and a screening to determine whether a project should proceed to the feasibility study. Projects that are clearly not feasible will continue to be rejected, but sooner rather than later. Projects that are likely to have favorable recommendations can be quickly moved to the feasibility stage.

The expedited process will probably have its most significant impact on those projects for which beneficial and adverse effects are closely balanced. For those projects, two kinds of errors are possible. One is that potentially worthwhile projects could be rejected prematurely because the abbreviated reconnaissance process provides too little time to modify unacceptable initial designs. A second kind of error could occur when an unacceptable project is not rejected in the reconnaissance phase because of a lack of time and resources to support the required analyses. In this case, feasibility studies could cost far more than the added cost of a more complete reconnaissance study.

Too few projects have been subjected to the expedited planning process to draw firm conclusions regarding its effects. If the rate at which feasible projects are found from the pool of feasibility studies does not improve significantly over the historical rate of 27 percent, the process should be reevaluated. Failure to significantly increase that percentage would signify that too many doubtful prospects are being forwarded to the feasibility stage.

Toward that goal, the Corps should seek to improve its tracking system for all potential projects for which reconnaissance studies are initiated. The committee reviewed computerized records, which contained dates and costs of reconnaissance and feasibility studies, but did not contain information about recommendations. The committee was left to infer that reconnaissance studies not followed by feasibility studies resulted in no recommended project. No information was available about feasibility study outcomes. Periodic reports (annual, biannual, every five years) showing all planning studies, dates of initiation and completion, costs, recommendations, and current status in authorization and appropriation processes, would be most useful in evaluating Corps planning. These data are available from the Corps, although not in readily retrievable form.

From a budgetary standpoint, there may be little to gain by streamlining the planning process. The expedited reconnaissance process should cut planning costs by approximately $300,000 per study, at a rate of approximately 55 studies per year, with a total cost savings of $16.5 million. Balancing that savings is a potential increase in the number of infeasible projects for which decisions are deferred to the feasibility stage. If the average cost of those studies is the same as those over the 1986-1996 period, it would take only a few additional feasibility studies to offset gains from reduced reconnaissance costs. If the cost of feasibility studies can be reduced, then there would be a net gain in efficiency.

Three other steps seem desirable. First, the cap on individual projects funded under the Corps' Continuing Authority Program (CAP) should be increased to $10 million. The CAP allows the Secretary of the Army to approve and construct certain types of projects within a "continuing authority" (rather than requiring specific authorization for every Corps project by the Congress). Congress establishes the type of projects that can be built without specific Congressional authorization in the language that creates the authority. The authorities are generally found in one of the omnibus bills, such as the various Water Resource Development Acts. Each continuing authority program has a separate authorization, a spending limit, and a budget. Examples of continuing authority programs include:

- Section 204: Beneficial Uses of Dredged Material
- Section 205: Flood Damage Reduction
- Section 206: Aquatic Ecosystem Restoration
- Section 1135: Environmental Improvement

Although selection of the spending cap within the CAP is arbitrary, the committee believes that the current limit of $5 million is too low. As these continuing authority programs allow the Secretary of the Army to approve certain types of projects, rather than requiring a specific project authorization by Congress, they can significantly reduce delays due to authorization details and help streamline

project planning and implementation. Congress may wish to control the amount of spending under that authority, but the more appropriate way to do that is through the budget process, not a review of small individual projects.

Second, Congress should consider seamless funding of projects, assuring that funds are immediately available to begin the PED process as the first step in construction following a favorable feasibility study outcome. Third, the lag time between the feasibility study and initiation of the PED processes should be eliminated if the nonfederal partner agrees to share the costs of preconstruction, engineering, and design. Either seamless funding or some other mechanism could be used to reduce the lag time from feasibility to construction. Under present policy, PED cannot be initiated until a cost-sharing agreement for construction has been signed. As long as a nonfederal sponsor is willing to guarantee payment for its share of PED activities, the process need not be delayed until a complete cost-sharing agreement is signed by both parties.

A basic question remains unanswered, however: Does the Corps process take longer and cost more than similar projects that do not involve federal cost sharing? Concerns expressed about inefficiencies in the Corps processes are similar to those involving all water projects, as well as nearly any other development project. There is no readily available set of data by which such projects can be compared with cost-shared Corps projects. However, it is not uncommon for public water supply projects financed solely by local governments to take eight years to be completed. Any project undertaken by a public agency involves developing a level of consensus sufficient to gain the sponsor's approval. It also involves acquisition of necessary lands, easements, and other property rights. Project financing must also be secured. All such projects must obtain a variety of state and federal permits that trigger provisions of the National Environmental Policy Act. Although these processes are subject to inefficiencies, they may very well take as long or longer than Corps cost-sharing projects. Any public organization that believes it can or should move from identification of the need for a project, to design and construction within a four-year period, is either considering a simple project with few complications or is overly optimistic.

The key planning guidance documents for the Corps—the *P&G* and the "Guidance for Conducting Civil Works Planning Studies" (ER-1105-2-100)—have become outdated (although the Corps is currently updating ER 1105-2-100) and should be revised to reflect contemporary analytical techniques and planning concepts. Revising these documents, however, will not result in further significant reductions in the length of the Corps planning process.

The recommendations offered in this chapter would allow the Corps to further reduce the time required in its two-step planning process without significantly reducing planning quality. Beyond the committee's recommendations, there are few other steps the Corps could implement that would not compromise the integrity of that process. It bears repeating that further cuts in the time and cost of the planning process do not necessarily result in a better process.

The Corps' planning procedures have evolved with changes in national water policy and advancements in economic and engineering techniques. However,

as Chapter 4 describes, the nation's water policies and practices do not always square with widely-accepted principles of water resources planning.

4

Gaps Between Practices and Principles: Adjusting Planning and Guidance

WATER RESOURCE PLANNING PRINCIPLES

Beyond considering the necessity for a major evaluation of the *Principles and Guidelines*, the committee's recommendations for improving the Corps' planning process must be considered in the context of larger, federal water policy issues. This chapter identifies shortcomings of federal water policy formulation and ways in which the *P&G* might be revised to enhance the Corps' and other federal agency planning procedures.

A useful approach to analyze the nation's water development and management policies is to compare them with principles of water resources planning and financing that have emerged from analyses of practices in the United States, including those of the Corps, other federal agencies, and state and local governments. Although those principles grew mainly from of an era in which water resources were developed to promote national economic development, many of them apply to the contemporary policy environment. Moreover, current Corps planning activities are often constrained by larger, national policies. Existing policies may be outdated and should be reviewed to ensure that they are based upon current problems, opportunities, values, and attitudes about the role of government. Given the current emphasis on reducing the federal role and greater reliance on cost-shared projects, it is important to compare practices with basic principles to judge the need for change.

As noted in Chapter 1, water management principles have been historically articulated by several water policy organizations, including the Inland Waterways Commission, the President's Water Resources Policy Commission, the Senate Select Committee on National Water Resources, the Water Resources Council, and the National Water Commission. Among the important water management principles identified by these groups include:

- Management should be informed by up-to-date assessments of current conditions of water, related land, and ecological resources.
- Plans should recognize inherent linkages in hydrologic systems that extend throughout watersheds, economic linkages, and other linkages that may extend across multiple basins within economic regions.
- Plans should address the full range of opportunities to use, protect, or restore water and related land and ecological resources of a watershed, resulting in multiple-purpose and integrated programs.
- Plans should be formulated and evaluated using well-developed criteria

and procedures.

- Planning processes should encourage participation of a wide range of affected parties, particularly local and state governments and public and private interests.

Although water management in the United States has never been fully consistent with these principles, the failure to design appropriate policies and organizational arrangements to address current problems has tended to widen the gap between principles and practices since the 1970s. Basinwide and watershed planning by environmental agencies has tended to focus primarily on water quality, ignoring interrelationships among multiple uses. Capturing economies of scale of multi-objective projects has become more difficult. Planning for protection, restoration, and water uses frequently lacks regional or basinwide perspectives, and information about the state of water and related land resources is outdated.

Watershed, Basinwide, and Regional Perspectives

A basic tenet of water resource planning throughout the 20th century has been that river basins or watersheds, from their headwaters to their mouths, are hydrologically interconnected systems and should be treated as such in water planning. That principle was articulated well in the *Report of the Inland Waterways Commission* (1908). In 1927, the Corps adopted the principle as a cornerstone of planning in support of the Federal Power Act, and it remained a basic principle throughout the period of comprehensive planning in the 1940s and 1950s. In the 1960s, the WRC recognized that in some parts of the country, notably New England, regional economic ties extended across several basins, and that proper water resource planning should recognize significant interdependencies among activities affecting demand for water-based services.

With the passing of that era, the dismantling of the federal WRC, and enactment of WRDA '86, the nature of Corps projects fell into several categories, two of which are relevant to this review. One is the single-purpose, relatively small-scale project with primarily local effects, funded through cost-sharing arrangements with a single local sponsor. For purposes of this discussion, this kind of project is referred to as type A. It represents the largest number of projects that require individual authorizations by Congress. Type B projects are watershed- or basinwide scale projects focused more toward water management than construction. In several of these projects, reallocation of storage in existing systems is emphasized; in others, environmental outputs are the primary objective. Examples include the Alabama-Coosa-Tallapoosa/Apalachicola-Chattahoochee-Flint (ACT/ACF) project in Georgia, Alabama, and Florida; the Everglades restoration project (Box 4.1); the Upper Mississippi Navigation Study; and the Missouri River Basin Operations Study. All of these involve a restudy of an existing Corps project or system of projects.

In type A projects, basinwide and regional perspectives within the Corps and the larger federal water apparatus have suffered. Gone are the days when generous funding was available to support basinwide analysis. The Corps now has the incentive to concentrate on individual projects of benefit to local interests who have

BOX 4.1

ECOSYSTEM MODELS OF THE EVERGLADES

The Central and Southern Florida project for flood damage reduction, water supply, prevention of saltwater intrusion and protection of fish and wildlife resources was authorized by Congress in 1948. Pursuant to that authority, the Corps of Engineers, in cooperation with the South Florida Water Management District (SFWMD), constructed approximately 1,000 miles each of levees and canals, 150 water control structures, and 16 major pump stations. While it achieved many those purposes, it also had unintended environmental affects resulting from extensive hydrologic alterations to the Everglades National Park and related systems. Growing public interest in the ecosystems led Congress to amend the authorization in WRDA 1992, directing the Corps to restudy the Central and South Florida project to determine whether modifications to the existing project are advisable. Modifications would be intended to restore the Everglades and Florida Bay ecosystems while providing for other water-related needs in the region. The Corps produced a reconnaissance study in 1994, proposing a series of alternative ecosystem restoration plans to be examined in more detail in the feasibility phase, begun in 1995 and scheduled for delivery to Congress at the end of 1998. Costs of the restudy are shared by the Corps and the South Florida Water Management District.

Many other agencies are involved in the process. In September 1993, the administration convened an interagency task force on restoration of the South Florida ecosystem. That task force was chaired by the Department of the Interior and included the Departments of the Army, Agriculture, Commerce, and Justice. In 1994, Florida Governor Lawton Chiles convened a Governor's Commission on Sustainable South Florida. WRDA '96 provided statutory authorization for the task and added representatives of the Miccosukee and Seminole Indian Tribes, the State of Florida, the South Florida Water Management District, and representatives of local government.

The Restudy Team initially formulated six alternatives, referred to simply as Alternatives 1 through 6. Upon further analysis, it was noted that Alternatives 1 and 2 did not contain sufficient storage to meet water supply needs of the region, and those two options were eliminated. The remaining four alternatives were then referred to as Alternatives A, B, C, and D. Alternative A was primarily a water supply plan for the region. Alternative B examined the possibility of "decompartmentalizing" the water conservation areas by removing as many levees as possible to enhance the flow of water into the Everglades National Park. Alternative C involved a more modest decompartmentalization of water conservation areas to avoid development of deep water areas along the eastern levees that would have resulted from Alternative B. Alternative D was added to capture excess water that had previously been going to the Gulf of Mexico through the Caloosahatche River. A number of minor variations to Alternative D were examined, with variation D13R being selected as the preferred alternative on which the initial draft of the feasibility report and environmental impact statement issued in October 1998 will be based.

In addition to an economic evaluation, performances of hydrological, zoological, and botanical outputs of alternatives are being evaluated using a variety of highly complex computer simulation models. Most, if not all, analyses begin with modifications to the hydrologic system, simulated by the SFWMD's South Florida Water Management Model. Populations of species at several trophic levels are simulated using the Across Trophic Level System Simulation developed by a group at the University of Tennessee with support from the U.S. Geological Survey, the Corps, and the private sector.

indicated an ability and willingness to shoulder a substantial portion of project costs. Little incentive exists for sponsors of those projects to be concerned about upstream and downstream effects of their projects, and they have little interest in supporting planning studies to investigate those effects.

> Landscape responses, including vegetation community and biomass, sediments and nutrients, and periphyton are being simulated using the Everglades Landscape Model, developed jointly by Institute for Ecological Economics of the University of Maryland and SFWMD. Behavior of mangrove wetlands has been modeled by a group at the University of Southwestern Louisiana. Water quality in the Everglades and Lake Okeechobee has been simulated using models developed by the U.S. Environmental Protection Agency. The Corps has used its own River of Grass Model, a model similar to the Habitat Evaluation Procedure of the Department of Interior, to evaluate habitat changes. For further information on the Corps' efforts in Everglades restoration, please visit http://www.saj.usace.armymil/restudy.

The shift from watershed level to project planning within the Corps comes at a time when many professionals within the water resources community are calling for a renewal of water management at the watershed level (Schad, 1998). A recent Water Science and Technology Board report (NRC, 1998) advocates and provides direction on management aspects of the watershed approach. The EPA has also promoted watershed management, encouraging states to use watersheds as the basis for their water-quality management plans. Several states have taken leadership roles in using this approach to formulate basinwide policies and coordinate issuance of discharge permits. However, they generally lack attention to other aspects of water management, including urban water supplies, navigation facilities, and electric power production facilities, that in many cases are affected by or constrain water quality.

The report of the Interagency Floodplain Management Review Committee (IFMRC, 1994), also known as "the Galloway report" (the committee was chaired by U.S. Army Brigadier General Gerald Galloway), recommended a shift away from what has been primarily a federal-local relationship in floodplain and flood damage reduction planning, toward state leadership. This, of course, has implications for federal agencies' relationships with the states. States have the ability to enact statues that can profoundly affect water management. They also have unique constitutional powers to guide local policies through incentives, regulations, and sanctions. They are therefore in a unique position to integrate project planning with land use planning and resource management programs.

The Association of State Floodplain Managers (ASFPM) has developed a library of cases and research that supports the tenet that states with strong floodplain management programs have better results in reducing flood-related damages. Programs established by the Clean Water Act and the Coastal Zone Management Act, too, indicate that the uses of federal resources to build state and local resources can be an efficient way to achieve federal objectives. Top-down planning and implementation of federal agency projects, the association notes, does not build standing

capability within a state and can help perpetuate a reliance upon the federal government for technical plans. The association recommends, for example, that the Corps, the NRCS, and the Tennessee Valley Authority develop grant programs to fund state mitigation initiatives (ASFPM, 1991). A new document published by the Western Governors Association (WGA, 1997) calls for joint state-federal efforts to make flood damage reduction programs more effective by funding community-based programs.

The movement toward greater lead roles for the states suggests that in the future the Corps will increasingly participate as a member of a team led by state agencies. The committee recommends that the Corps formulate a cost-sharing program with the states to provide technical assistance in preparing water management plans.

Comprehensiveness

There are no particular incentives for the Corps to emphasize basinwide planning, which results in a lack of comprehensiveness in the Corps' planning processes for type A projects. The principle of comprehensiveness in water resource planning historically includes two important concepts: the first is that consideration should be given to all opportunities to develop, protect, or restore the water and related land and ecological resources; the second recognizes that substantial economies of scale can be achieved through the use of multiple-purpose projects or reservoirs. Water projects justified primarily by their ability to reduce flood damages could also be designed to provide public water supply, hydroelectric power, flat-water recreation, and low flow augmentation. In the present cost-sharing environment there is less emphasis on multipurpose projects, as local sponsors tend to promote investments that address a particular need and serve a single purpose. Given the trend toward small-scale projects, there may be limited opportunity or necessity for the Corps to consider more comprehensive alternatives to the plan preferred by nonfederal sponsors. The Corps should, however, give greater attention to multipurpose options when formulating and evaluating alternatives.

With the emergence of environmental protection and restoration as authorized project purposes, the Corps faces the challenge of manipulating ecological systems and integrating them with other management purposes. Presently, only conceptual models and general principles guide ecological system planning. Outcomes resulting from manipulation of ecosystems are generally considered to be highly uncertain. Suggestions for environmental protection and restoration planning are discussed in greater detail in Chapter 5.

Criteria and Procedures

Since World War II, considerable efforts have been made at the federal level to develop principles, standards, criteria, and procedures to guide investments in water resources. Most of the techniques of benefit-cost and multiple-objective analysis evolved in the realm of water project planning, and federal agencies have

arguably produced the most refined package of analytical techniques for public investment analysis currently available. The *P&G* and *P&S* both represented the state of the art when they were published. Unfortunately, the *P&G* have not been changed since 1983.

Although many sections in the *P&G* are still relevant, they need to be updated to reflect changes in project purposes and advances in evaluation techniques. As was the case when the *P&G* replaced the *P&S*, the president could either reconvene the WRC or take other executive action to institute changes. At least three reasons support the need to bring planning criteria and guidance up-to-date. First, the *P&G* are oriented toward evaluation of several types of projects in which federal agencies are no longer engaged. Of the four federal agencies affected by the *P&G*, the Corps is now the only one with an active construction program to which the *P&G* might apply. Second, the *P&G* are woefully out-of-date in providing guidance to the Corps for environmental protection and restoration projects. Language in the *P&G* is more relevant to assessing environmental impacts of resource development projects than evaluating outcomes of environmental restoration projects. Third, substantial advances have been made since 1983 in developing procedures for evaluating economic and environmental consequences of projects and assessing risk and uncertainty. Some of those techniques are being used (or being withheld from use) without the benefit of policy review by the nation's water planning community.

Of particular concern is the emergence of environmental restoration as a project purpose for the Corps. The *P&G* offer almost no guidance on this subject. The Corps provided a directive for project modifications to improve the environment and aquatic ecosystem restoration through its engineering circular series (EC 1105-2-214; USACE, 1997b), but it mainly describes procedural matters. It provides little instruction on assessing project outcomes and assigning benefits and costs, a deficiency which needs to be reduced or eliminated.

REGIONAL-SCALE PLANNING

As discussed in Chapter 1, river basin commissions were established under the Water Resources Planning Act of 1965 to facilitate planning in the nation's large, interstate river basin systems. With virtual elimination of the WRC, however, only remnants of those commissions remain. A fundamental criticism of planning by the river basin commissions was that it was not meaningfully integrated into existing governmental decision making and budgeting processes. Nonetheless, ad hoc organizations have been created to address specific problems, as in the formulation of management plans for the Upper Mississippi River.

Renewed congressional interest in the Mississippi River after the 1993 floods resulted in legislative proposals for comprehensive planning through the Upper Mississippi River Environmental Management Program (EMP) and the establishment of an interstate basin management council for the Upper Mississippi River. As coordination is required between the Upper Mississippi River EMP, the U.S. Fish and Wildlife Service's ecosystem management and restoration efforts, and the Corps' navigation studies and floodplain management assessments, the governors of Illinois, Iowa, Minnesota, Missouri, and Wisconsin created the Upper Mississippi

River Basin Association (UMRBA) to fill the void left by the dissolution of the federal-state river basin commission in 1981. Following a conference to evaluate regional planning, the UMRBA released a report defining the strengths and weaknesses of the Corps' planning processes within a basin planning framework (UMRBA, n.d.).

UMBRA commented on the failure of prior efforts to connect plans to federal, state, and local budgeting and appropriation processes. It also criticized the use of comprehensive, basinwide planning, as it may have caused delays in funding high-priority projects which had strong consensus. It argued for greater flexibility in regional planning, citing as a success an approach that allowed 24 logical environmental mitigation projects to be planned and implemented while a larger, more time-demanding regional plan could be formulated

UMBRA commented that planning should be output oriented and address projects on a case-by-case basis when there was a general consensus on the needs for the project, thereby building credibility for broader coordination. The association also recommended that states take a more active leadership role in the process (Stoerker, 1998). UMBRA state members cautioned that collaboration called for a balance of power among its federal, state, and local members and that all relevant stakeholders need to be involved, including citizen groups. It recommended that a federal-interstate compact model, such as the Delaware River Basin Commission, has the advantage of providing for legally binding agreements that can act as a strong mechanism not only for plan formulation, but for implementation and enforcement. It also proposed limiting compacts on such a large geographic scale to focus on three or four of the more critical management issues.

For large scale regional programs involving multiple projects, the Corps should seek authorizations and appropriations for the program instead of individual projects. Examples to which this strategy could prove beneficial would be the Upper Mississippi River navigation study and the Everglades restoration project. Programmatic authorizations and appropriations would allow the Corps to reduce time between projects, schedule its resources and those of its contractors more effectively, and eliminate costly duplication of administrative processes. Because programs at this scale are likely to extend over several years, there will be ample time for corrections and adjustments to be made to schedules of activity as additional information becomes available.

PARTNERSHIP PLANNING

New cost-sharing policies involving more nonfederal investment in projects may have set the stage for more collaborative efforts between the Corps and its nonfederal partners. However, in discussions with project collaborators in navigation, port, flood damage reduction, and watershed management projects, the committee learned that Corps planning policies and methods still occasionally frustrate stakeholders. Representatives of port authorities identified two specific problems: (1) a Corps policy to design the optimum national economic development (NED) plan when the local sponsor had already informed the Corps that it neither could nor would pay for the plan, and; (2) Corps policies that have stifled innovative

methods for disposal of dredge materials that could be ecologically enhancing. Local sponsors of flood damage reduction projects cited instances where pre-1986 authorizations and cost-sharing arrangements presented barriers to more contemporary design options.

Many local government sponsors are accustomed to planning processes that are either far less constrained by specified procedures and criteria or simply guided by different criteria. Particular clashes have occurred as innovations in storm water management have been initiated by local governments, nongovernmental organizations, and consultants. In recent years, several Corps projects have been significantly influenced by or modified to accommodate designs advocated by local governments. Among them are:

- nonstructural flood damage reduction measures on the South Platte River in Littleton, Colorado, Mingo Creek in Tulsa, Oklahoma, and Indian Bend Wash in Scottdale, Arizona;
- Gila River relocations project at Allenville, Arizona;
- recent innovations in river and floodplain restoration and flood damage reduction projects in the Wildcat and San Pablo Creeks in Richmond, California; San Pedro Creek in Pacific, California; and Napa River in Napa, California (Box 4.2).

Current planning processes and funding arrangements have a tendency to force the Corps districts to view their constituencies narrowly, focusing upon the local sponsor. Efforts by local interests to include a broad range of participants in planning and to reach consensus on project plans require extra time, in some instances creating tensions between field level planners in the Corps and policy makers who are responding to the mandate to streamline the process.

The local sponsor is often the best organization to incorporate local interests in the planning process. The committee concluded that the local sponsor should be required to solicit the viewpoints of all interested stakeholders before asking the Corps to initiate a reconnaissance study.

REDUCING THE NATION'S FLOOD DAMAGES: POLICY AND PROCEDURAL ISSUES

Policy issues: Cost-sharing

One point made within the Galloway Report (IFMRC, 1994) was that those floodplain occupants affected by the Mississippi River floods of 1993 were disproportionately of lower income. Recent changes in cost-sharing policies may have made it more difficult to address such inequities. Since 1994, it has become more costly to obtain federal assistance for flood damage reduction projects, making it even more difficult for lower-income communities to avail themselves of federal resources. Cost-sharing provisions for conventional flood damage reduction projects prior to 1986 were 25 percent nonfederal and 75 percent federal. Projects authorized

BOX 4.2

NAPA RIVER FLOOD DAMAGE REDUCTION PROJECT NAPA, CALIFORNIA

The flood damage reduction project for the Napa River received wide publicity in 1998 as part of a new generation of Corps projects. Originally designed as a conventional flood damage reduction project, it was transformed into primarily a nonstructural program providing the same level of protection as the conventional plan. Widespread participation and leadership by local citizens in formulating the nonstructural plan led to an affirmative vote by Napa County residents to finance the plan with sales tax revenues. This was despite the higher nonfederal cost of the nonstructural plan, and a higher total cost than the conventional plan, which was identified as the NED plan by the Corps in 1995.

The City of Napa has been subjected to damaging floods since its founding in 1862. The Corps was authorized to conduct preliminary examinations and surveys of the problem in 1938, and channel improvements and an upstream dam were authorized in the Flood Control Act of 1944, but funds were never appropriated. Corps planning activities were again authorized by the Flood Control Acts of 1965 and 1976, but the recommended plan was rejected by referendum election in 1977. Among the reasons cited for that defeat were: (1) high nonfederal costs ($54 million), (2) lack of public consensus on the need for the project, and (3) conflicts between interest groups, one primarily concerned with reducing damages from floods and another primarily with development of Napa's waterfront for tourists. Flooding in 1986 again reactivated interest in flood problems, and the Corps used its earlier authority to formulate another plan. In 1995 the Corps released the draft environmental impact statement for the NED plan. A somewhat modified version of the 1970s plan, it called for the channelization of Napa Creek and a 5.7-mile stretch of the Napa River. Estimated total cost of that plan was $129.4 million, of which $60 million was to be provided by the local sponsor. Benefits were estimated to be 136% of costs. State and other federal resource agencies gave notice to the Corps in fall 1995 that the plan's significant environmental effects would pose substantial hurdles to its implementation.

In December 1995, the local project sponsor, the Flood Control Project Executive Committee, representing the City of Napa and Napa County, established a stakeholder group of 22 citizens' organizations, 5 cities, a county, 6 state agencies, and 5 federal agencies. That group, known as the Community Coalition, represented a variety of business, agricultural, neighborhood, and environmental groups, as well as governmental units. Its charge was to produce a plan, an environmental impact report, and a final design memorandum by December 1997, a deadline set to assure timely consideration in federal review, budgeting and appropriations processes. The plan was to provide the same level of protection as earlier plans, conform to downtown redevelopment plans, and represent a sufficiently broad range of interests to attract the necessary political support. The process was also driven by goals of minimizing river dredging, restoring floodplains, and providing alternatives to channelization of Napa Creek for the conveyance of flood flows. By minimizing the deepening of the existing Napa River channel, while at the same time achieving a comparable level of flood protection as the prior plan through the acquisition of additional lands and with setback levees, the nonstructural plan was able to meet state and federal regulatory requirements. The revised plan was recommended for funding in the president's 1998 budget.

after the WRDA '86 usually increased the nonfederal share to 35 percent, not to exceed 50 percent. Added to that change is the requirement that cost sharing with nonfederal entities now begins at the planning stages rather than in the construction stages.

> The committee produced a plan through a series of design workshops and judged that it had met the goals to its satisfaction. Estimated total cost of the project was $155.5 million, some $26 million more than the 1995 plan. The local share increased by $22 million, and the benefit-cost ratio decreased from 135 to 1.27. This ratio was lower despite the increased benefits of meeting federal water quality and endangered species protection objectives, and public objectives for river and waterfront restoration. Efforts to address flood problems in Napa, California demonstrated that even costly projects can be constructed when they include a broad range of stakeholders and help meet a range of needs.

Implications of these changes for the nation's poor who reside in high-hazard areas have not been adequately explored. Cost-sharing policies have not taken into account income levels of those most affected by flooding, and the nation may not be able realistically to address the issue of occupancy in hazardous areas without considering income, according to statute (WRDA '90, Section 305). Low-income communities can appeal to the Secretary of the Army for a reduction in their share of project costs, but in practice this is not occurring. Congressional staff (Spillan, 1990, personal communication) reports that only one project in the country, the Three Mile Creek in Mobile, Alabama, has ever been approved for waiver of standard cost-sharing policies. This waiver ultimately required the approval of both the OMB and the Secretary of the Army.

A review of cost-sharing provisions for some similar multiple-objective floodplain evacuation, river floodplain restoration, and flood damage reduction projects shows widely varying costs incurred by local entities, with some poorer communities paying substantially more than wealthier ones for similar project outputs. For example, the 45 percent-55 percent nonfederal-federal cost-sharing arrangement for a floodplain restoration project in the low-income community of North Richmond on Wildcat Creek, California, with a poverty rate of 64.5 percent (defined by average household income through the U.S. Census), can be compared to the 20 percent-80 percent cost-sharing arrangement in a similar floodplain restoration and acquisition project in the middle-income community of Littleton, Colorado (Shabman et al., 1997).

The National Wildlife Federation (1998) found that 1.6 percent of the communities enrolled in the National Flood Insurance Program (NFIP) account for "49.8 percent of all NFIP repetitive loss payments *and 20 percent of all NFIP payments nationwide"* (NWF, 1998. Emphasis in original quote). If the nation's flood damage reduction programs are to design responses which avoid the costs of future damages, it may make economic sense to directly address the issue of poverty in hazard-prone areas. Increasing cost-sharing for federally-assisted flood damage

reduction projects may have an unintended effect: preventing the Corps from setting the most cost-effective priorities of addressing chronic hazard issues in low-income areas, which may be responsible for the greatest portion of the national flood damages.

Poor communities are already at a relative disadvantage for federal flood protection projects because benefits of flood damage reduction are measured by property damage avoided. The same project controlling the same flood thus results in greater benefits if it protects a high-income neighborhood rather than a low-income neighborhood, even though damage to the poor area may be more devastating to affected residents. Charging a larger share of costs to local areas for such protection simply exacerbates the problem of alleviating flood damage in poor communities.

In order to eliminate any biases which may exist toward low-income people and areas, the Corps' cost-sharing criteria should be reviewed to determine how they affect a local sponsor's ability-to-pay. Close attention should be paid to identifying any systematic problems which may hamper the Corps' ability to help the poor address their water-related problems, especially floods.

Procedural Issues: Possible Biases Against Nonstructural Projects

As explained in Chapter 2, it is clear that federal cost-sharing criteria are intended to not only prevent biases against nonstructural projects, but also to provide incentives for their selection. To determine whether these federal arrangements are having their desired effects, they should be compared against local level results. Several case studies published between 1977 and 1997 identify a range of issues which describe barriers to the Corps' construction of nonstructural flood damage reduction projects (Field, 1977; Platt, 1979; U.S. Army Corps of Engineers, 1979; Chin, 1981; Kusler, 1982; Institute for Water Resources, 1983; Moore and Moore, 1989; Chao et al., 1997; Shabman et al., 1997). These case studies indicate that many of the barriers described in the 1970s and early 1980s seem to be present in the 1990s. These studies also demonstrate that nonstructural alternatives were considered in very different and complicated contexts, including differences in project costs, cost-sharing arrangements, benefit-cost analysis, planning methods, and technical biases of federal and local engineers.

The range of barriers to the selection of nonstructural alternatives identified by these authors included: project benefits were not adequately and fairly quantified and represented; problems in crediting fair values to project lands contributed by nonfederal sponsors; the counting of locally donated lands as federal project costs; fears of nonfederal sponsors over receiving timely reimbursements for land costs; confusion regarding which government program funding is considered a federal or nonfederal contribution; and difficulties of nonfederal sponsors in meeting land acquisition costs. While these were perceived to be problems by the authors of these reports, they would require closer examination to determine their relative merits.

Several of their concerns related to the calculation of benefits and costs, including inadequate benefits assigned to flood prone areas converted to urban parks, ecological protection afforded to threatened and endangered species, and other

objectives of federal programs. Furthermore, nonstructural (but not structural) projects must deduct the expenses of flood insurance premiums and deductibles from project benefits. A recent IWR study concluded that the benefits assigned to nonstructural flood damage projects which permanently remove structures from flood prone areas are inadequate: "The inability of the Corps to economically justify permanent evacuation projects under the P&G is due mainly to the guideline that the reduction of primary flood damages resulting from a permanent evacuation project is not to be counted as a project benefit" (Chao et al., 1997). This practice conflicts with FEMA's practice of determining benefits for acquisition and relocation projects (ibid.). Some cases point to the time period over which benefits and costs are annualized (50 years) as having favored the selection of structural over nonstructural measures. In some cases, it appeared that the calculation of benefits and costs for individual structures rather than on a community-wide basis was an impediment to relocating structures from flood prone areas.

This committee concluded that it was important to include the benefits of flood damages avoided in nonstructural project benefit-cost analysis, and that the risk of such damages was often not fully reflected in lower values of floodplain property. As Chao et al. (1997) concluded, "A general discount for floodplain *location* . . . does not exist". The committee recommends that these benefits be included in project benefit-cost analysis through a standardized framework and methods.

Regarding cost-sharing arrangements, these case studies revealed a class of older, authorized, and still active flood damage reduction projects that are not benefiting from several post-1986 legislative reforms. Box 2.1 described federal cost-sharing policies as representing a clear choice of project authorities, whether they are for structural, nonstructural, or restoration projects. However, Corps districts and nonfederal sponsors occasionally find they are compelled to abide by old authorities, rather than acquire project reauthorization (which is costly and time-consuming) under different planning categories that have better planning and funding policies for nonstructural projects. Under these circumstances, communities will tend to keep an existing, structural authority and minimize costs, keeping the nonfederal share to no more than 40%. The Napa River project (Box 4.2) represents an example of the design of a contemporary river and floodplain restoration project under an existing structural authority. In this case, the nonfederal sponsors are paying 50% of the costs for a mostly nonstructural project, and purchasing lands (without federal reimbursement) necessary to realize the project. If these land costs had been included in the project area and included in the benefit-cost analysis, the project would not have been economically justified.

While beyond the scope of this report to evaluate the validity and policy implications for all these issues described, the committee recommends a study be conducted (by the Corps or an independent group) to determine if any systematic biases exist within the Corps analysis against nonstructural flood damage reduction projects. A 1983 Corps symposium on nonstructural measures allowed Corps district-level personnel to present their views on similar issues (IWR, 1983). This symposium could be used as a model in which to investigate a representative sample of the Corps flood damage reduction projects. Reducing or removing any biases that may exist could ultimately lead to enhanced ecological processes in the nation's floodplains and a reduction of increasingly expensive disaster assistance payouts.

Damages from floods were estimated to have risen to more than $4 billion annually in the 1990s (NWF, 1998).

Although Congress failed to enact a Water Resources Development Act (WRDA) in 1998, it appears likely that a WRDA will be passed during the 106th Congress in 1999 or 2000. The centerpiece of this legislation (from the administration's position) is the "Riverine Ecosystem Restoration and Flood Hazard Mitigation Initiative", also known as "Challenge 21". As proposed, this initiative would expand the use of nonstructural flood hazard mitigation options to simultaneously achieve the purposes of flood damage reduction and restoration of the functions and values of riverine ecosystems. Challenge 21 is expected to build on existing programs and initiatives, using a watershed approach and including partnerships with other federal agencies. It is thus essential that the Corps address its inability to justify and recommend more nonstructural options. This may require changes to the Corps' planning guidance that relates to the computation of benefits of nonstructural flood damage reduction alternatives.

OTHER CONSIDERATIONS: THE NEED FOR ASSESSMENTS

An assessment of the adequacy of the nation's water supply and demand under present and future conditions is needed to establish priorities for action in water planning, development, and conservation. Several water and related resource issues—such as floods, sedimentation, and navigation in the Upper Mississippi River, investments in ports in Gulf coast areas, public water supplies in California and the Northeast, Everglades restoration, protection of endangered species in the West, and protection and restoration of water quality in the Great Lakes, the Chesapeake Bay and other sensitive water bodies—continue to present management challenges. The last comprehensive assessment of resource conditions and needs was prepared by the WRC in 1978. The U.S. Geological Survey has provided useful information through its National Water Quality Assessment (NAWQA) program and the National Water Summary program (until it ceased publication several years ago), but neither of these sources would be considered a comprehensive assessment. The nation desperately needs a comprehensive assessment of its water resource systems to provide guidelines for present and future actions.

Some of the better information on current water resource conditions is now compiled from data collected after water-related disasters. For instance, the Interagency Floodplain Management Review Committee was established in January 1994 to investigate the causes and consequences of the 1993 Mississippi river floods. Disaster declarations under the 1988 Stafford Disaster Relief and Emergency Assistance Act offer another source of information about floods. Such information is useful but it comes only after disasters have occurred. In fact, not even the Stafford Act provides information about current vulnerabilities to drought, as droughts have not been the subject of disaster declarations. Following the national drought of 1988, the Corps conducted the National Study of Water Management During Drought (USACE, 1994), in which state governments were surveyed to identify the types of impacts experienced in each state. That effort provided scant assessment of national and regional risks of drought and few strategies for coping with drought.

The committee recommends that the Corps, in cooperation with state and other federal agencies, periodically prepare an overview of the status and trends of the nation's water and related land and ecological resources. Cooperation with other federal agencies is especially important. Emphasis should be upon those purposes for which the Corps and cooperating agencies are responsible, namely, flood damage reduction, hurricane damage protection, beach nourishment, aquatic ecological restoration, and navigation. The committee is mindful that national assessments under the auspices of the WRC were rich in detail, expensive to produce, and did not play a prominent role in the establishment of national water policies. The committee suggests development of reconnaissance-level assessments that focus on national and interstate needs relevant to federal policy making processes.

5

The Corps' Environmental Protection and Restoration Programs

Several Water Resource Development Acts since 1986 have mandated a variety of environmental protection and restoration activities for the Corps. The Corps' authority to determine if changes can be made in existing structures or operations to improve environmental quality rests in WRDA '86, Section 1135 ("Project Modifications for Improvement of the Environment"). This continuing authority requires 25 percent cost sharing with nonfederal partners and limits federal expenditures to $5 million per project. Total appropriations to this section are generally limited to $25 million per year.

The Corps was given an additional mission with the passage of WRDA '90. Section 306 states that "the Secretary [of the Army] shall include environmental protection as one of the primary missions of the Corps of Engineers in planning, designing, constructing, operating, and maintaining water resources projects." In a complementary action, Section 307(a) set the goals of "no net loss of wetlands" and "an increase in the quantity of the Nation's wetlands."

The Corps was authorized to implement projects for protection, restoration, and creation of aquatic and ecologically related habitats, including wetlands, in connection with dredging of authorized navigation projects in WRDA '92, Section 204 ("Beneficial Uses of Dredged Materials"). This legislation essentially states that the Corps can now use material formerly called "spoils" for beneficial ecological purposes. Nonfederal sponsors are responsible for 25 percent of the project costs and 100 percent of operations and maintenance. The annual appropriation limit is $15 million.

The Corps' environmental programs were broadened further with passage of WRDA '96. Section 206 authorizes the Corps to engage in aquatic ecosystem restoration projects that will improve environmental quality when they are in the public interest and are cost-effective. Unlike legislation that restricts work to existing Corps projects, this stipulates that the Corps can fix environmental damage created by others. Nonfederal sponsors must pay 35 percent of construction costs and accept 100 percent of operation and maintenance costs. The federal limit is $5 million per project and the annual appropriation will not exceed $25 million.

Corps Initiatives and Planning Guidance

With publication of a relatively inconspicuous "statement of new environ

mental approaches" by the Office of the Assistant Secretary of the Army (civil works) on June 25, 1990, the Corps embraced environmental restoration as a primary project purpose. The document states:

> Maintaining and restoring the health of the environment is an important goal of the President. Investments to achieve this goal are responsible investments—if they are made with due care, thought and foresight. New approaches in the regulatory program, in new construction, in operation and maintenance, and in support of the other agencies are being adopted by the Army Corps of Engineers to align the Civil works program with the President's goal.
>
> Civil Works funds are to be used for justified (based on consideration of both monetary and nonmonetary effects), cost shared proposals which restore to historic levels environmental values in situations where (1) a Civil Works project has contributed to degradation, or (2) where restoration can be cost effectively accomplished through modification of an existing Civil Works project.

Assistant Secretary of the Army for Civil Works, Nancy Dorn, reiterated this position in 1992 in a letter to Max Peterson of the International Association of Fish and Wildlife Agencies. She wrote: "Early in 1990, we announced an environmental initiative for the Corps water resources development program which included the establishment of fish and wildlife restoration as *a priority project output*. We have provided strong budgetary support for this initiative" (emphasis added).

INTEGRATING ECOLOGY INTO WATER RESOURCES PLANNING

Many of the Corps' customers view the accommodation of new ecological knowledge as a dramatic shift in program emphasis. Some fear that the emerging focus on ecological processes in water resources management will detract from the Corps' traditional missions in flood damage reduction and navigation. It is more accurate to view the incorporation of ecological knowledge into the Corps' portfolio as broadening, rather than abandoning, its traditional programs. The Corps project of the future (and some Corps projects today) will incorporate environmental protection and restoration as primary objectives of water resources planning, and frequently as a means of achieving other water management objectives.

The Corps' involvement in watershed-scale, environmentally oriented water resources management processes is generally motivated by a blend of federal interests, such as the need to maintain navigation or reduce flood damages while conserving endangered species or restoring fishery resources. These projects often cross agency jurisdictions and require interagency participation. Many involve the alteration of structures built to perform a narrower range of tasks. These structures, including dams, levees, and drainage canals, are currently undergoing operating criteria reformulation or structural modifications to support environmental objectives,

while maintaining the Corps' traditional program goals. Such reformulations are currently occurring in the Columbia and Upper Mississippi River basins and the Everglades.

These projects are similar to the multiple-purpose projects earlier in the 20th century but have fundamentally different goals. The older multiple-purpose projects sought to control natural hydrologic patterns. They were generally designed for regulating streamflows, storing peak flows, and releasing them during low-flow seasons to provide water for power, navigation, and municipal and industrial supplies. By contrast, the reformulated projects frequently seek to restore natural hydrologic patterns and ecological processes.

It has long been understood that the relationships between water and land resources must be considered in water planning. The importance of this principle is reflected in the titles of Senate Document 97 and the WRC's *P&G* and *P&S*, all of which included the phrase "planning for water and related land resources." These considerations are even more important as the Corps seeks to further integrate ecological concerns into water resources planning and management.

Even more demanding are efforts to incorporate protection or restoration of ecosystems in water resource planning. Since 1986, the Corps has considered many possible restoration projects. Some have been completed, and others are at various stages of planning. In an attempt to understand the breadth and implications of the restoration program on a Corps-wide basis, the Institute for Water Resources conducted a national review of projects in 1996. Fifty-two projects were selected from an 80-project data base of reports and fact sheets. The national review showed that 16 different districts and divisions were involved in restoration (IWR, 1996). Fourteen projects were authorized under Section 1135, twelve under the Upper Mississippi River EMP; fourteen under the Coastal Wetlands Planning and Restoration Act; seven under Flood Plain Management with Environmental Features (pre-1986 legislation); and five under the Beneficial Uses of Dredged Material Program. Among their objectives were restoring salt marshes, barrier islands, wetlands, stream channels, and rivers; reducing sedimentation and saltwater intrusion; improving water level control; utilizing available sedimentation; reducing flood damages; and preserving environmental resources. Project costs were in the range of $79,000 to $20 million, but the vast majority involved less than $5 million.

The evolving restoration program has had a significant impact on Corps planning. Certain projects have taken longer to complete because of new information requirements and new cost-sharing rules. Biologists and other scientists are being given a more prominent role in Corps project planning. It may take time to fully assimilate those developments within the Corps' culture.

VALUING THE BENEFITS OF ENVIRONMENTAL PROJECTS

Many problems attend the calculation of benefits of the Corps' environmental projects. The benefits from traditional Corps projects can typically be expressed in monetary terms, such as the dollar value of flood damages avoided or additional commerce transported. By contrast, outputs of ecological restoration projects tend to include intangible values such as endangered species protection,

aquatic ecosystem protection or restoration, as well as aesthetic values. These types of project outputs defy monetization and do not easily fit into a traditional benefit-cost valuation framework. This section reviews Corps initiatives and general concepts related to the valuation of the outputs from restoration projects.

Mainly through its Institute for Water Resources, the Corps has had many research projects directed at improving its ability to evaluate the outputs of proposed projects. The Corps' traditional objective has been to recommend project alternatives and projects that maximize net national economic benefits, expressing benefits and costs in monetary terms. Deciding which outputs to quantify and whether to describe those outputs in monetary terms has caused a great deal of discussion within the Corps. Some project outputs, such as hydroelectricity, readily lend themselves to being expressed in monetary terms. Others such as flood protection can be monetized if based upon physical damage to structures and contents, although the process of arriving at a dollar value can be complex. Outdoor recreation provides environmental amenities traditionally valued in monetary terms. The Corps' restoration projects typically aim to enhance or restore ecosystem services such as biodiversity, ecosystem resilience, food web support, and natural carbon storage. These ecosystem services generally do not have market values, though there have been recent attempts at monetizing them (Costanza et al., 1997).

The difference between outdoor recreation and outputs such as electricity and flood protection is that outdoor recreation is not bought and sold in the marketplace, so an estimate of its monetary value must be based on nonmarket valuation techniques (Freeman, 1993; Just et al., 1982).[1] These techniques are designed to estimate the maximum amount a consumer would have been willing to pay for the recreational experience, rather than do without. Procedures for placing a monetary value on recreation are detailed in the *P&G*. The Corps also produced more detailed documents on the use of other nonmarket valuation techniques, such as contingent valuation (Moser and Dunning, 1986) and travel cost analysis (Vincent et al., 1986).

Using these nonmarket valuation techniques, the Corps could place a dollar value on all project outputs resulting from changes in environmental amenities. Desired improvements would increase net economic benefits whereas undesired impacts would decrease net economic benefits. This analysis would allow the Corps to continue to pursue its historical objective of maximizing net national economic benefits, as well as to maximize the national interest (OECD, 1989; 1992; 1994).[2]

Over the past few years, Corps headquarters has sponsored the Evaluation of Environmental Investments Research Program (EEIRP), a joint research effort by the Institute for Water Resources and the Corps' Waterways Experiment Station. The program's work units were assigned specific tasks related to the overall objective of

[1] The history of the development of such techniques is closely tied to Corps water projects. Hanemann (1992) provides an interesting overview.

[2] Because negative environmental impacts are costly they tend to be avoided, and because positive environmental impacts are profitable, they tend to be pursued. The practice of assigning monetary value to environmental impacts has been controversial among environmental groups. Some groups argue that this practice is immoral, others that it is the most effective approach to improving the environment.

developing a practical evaluation framework for projects with substantial environmental components. The tasks of the nine EEIRP work units are: (1) determining and describing environmental significance; (2) determining objectives and measuring outputs; (3) objectively evaluating cultural resources; (4) engineering environmental investments; (5) using cost-effective analysis techniques; (6) applying monetary and other valuation techniques; (7) incorporating risk and uncertainty into environmental evaluation; (8) setting up environmental data bases and managing information; and (9) developing the evaluation framework (a summary of the EEIRP's research is contained in IWR, 1997).

Many federal agencies with which the Corps works, such as the EPA and the Fish and Wildlife Service, are often legally prohibited from considering economic values in their decision making procedures. Congress has given the Corps authorization (WRDA '86, Section 1135) to formally undertake environmental improvement and restoration projects without conducting formal benefit-cost analyses. The Corps has thus begun to consider maximizing other criteria, such as those featured in the Fish and Wildlife Service's Habitat Evaluation Procedures (HEP), as well as various measures of the environmental significance of resources, such as designation by preexisting legislative statute and subjective evaluation (Apogee Research, 1997). In both instances this usually results in adopting the specific legislative mandate of another agency as the project objective. Economic analysis in these cases typically takes the form of identifying the most cost-effective way of meeting a stated environmental objective and/or looking at the incremental cost of obtaining a marginal increase in environmental quality (Robinson et al., 1995).

The EEIRP reports identify three principal difficulties with the measurement of environmental outputs in quantitative but nonmonetary terms. The first is that most of the biological models available, like HEP, are principally designed to look at a single species. This orientation is not surprising given the endangered species mandate of the Fish and Wildlife Service, along with its traditional orientation toward hunting and fishing. However, the typical Corps project is aimed at general ecosystem restoration, and it is obvious that single-species models are often inadequate, even if the models are based on indicator species.

Second, examination of more general models for predicting detailed system-wide ecosystem effects suggests that the underlying science for developing easy-to-use portable ecosystem models is still immature. Progress is being made with less ambitious models such as the wetland evaluation technique, which considers a range of different functional relationships for wetlands. Problems with ecosystem modeling are also apparent in attempts to fully specify the linkages between environmental outputs of projects and human services (Cole et al., 1996). These linkages are important because they provide the interface between ecological and economic models, but they are not addressed at all in most available ecological models.

Third, for a project with multiple environmental outputs, it is not clear how to compare different outputs, much less how to make trade-offs when they conflict. A good example of this problem comes from the Everglades restoration project. Restoring the water flows in particular areas is beneficial to some endangered species but detrimental to others. Standard multi-attribute decision theory (Keeney and

Raiffa, 1976) explicitly or implicitly requires conversion of the different environmental outputs to some common unit so they can be consistently traded-off against each other. These trade-off issues become substantially more complicated when one moves from considering alternatives for a single project to attempting to make trade-offs on the larger scale of competing projects if the outputs are all denominated in different metrics.

OPTIONS FOR THE CORPS

The Corps is currently at a crossroads in defining its primary mission. The Corps has traditionally been charged to undertake projects in the national interest, however defined by Congress. One path open to the Corps is to continue to determine whether proposed projects are in the national interest and to recommend the best of these projects to Congress for funding consideration. If the Corps follows this path, the measure of the national interest must be revised to more appropriately account for projects' beneficial and detrimental environmental impacts.

The second path the Corps can take is to become a service provider to local, state, and federal agencies. This perspective is the logical implication of the "shared vision" concept put forth in the Galloway report and advocated in many recent IWR reports. Under this concept, local sponsors determine whether particular project alternatives are worth the costs to them. Local, state, and federal agencies then begin negotiations with the local sponsor to choose one of those alternatives. Within this paradigm, the Corps' role would be to: (1) facilitate cooperation of all relevant stakeholders; (2) provide technical expertise with respect to project design, construction, and maintenance; and (3) provide a large share of the chosen project's cost. Because the Corps would mainly provide a service to other agencies, a project's justification would come mainly from those agencies. The value of a project alternative is defined internally relative to each project, rather than reflecting an overall national objective.

A third option, which the Corps appears to be following, lies between the first two: adhering formally to the *P&G* but largely adopting the substance of the shared-vision concept. The Corps is doing this by embracing a broader concept of the national interest. The Corps sometimes adopts the objectives of other federal, state, and local agencies as the national interest it seeks maximize. This is coupled with a shift toward doing cost-effectiveness and incremental cost analysis at the project level as a substitute for, not part of, a comprehensive assessment of the benefits and costs of project alternatives. This more limited analysis is often sufficient for choosing among alternatives for a single project; however, it makes it difficult, if not impossible, to make objective comparisons across projects in order to decide which are the most desirable to fund.

Much of the Corps' dilemma regarding its future direction relates to whether it is possible to place a monetary value on changes in environmental amenities. This dilemma was clearly evident when the Corps started using economic analysis. Hanemann (1992) provides an interesting history of the development and evolution of benefit-cost analysis for public projects in the United States. In practice, there are four distinct options for monetizing environmental amenities.

Under option 1, a monetary value is established by legislative or administrative fiat. Many fines are of this nature: for example, a certain dollar amount per gallon of oil spilled. Under option 2, monetary value is inferred from agency decisions. When one project alternative is chosen over another and those alternatives involved different quantities of the environmental amenity and different costs, for instance, it is possible to infer how much the agency values the environmental amenity. Under option 3, monetary value can be set by a committee of experts (Cropper et al., 1992; McFadden, 1976). [3] The use of this option always raises questions about who appoints the experts and on what basis those experts are asked to determine the monetary value. Finally, under option 4, monetary value is inferred from the trade-offs the public is willing to make with respect to the environmental amenity and other opportunities. One of these four options is always chosen. Thus, implicitly or explicitly, a monetary value is always placed on changes in environmental amenities in the policy making process.

For the Corps, option 1 (administrative fiat) would appear to be an undesirable and unlikely option for deciding among alternatives, although for a specific project this approach has some advantages. Likewise, relying on option 3 alone seems undesirable in principle, but there are clearly bureaucratic forces that will make it more likely to be the chosen option in practice. Option 2 is the only one (other than option 4) under which monetary value is not directly stated, but because the value can be readily inferred, use of option 2 raises questions about what the gains are (and to whom) by not making the monetary value explicit.

Although nearly always the most difficult option to follow, option 4 is the only option directly consistent with the Corps' mandate to maximize the net benefits of its projects to the public. Option 1 is consistent only if the monetary value set by administrative fiat is equal to the public value. Option 2 is consistent only if the projects undertaken (and not undertaken) are consistent with the trade-offs the public would make. This may be straightforward for a single, relatively unique project approved by the public's elected representatives, but the difficulties of consistent decision making become readily apparent when there are more alternatives. Option 3 is consistent only if the experts chosen and the decision making criteria they are given are consistent with trade-offs the public would make.

The Corps is effectively mandated to assist Congress in maximizing the net public benefits of Corps spending by developing projects that maximize increases in public welfare and, with the assistance of the Office of Management and Budget, submitting those projects to Congress for approval and funding. Fulfilling this mandate requires the use of benefit-cost analysis and the comparison of benefit-cost ratios. Effectively, this is the issue of choosing among alternatives for a particular project versus assembling a portfolio of different projects.

[3] Van Houten and Cropper (1996) show that the benefits and costs of alternative actions expressed in monetary terms influence agency decision making even when legislation explicitly rules out making such comparisons.

CHOOSING PROJECT ALTERNATIVES

A discussion of the use of economic analysis in Corps projects could be framed in many ways. One useful way is in terms of four stages of a project's preapproval life: (1) choice of several project alternatives; (2) assessing benefits and costs of each project alternative; (3) choice of a project alternative agreed upon by the Corps and local sponsor to seek funding approval; and (4) the Corps, OMB, and Congress' determination whether the proposed project alternative is funded. Some project alternatives are never considered, and some project options initially considered do not have their benefits and costs formally estimated. For some projects, no alternative can be agreed upon by the local sponsor and the Corps as a candidate for possible funding, and some projects the Corps recommends for funding are never funded.

Preliminary questions that arise with any project proposal include: How was this particular option chosen? Was the process sufficiently inclusive of stakeholders and did it consider a broad range of options? Were promising options prematurely eliminated and, if so, on what basis? Project alternatives that pass this initial reconnaissance are formally assessed with respect to their potential benefits and costs. At this level of analysis, the issue arises of whether and various types of benefits and costs can be measured. Should everything be placed in monetary terms? If not, is it possible in both a technical and an agency procedural sense to make consistent trade-offs between monetized and nonmonetized benefits and costs? At a more detailed level, specific questions arise about whether the Corps is using the most suitable techniques for determining benefits and costs. Here questions about the appropriate level of expenditures to determine benefits and costs arise and can influence what can be measured with reasonable precision and how successful monetization of environmental benefits and costs is likely to be.

At a more fundamental level, one must ask what are being counted as benefits and costs. There are clearly problems when land purchased to provide nonstructural flood damage reduction is counted as a cost while the benefits of open space and ecosystem restoration are ignored. Given the desirability of reducing the time and cost of doing assessments, there is a clear need for easy-to-apply criteria to enable planners to stop a detailed benefit-cost analysis of a project alternative if it is clear that it has negative net benefits or is clearly inferior to another alternative.

Having performed a benefit-cost assessment for each project option, one then needs to look at how the Corps determines its preferred alternative, how the local sponsor determines its preferred alternative, and how conflicts between the Corps and the local sponsors' choices are resolved. There are three obvious sources of potential disagreement between the Corps and the local sponsor. The first concerns the possible divergence between national and local benefits; the second, differences in financial constraints related to funding a particular project alternative; and the third, differences the two parties face with respect to the characteristics an accepted project has for relevant political funding sources. There are two other interesting issues to consider. The first is whether a "nonfundable" project option should be actively considered even if it is obvious that the project alternative is the one that maximizes net benefits. The second is whether changes in the share of the

project to be funded by the local sponsor and the Corps should be allowed formally to influence the nature of any compromise among project alternatives.

When the Corps provided all or almost all of the funding for a project and its evaluation, it seemed obvious that national objectives should prevail over local ones. The shift in financing responsibility toward local sponsors introduces the possibility of a substantial divergence between national and local interests. With project financing now a shared obligation, it is not clear how to balance national and local objectives.

THE CURRENT DEBATE OVER PROJECT EVALUATION

The Galloway report (IFMRC, 1994) typifies the current dissatisfaction with the role of the NED objective. That report argues for a coequal objective system in which environmental quality (EQ) has equal status with NED (essentially a return to project accounting with the *P&S* framework). The basis of this argument is that "unquantifiable environmental and social values" cannot be given adequate consideration in the analysis of projects. This argument, however, is increasingly rejected by economists working on environmental, health, and safety issues (Arrow et al., 1996), who contend that the benefits and costs of government projects and regulations should be measured in monetary terms and argue that benefit-cost analysis should play a major, but not necessarily decisive, role in government policy making.

Since the early 1960s, four key changes have occurred in the treatment of environmental values in benefit-cost calculations. First, there has been substantial progress in measuring a large class of environmental benefits that, prior to the introduction of multiple-objective evaluation in the *P&S*, were treated as "intangibles." Second, the movement toward monetization has encountered opposition from groups who argue that assignment of monetary equivalents to environmental projects is unethical. Third, there is much greater recognition of the conceptual and practical difficulties of developing nonmonetary environmental quality (EQ) measures comparable across project alternatives and projects. And fourth, there is a greater commitment to using nonmonetary EQ measures.

The Corps is currently required to assess the economic benefits and costs of water projects under the *P&G*. It is allowed to consider other factors contained in other accounts specifically related to environmental, social, and regional impacts not adequately captured in the NED calculation. The *P&G* contain an evaluation framework similar to that in the *P&S*. Each successive planning guidance document has moved more unquantifiable factors from the environmental account to the NED account. The role of the environmental account has not changed substantively over time, but the *P&G* formally took the position that only consideration of NED was necessary, whereas previous guidance documents contained language more consistent with a final multiple-objective trade-off.

At one level, the basic economic guidance provided in the *P&G* remains largely sound, but the technical guidance on the application of particular techniques in particular circumstances should be updated. Since the early 1980s there has been a tremendous increase in the use of various economic techniques to place a monetary

value on nonmarketed goods (Braden and Kolstad, 1991; Cropper and Oates, 1992; Freeman, 1993). Those techniques are now on more solid theoretical ground.

The two most intensely debated issues with respect to monetizing changes in environmental amenities are the inclusion of so-called passive-use, or existence, values in economic analysis, and their measurement by a survey method known as contingent valuation. These issues have drawn extensive comments both inside and outside the economics community, which is not surprising considering the stakes involved. In response to the controversy over the use of contingent valuation in natural resource damage cases, the National Oceanic and Atmospheric Administration (NOAA) put together a blue-ribbon panel cochaired by U.S. economists and Nobel prize winners Kenneth Arrow and Robert Solow. The NOAA Panel concluded that: "CV studies can produce estimates reliable enough to be the starting point for a judicial or administrative determination of natural resource damages including passive use values" (Arrow et al., 1993).

In drawing this conclusion, the panel first considered and rejected (e.g., Rosenthal and Nelson, 1992) arguments that lost passive-use values should not be counted as economic loss.[4] The key implication is that if all passive-use values can be reliably measured, then there are no "unquantifiable environmental and social values" left in an environmental account to be traded off against the NED account. After hearing substantial public testimony and submissions, the NOAA panel concluded that passive-use values could be reliably measured with contingent valuation. They further recommended guidelines to help ensure the reliability of the application of contingent valuation techniques. These recommendations have considerable implications for the economic analysis of a wide range of Corps projects because they are very expensive to implement.[5]

Acknowledging the difficulties in monetizing the benefits and costs of environmental improvements, the committee ultimately concluded that the failure to do so actually does more harm to the environment. The arguments in support of this position are simple: harm done to ecosystem services does not reduce the NED estimate, and improvements do not increase the NED estimate. At present, harm to the environment either acts as a constraint on the feasibility, or mitigation (partial or full) is required after harm reaches some level. With respect to ecosystem restoration, multipurpose projects are clearly the most impacted by the failure to put changes in ecosystem services into monetary terms, as there is no way to compare

[4] See also Kopp, 1992, the companion piece to Rosenthal and Nelson, 1992, which takes the standard neoclassical economic position adopted by the NOAA panel that passive-use values are fundamentally no different than any other factors that contribute to a person's utility level. Passive-use values include or encompass what are often referred to as nonuse values, existence values, bequest values, stewardship values, and option values.

[5] It should be kept in mind that the NOAA panel's recommendations for how to implement contingent valuation studies were made in the context of natural resource damage litigation, where the enabling legislation provides for the government to get reimbursed for the full cost of the technical studies done (plus interest) as long as the cost of the studies was reasonable and conformed to best practices.

multipurpose projects without expressing the outputs of those projects in a common metric. As some outputs of those projects are already in monetary terms, a monetary metric is the natural method to use. For purely environmental projects, the committee believes that existing Corps authorizations that do not require a benefit-cost assessment provide sufficient flexibility for these projects to come forward to Congress for its decision.

MEASURING ENVIRONMENTAL BENEFITS AND COSTS

Three aspects of the Corps' analysis of projects that have changed are relevant to discussion in this section. First, Corps projects on average have become smaller and more localized. Second, explicit environmental elements have become more common in Corps projects and often go well beyond simple mitigation requirements. And third, the number of alternatives considered in the decision process has increased. The first aspect of the change in Corps projects suggests that the costs of conducting a comprehensive, rigorous analysis for each project may be quite large in relation to the project's costs. Indeed, these costs may exceed the net benefits of even project alternatives with extremely favorable benefit-cost ratios. The second suggests that the valuation of changes in environmental amenities will play a larger and hence more controversial role in choosing among project alternatives. The third aspect implies that the costs of doing a rigorous analysis for the purpose of selecting a project alternative are increasing. Each of these aspects of Corps projects suggests the need to develop a formal set of procedures for evaluating small projects in a cost-effective, standardized way and to consider their impacts at a larger level, such as the river basin.

The first step in assessing the benefits and costs of a project alternative is to enumerate them clearly in physical/biological terms. This is consistent with the NEPA process and can provide the inputs to the EQ account where environmental amenities are involved. For example, a recent study (Cole et al., 1996) categorized benefits in typical Corps projects as arising from the following sources:

1. Direct uses in production:

- resource input in navigation and hydropower production;
- increased food and fiber production, and commercial and industrial production;
- water input for industrial processes and municipal/residential water supply;
- commercially harvested fish, wildlife, and natural products.

2. Direct consumptive and nonconsumptive uses:

- aquatic habitat-based consumptive recreation (fishing, swimming, boating);
- amenities and aesthetics (visual and cultural benefits);
- water-enhanced, nonconsumptive recreation (picnicking, bird viewing, camping).

3. Indirect uses:

- flood storage and conveyance;
- sediment retention;
- wind and wave buffer;
- pollution uptake and detoxification.

4. Passive, nonuse, or option values:

- values associated with knowing an ecosystem and its services (e.g., biodiversity) are intact.

Some of these project outputs have market prices (e.g., electricity), though many do not. In cases where market prices are not available, nonmarket valuation techniques need to be used.

Nonmarket valuation techniques attempt to measure the public's maximum willingness to pay for a project output that is not normally bought and sold in the marketplace. At the individual household level, this is the maximum amount that a household could be asked to pay for a project output and still be as well-off as before the project output was provided (Just et al., 1982). The nonmarket valuation techniques (Freeman, 1993) available to the Corps, using ecosystem services as an example, can be summarized as follows:

1. Factor income/productivity approach. Under this approach, benefits and costs can be evaluated by determining the contribution of the change in ecosystem services to the value of goods that are sold directly in markets (where those ecosystems serve as an input to marketed goods). Classic examples are the contribution of wetlands to commercial fisheries and of water quality to agricultural production.
2. Travel cost analysis/averting behavior/household production function. This approach looks at how use of a nonmarketed good changes as the cost of a marketed good necessary to use the nonmarketed good changes. From this relationship, one can infer how much the person would have been willing to pay to use the nonmarketed good. The classic example of travel cost analysis is a recreation site where participation falls as the cost of getting to the site increases.
3. Hedonic pricing (property/wage). This approach examines how the price of a good changes as its characteristics change. The classical examples here are to examine how housing prices change with respect to proximity to a lake or to look at how wage rates change with the level of on-the-job accident risks.
4. Contingent valuation. This approach surveys consumers about trade-offs. Based upon their responses, the values that the public is willing to pay in order to obtain changes in ecosystem services are inferred.

A fifth approach, which effectively draws from the other four approaches, is known as the benefit transfer method. This method takes monetary estimates from other studies, which have valued similar ecosystem services, makes appropriate adjustments to account for differences in circumstances, and applies that estimate to the project alternative being evaluated.

Each of these approaches is appropriate for particular types of nonmarketed goods under particular circumstances. The key is to apply the right tool given the resource constraints on the assessment. It appears to the committee that the Corps should probably pursue the benefit-transfer approach (Brookshire and Neal, 1992) in analyzing its small and medium-sized projects.

Three key difficulties with the benefit transfer are that: (1) it can only be as good as the original studies it is based upon; (2) the factors on which adjustments should be made are not often well understood; and (3) there is not a great deal of experience with conducting benefit transfers for nonmarketed goods other than health effects and outdoor recreation. As the Corps undertakes a large number of multipurpose projects that have similar outputs, they could routinely commission studies to obtain original estimates with respect to the types of outputs they are frequently called upon to value. The Corps can also sponsor original research to look at the other two issues in benefit transfer.

OTHER ISSUES

Other issues relating to economic analysis of environmental restoration projects include the measurement and discounting of environmental outcomes and how cost-sharing rules apply to environmental projects. Corps ecologists rely frequently upon the Fish and Wildlife Service's Habitat Evaluation Procedure (HEP) to quantify outputs of environmental programs. Output measures used in HEP are referred to as "habitat units" obtained by multiplying affected areas of habitat for a selected species by a habitat suitability index for that species. As such, habitat units reflect both the quantity and quality of habitat as an output for the selected species. For example, if a 100-acre parcel of wetlands is restored as habitat for a particular migratory fowl, and the quality of that habitat is assigned a suitability index of 0.6, the output would be 60 habitat units for that particular fowl. Corps guidance, such as the *Evaluation of Environmental Investment Procedures: Interim Overview Manual* (Harrington and Feather, 1996), defines these habitat units as important alternative metrics for assessing restoration project benefits. Indeed, it would appear that the purpose of environmental restoration projects is solely to produce HEP units in the most cost-efficient manner. The difficulty with HEP and similar methods is that they capture only a part of the national interest. They focus on habitat aspects of ecosystems and then only on a select species. Public preferences may be stated in more holistic views of which ecosystems should be restored.

Even if a perfect measure of environmental effects was found, other issues would be at stake. Regardless of whether the theoretical habitat units are general ecological goods or species specific, one must still recognize that they can be counted across three dimensions: time, quality, and surface area. Furthermore, there are many potential trade-offs across the three dimensions. For example, consider a case in which the goal is to increase the quantity of a specific fish species that is popular with anglers. A single planning alternative could produce a large quantity of small fish in a short period of time (perhaps all in one year) and in a highly confined area. A different alternative might produce the same number of fish, but they could be larger specimens available over longer periods of time, perhaps many years, and spaced

across a wide geographic area. The two alternatives might be equal in one unit of measurement, but may not be equal in terms of production costs and preferences to the anglers.

There are instances where cost-effectiveness analysis of supplying some desired number of HEP units is appropriate. A common instance is where protection of an endangered species is called for and the particular HEP model is calibrated to that species. In this instance, the Corps is helping to fulfill a legislative mandate and there is no need to conduct a benefit-cost analysis, only to accomplish the mandate at the lowest cost, subject perhaps to a spending constraint.

The interesting and challenging task for the Corps is to link outputs of ecological models, in whatever units are appropriate, with economic benefits. In doing so, the Corps should be careful not to confuse HEP unit maximization with actual restoration of the original ecosystem.

Conventional Corps planning studies discount all future flows of monetized benefits to present values using a single interest rate mandated by the Office of Management and Budget. Several issues arise regarding the choice of a particular discount rate and how it is chosen. One of these issues is the following: What is an appropriate choice when a current change in an environmental amenity is being traded off against a distant future change in that same amenity? Other federal agencies, such as the EPA and NOAA, are starting to consider this issue, as should the Corps. Coordination of a consistent federal policy on this issue would be desirable.

6

Recommendations

Primarily in response to complaints from its project cosponsors, the U.S. Army Corps of Engineers requested the Water Science and Technology Board of the National Research Council to conduct this study. The committee was asked to provide advice on the following:

1. Assess the Corps' structured project planning process to determine if all steps are necessary and if the process can be streamlined. Is the Corps' planning effort reasonable, given the level of investment?
2. Consider the necessity for a major evaluation of the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*. Can this process be streamlined without undue harm to land and water resources?
3. Consider how the cost-sharing requirements of the 1986 Water Resources Development Act have affected the potential development of new Corps water projects. This should address the number and size of projects, as well as effects on study duration and timing.
4. Consider how the requirement to include risk and uncertainty analysis has affected project planning, development, and the range of alternatives considered.

The Corps has taken several steps during the past two to three years to help streamline its planning processes. The committee has identified additional steps which can help the Corps further reduce planning time. However, the Corps project planning procedures are generally sound and not excessively lengthy when compared to private sector water planning studies.

The committee was also requested to consider whether the *Principles and Guidelines* required major review. The *P&G* are central to Corps planning and have been incorporated in the Corps' primary planning document, "Guidance for Conducting Civil Works Planning Studies" (ER 1105-2-100). The *P&G* have not been updated since they were adopted in 1983. While the *P&G* have not changed, water resource programs and analytical techniques have evolved considerably over the past 15 years. The Corps' current work program includes a complex mixture of structural and nonstructural elements designed to reduce damages from floods, as well as restore the natural structure and processes of aquatic ecosystems in others. These new missions and their ramifications were not anticipated when the *P&G* were developed.

Though the *P&G* have been valuable, they are in need of modernization. But

if the need for modernization of the *P&G* is clear, the procedures for accomplishing their modification are not, because the WRC is dormant and there are no plans to reestablish it. The administration should take whatever action necessary to charge someone to carefully evaluate the *P&G*, make updates and revisions, and propose a new document. If neither the administration nor Congress soon begins a new interagency effort to update these procedures, the Corps should take it upon itself to draft new planning procedures that reflect current conditions. The Corps is currently moving in that direction through its draft revisions of the "Guidance for Conducting Civil Works Planning Studies."

The Science Advisory Board of the EPA recently called attention to the fact that no existing federal program systematically addresses the highest categories of ecological risks, such as hydrologic alteration, habitat conversion, turbidity/sedimentation, habitat fragmentation, and introduction of exotic species. The Corps should take the opportunity to revise its planning guidelines to address these issues.

The understanding, modeling, and prediction of ecological system behavior is complex and time-consuming, even more challenging than the Corps' complex hydrologic modeling studies. To build on its existing expertise and extend it into these new areas, the Corps must continue to strengthen its knowledge in the biological and ecological sciences and attempt to quantify ecological benefits and costs as part of its modeling processes. Beyond monetized ecological values, the Corps should consider noneconomic ecosystem values and services, such as biodiversity and natural carbon storage, in considering water project alternatives. In revising its planning processes, the Corps should reconsider WRC standards and analytical techniques that disfavored nonstructural solutions to water resource problems. The best modem engineering practices usually lead to projects that include both structural and nonstructural components, and the planning rules should not bias the selection of the mixture.

To manage the nation's water resources effectively, the Corps must evaluate its larger projects from a regional perspective. For example, flood damage reduction projects that merely pass floods downstream do not serve the national interest, nor does shoreline protection that increases erosion elsewhere. The Corps should use the watershed or river basin, the estuarial region, and coastal unit as the basic spatial units in planning to account for the cumulative effects of water projects in the same hydrologic system.

The expansion of scientific knowledge has caused increased planning time not only for the Corps, but for every other government agency and the private sector. Similarly, increasingly complex analytical procedures, such as the Corps risk and uncertainty analyses, further lengthen the process. Our understanding of the world's complexity will only increase, and time saved through improved communications and more streamlined procedures can counteract but not reverse this trend. Expectations of reduced planning times should thus be modest.

Local cosponsors occasionally do not provide the Corps with adequate information about local stakeholder interests and desires, contributing to delays in planning. The committee thus recommends that local sponsors be required to provide basic economic and demographic data to the Corps, as well as provide assurances of local stakeholder involvement, before asking the Corps to undertake water project planning. The local sponsor should also be required to identify the

alternatives proposed by all interested stakeholders and provide their supporting rationale before the Corps undertakes a reconnaissance study. Similarly, the Corps can increase the speed and cost-effectiveness of planning by providing more complete guidance to local sponsors on information to include when submitting a proposal for a reconnaissance study. As this report has explained, however, further reductions in the time and cost of Corps planning studies do not necessarily result in a better planning process. The Corps planning process takes as long as it does, at least in part, due to federal, state, and local regulations, including local sponsor input, and the Corps' own stringent requirements.

The committee's recommendations are divided into four categories: (1) internal organization; (2) external issues; (3) relations with local sponsors; and (4) analytical methodology.

INTERNAL ORGANIZATION

These recommendations can be implemented internally by the Corps.

1. The Corps should emphasize a basinwide or regional perspective in all major planning studies in order to fully account for all impacts in the relevant river systems.
2. The Corps should eliminate needless gaps in the project planning process. For example, the negotiated PED cost-sharing agreement should be completed at the time the division engineer's report is released to Corps headquarters.
3. The Corps should include a monitoring and evaluation component in the planning of all water resource projects. The project should be charged with the cost of the monitoring component to the extent it is needed to manage the project adaptively.
4. The Corps should allow for the omission of analysis of expensive alternatives and levels or stages of review for small projects on which a consensus exists. Regulations need not impose the same procedural steps for all sizes of project.
5. The Corps or an independent research group should conduct a study to determine whether any systematic biases exist against the Corps' nonstructural flood damage reduction projects.

EXTERNAL ISSUES

These recommendations require action by Congress or coordination with agencies other than the Corps.

1. The committee recommends that the *P&G* be thoroughly reviewed and modernized. As discussed, the committee found several reasons why the *P&G* need to be updated, including: (a) a need to move away from strict adherence to the NED account; (b) the Corps' environmental improvement and restoration programs were

all enacted after the *P&G* were formulated; (c) a need to update analytical techniques; and (d) the need to consistently consider benefits of flood damages avoided in all nonstructural flood damage reduction projects.

Procedural details over which agency will refine the *P&G* should not be allowed to delay this action. Much of the excellent work that went into their conceptualization can be retained in new guidelines that reflect changing Corps (and other federal, water-related agencies) missions and advances in scientific and engineering knowledge.

2. Unless the administration or Congress takes some other action to review and modify the *P&G*, the Corps should initiate a comprehensive rule-making process to adopt its own planning procedures and guidelines, providing maximum opportunities for input from other public agencies and the private and nonprofit sectors.
3. The Corps should be given more extensive authorization by Congress to formally undertake large scale regional planning activities which include multiple projects. These activities will allow the Corps to budget resources and complete projects in a more efficient and timely manner.
4. The committee noted excessive fragmentation of responsibilities for federal water planning, significant changes in the programs and capabilities across the federal water apparatus, a lack of a comprehensive and up-to-date overview of the nation's significant water problems, and an erosion of basinwide perspectives and coordination. An executive-level group to formulate national water policy and to coordinate and promote interagency collaboration should thus be created. Initial tasks for this group could include coordinating information and analytical techniques across federal water planning agencies, as well as revising the *P&G*. The committee recommends that the Congress consider placing this body within the Office of Science and Technology Policy (OSTP). This recommendation is not intended to create another large government agency, but rather to create a means to help coordinate national water policies.
5. Congress should increase the cap on individual projects within continuing authority programs to $10 million and raise the cap on the entire program to a corresponding level. Many of these caps have not been increased to reflect the inflation of construction costs.
6. The Corps should continue its research on prospective global warming, climate change, and changes in sea-level, and attendant hydrologic, economic, and environmental impacts.

RELATIONS WITH LOCAL SPONSORS

Local sponsors and other stakeholders should be consulted before these recommendations are implemented.

1. As unorganized local sponsors can contribute to delays in the planning process, local sponsors should be required to consult with affected stakeholder groups to identify their desires, concerns, and the range of desired alternatives before the Corps undertakes a reconnaissance study. Local sponsors should also be required

to provide the Corps with basic economic and demographic data relevant to planning.

2. The Corps should revisit the current application of cost-sharing criteria based on the ability to pay and should devise more workable approaches. The Corps should review its current and recent projects to examine how local sponsors' ability-to-pay has been affected by cost-sharing criteria. Special attention should be paid to identifying any systematic problems that may limit the Corps' ability to help the poor address water-related problems, especially floods.
3. The Corps should seek to reduce delays between the reconnaissance and subsequent phases of a project. If it appears that a reconnaissance study will have a favorable outcome, the Corps should immediately begin to collaborate with the local sponsor on the various steps needed to launch the next phases of the project. Any time that will be wasted when a reconnaissance study develops last-minute problems will be outweighed by many months of time saved on most projects.

ANALYTICAL METHODOLOGY

1. Where there is a legislative or regulatory directive for an environmental improvement or restoration project, the evaluation should include, at a minimum, cost-effectiveness analysis. Where possible, the project evaluation should include benefit-cost analysis.
2. Analytical methods should be continually updated and improved to account correctly and adequately for all categories of benefits and costs. For example, avoidance of costly disaster relief assistance by relocating residents out of flood-prone areas should be considered in evaluating the benefits of all nonstructural flood damage reduction projects. A study which seeks to identify biases which may exist against the Corps' nonstructural flood damage reduction projects should be commissioned and conducted.
3. Closer examination should be given to the calculation of the monetary benefits and costs of environmental restoration. Work should proceed toward the development of a standard set of accounting units and easily applied computer models to quantify benefits and costs for all Corps projects. It should be recognized that but for the larger projects, it may be infeasible, due to time and financial constraints, to undertake major original studies. It will, however, be necessary for the Corps to undertake high quality original research which is now lacking in many areas in order to support the development of reliable benefit-transfer models.
4. The Corps should estimate the time required to conduct risk and uncertainty analysis of economic and hydraulic parameters in its flood damage reduction, navigation, and shoreline protection projects. If significant time and resources are required, the Corps should consider limiting its treatment of risk and uncertainty to sensitivity analysis. While historical records are commonly available to support assignment of probabilities to hydrologic events, data to support probability analysis of economic and hydraulic parameters in particular settings are limited. Furthermore, sensitivity analysis combined with expert judgment about probable ranges of parameters may be sufficient to support decision making in most cases.
5. The Corps should initiate development of techniques that give explicit

treatment of uncertainty in adaptive environmental management projects. Appropriate techniques should recognize the sequential decision making process inherent in projects of this kind, providing guidance as to whether such projects should be initiated and whether they should be continued or terminated when subsequent decision points are reached.

References

Apogee Research. 1997. Resource Significance Protocol for Environmental Project Planning. IWR Report 97-R-4. Alexandria, Va.: Institute for Water Resources.

Arrow, K., M. Cropper, G. Eads, R. Hahn, L. Lave, G. Noll, P. Portney, M. Russell, R Schmalensee, V. K. Smith and R. Stavins. 1996. Is there a role for benefit-cost analysis in environmental, health, and safety regulation? Science 272:221-222.

Arrow, K., R. Solow, P. R. Portney, E. E. Learner, R. Radner, and H. Schuman. 1993. Report of the NOAA panel on contingent valuation. Federal Register 58:4601-4614.

Association of State Wetland Managers and Association of State Floodplain Managers (ASFPM). 1991. A Case-Book in Managing Rivers for Multiple Uses. Washington, D.C.: Department of the Interior.

Bellman, R. 1961. Adaptive Control Processes: A Guided Tour. Princeton, N.J.: Princeton University Press.

Braden, J., and C. Kolstad, eds. 1991. Measuring the Demand for Environmental Quality. Amsterdam: North-Holland.

Brookshire, D., and H. Neil. 1992. Benefit Transfers: conceptual and empirical issues. Water Resources Research 28:651-655.

Caulfield, H. P., Jr. 1977. Let's dismantle (largely but not fully) the federal water resource development establishment. Pp. 171-178 in Water Needs for the Future, V.P. Nanda, ed. Boulder, Colo.: Westview Press.

Chao, P. T., J. M. Floyd, and W. Holliday. 1997. Empirical Studies of the Effect of Flood Risk on Housing Prices. IWR Report 96-PS-2. Alexandria, Vir.: Institute for Water Resources, U.S. Army Corps of Engineers. Review draft

Chin, A. E. 1981. Implementation of Non-structural Measures. Board of Engineers for Rivers and Harbors. U.S. Army Corps of Engineers. 15 January 1981.

Clarke, J. N., and D. McCool. 1996. Staking Out the Terrain: Power and Performance in Natural Resource Agencies. 2d ed. Albany: State University of New York Press.

Cole, R A., J. B. Loomis, T. D. Feather, and D. T. Caplan. 1996. Linkages Between Environmental Outputs and Human Services. IWR Report 96-R4. Alexandria, Va.: Institute of Water Resources.

Costanza, R., R d'Arge, R de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, RV. O'Neill, J. Paruelo, R.G. Raskin, P. Sutton, and M. van den Belt. 1997. The value of the world's ecosystem services and natural capital. Nature 30:253-260.

Cropper, M. L., and W. E. Oates. 1992. Environmental economics: A survey. Journal of Economic Literature 30(2): 675-740.

Feather, T. D., C. S. Russell, K. W. Harrington, and D. T. Caplan. 1996. Review of Monetary and Nonmonetary Valuation of Environmental Investments. IWR Report 95-R-2 Alexandria, Va.: Institute for Water Resources.

Field, R M. 1977. Profiles of communities with floodplain acquisition experience. Draft Connecticut U.S. Department of Housing and Urban Development

Freeman, A. M. 1993. The Measurement of Environmental and Resource Values: Theory and Methods. Washington, DC: Resources for the Future.

Freidel, F. 1990. Franklin D. Roosevelt: A Rendezvous with Destiny. Boston: Little and Brown.

Gunderson, L., C. Holling, and S. Light, eds. 1995. Barriers and Bridges to the Renewal of Ecosystems and Institutions. New York: Columbia University Press.

Hanemann, W. M. 1992. Preface in Valuing the European Environment, S. Navrud, ed. New York: Oxford University Press.

Harrington, K. and T. Feather. 1996. Evaluation of Environmental Investment Procedures: Interim Overview Manual. U.S. Army Corps of Engineers, Institute for Water Resources. Alexandria, Vir.

Hays, S. P. 1987. Beauty, Health, and Permanence: Environmental Politics in the United States, 1955-1985. Cambridge: Cambridge University Press .

Holling, C. S. 1978. Adaptive Environmental Assessment and Management. Chichester, N.Y.: John Wiley and Sons.

Houghton, J. T., L. G. Meira Filho, B. A. Callander, N. Harries, A. Kattenberg, and K. Maskell, eds. 1996. Climate Change 1995: The Science of Climate Change. Cambridge: Cambridge University Press.

Inland Waterways Commission. 1908. Preliminary Report. S. Doc. 325, 60th Congress, 1st session.

Institute for Water Resources. 1983. Seminar Proceedings Implementation of Non-structural Measures. Policy Study 83-G520. Prepared for the Office of the Chief of Engineers. Fort Belvoir, Vir.: U.S. Army Corps of Engineers.

Institute for Water Resources. 1996. Evaluation of Environmental Investments Procedures: Overview Manual IWR Report 96-R-30. Alexandria, Va.: Institute for Water Resources.

Institute for Water Resources. 1997. Evaluation of Environmental Investments Program. Revised draft document. November.

Interagency Committee on Water Resources. 1950. Proposed Practices for Economic Analysis of River Basin Projects. Washington, D.C.: U.S. Government Printing Office.

Interagency Floodplain Management Review Committee. 1994. Sharing the Challenge: Floodplain Management into the 21st Century. Washington, D.C.: U.S. Government Printing Office.

Just, R. E., D. Hueth, and A. Schmitz. 1982. Applied Welfare Economics and Public Policy. Englewood Cliffs, N.J.: Prentice-Hall.

Keeney, R L., and H. Raiffa. 1976. Decisions with Multiple Objectives: Preferences and Value Trade-offs. New York: Wiley.

Kneese, A. V. 1993. Economics and water resources. Pp. 23-35 in Water Resources Administration in the United States: Policy, Practice, and Emerging Issues, Reuss, M., ed. East Lansing: Michigan State University Press.

Kopp, R. J. 1992. Why existence values should be used in cost-benefit analysis. Journal of Policy Analysis and Management 11:123-130.

Krutilla, J. 1966. An economic approach to coping with flood damage. Water Resources Research 2(2): 183-190.

Kusler, J. A. 1982. Innovation in Local Floodplain Management: A Summary of Community Experiences. Special Publication 4 prepared for the U.S. Water Resources Council. National Hazards Research and Applications Information Center.

Lee, K. 1993. Compass and Gyroscope: Integrating Science and Politics for the Environment. Washington, D.C.: Island Press.

Maass, A. 1951. Muddy Waters: The Army Engineers and the Nation's Rivers. Cambridge:

Harvard University Press.
Mann, M., RS. Bradley, and M.K. Hughes. 1998. Global-scale temperature patterns and climate forcing over the past six centuries. Nature 392: 779-787.
Mazmanian, D. and J. Nienaber. 1979. Can Organizations Change? Environmental Protection, Citizen Participation, and the Corps of Engineers. Washington, D.C.: Brookings Institute.
Moore, J. W., and D. P. Moore. 1989. The Army Corps of Engineers and the Evolution of Federal Flood Plain Management Policy. Boulder Institute of Behavioral Science, University of Colorado.
Moreau, D. H. 1996. Principles of planning and financing for water resources in the United States: 4.1-4.41. In Water Resources Handbook, L. W. Mays, ed. New York, N.Y.: McGraw-Hill.
Moser, D. A. 1996. The Use of Risk Analysis by the U.S. Army Corps of Engineers. Water Resources Update: 27-34. Carbondale, IL. Universities Council on Water Resources.
Moser, D. A., and C. M. Dunning. 1986. A Guide for Using the Contingent Valuation Methodology in Recreation Studies, National Economic Development Procedures Manual-Recreation. Vol. 2. IWR Report 86-R-5. Fort Belvoir, Vir.: Institute for Water Resources.
Nash, R. 1990. American Environmentalism: Readings in conservation history. 3rd ed. New York: McGraw-Hill.
National Research Council. 1985. Safety of Dams: Flood and Earthquake Criteria. Washington, D.C.: National Academy Press.
National Research Council. 1995. Flood Risk Management and the American River Basin: An Evaluation. Washington, D.C.: National Academy Press.
National Research Council. 1998. New Strategies for America's Watersheds. Washington, D.C.: National Academy Press.
National Wildlife Federation. 1998. Higher Ground: A Report on Voluntary Property Buyouts in the Nation's Floodplains. National Wildlife Federation, Washington, DC.
Organization for Economic Cooperation and Development 1989. Environmental Policy Benefits: Monetary Valuation. Paris: OECD.
Organization for Economic Cooperation and Development 1994. Project and Policy Appraisal: Integrating Economics and the Environment Paris: OECD.
Organization for Economic Cooperation and Development 1992. Benefit Estimates and Decision Making. Paris: OECD.
Platt, R. 1979. Options to Improve Federal Non-structural Response to Floods. Washington, D.C.: U.S. Water Resources Council. December, 1979.
Reisner, M. 1986. Cadillac Desert: The American West and Its Disappearing Water . New York: Penguin Books.
Rieke, B., and D. Kenney. 1997. Resource Management at the Watershed Level. Boulder, Colo.: Natural Resources Law Center.
Robinson, R., W. Hansen, and K. Orth. 1995. Evaluation of Environmental Investments Procedures Manual Interim: Cost Effectiveness and Incremental Cost Analysis. IWR Report 95-R-1995. Alexandria, Vir.: U.S. Army Corps of Engineers, Institute for Water Resources.
Rogers, P. 1993. America's Water: Federal Roles and Responsibilities. Cambridge, Mass: MIT Press.
Rosenthal, D. H., and R Nelson. 1992. Why Existence value should not be used in cost-benefit analysis. Journal of Policy Analysis and Management 11:116-122.
Schad, T. 1998. Water Policy: Who Should do What? Water Resources Update.

No. 111: 51-61 . Carbondale, IL. Universities Council on Water Resources.
Shabman, L., A. Riley, and G. Stedge. 1997. Evaluation of Floodplain Permanent Evacuation Measures: An Alternative Approach for the U.S. Army Corps of Engineers. Draft interim report.
Spillan, H. 1990. Personal communication. (Former House subcommittee staff member of Energy and Water Development)
Stakhiv, E. Z. 1998. Policy implications of climate change impacts on water resources management Water Policy 1(2): 1-17 .
Steinberg, B. 1984. Flood Damage Prevention Services of the U.S. Army Corps of Engineers: An Evaluation of Policy Changes and Program Outcomes During 1970 to 1983 Measured Against Criteria of Equity, Efficiency, and Responsiveness. Dissertation, George Washington University School of Government and Business Administration. Unpublished.
Stoerker, H. 1998. Presentation to the National Research Council Committee to Assess the U.S. Army Corps of Engineers Water Resources Project Planning Procedures. West Palm Beach, Fla, February 19.
U.S. Army Corps of Engineers. 1979. The Development of Non-structural Alternatives: A Policy Discussion by the St Paul District U.S. Army Corps of Engineers, St Paul District May, 1979.
U.S. Army Corps of Engineers. 1990. Guidance for Conducting Civil Works Planning Studies. Engineering Regulation 1105-2-100. Washington, D.C.: Department of the Army.
U.S. Army Corps of Engineers. 1994. National Study of Water Management During Drought—The Report to Congress.
U.S. Army Corps of Engineers. 1996a Risk-Based Analysis for Evaluation of Hydrology/Hydraulics, Geotechnical Stability, and Economics in Flood Damage Reduction Studies. ER 1105-2-101 (March).
U.S. Army Corps of Engineers. 1996b. Task Force Report on Shortening the Planning/Design Process. 11 October 1996.
U.S. Army Corps of Engineers. 1997a. Risk-Based Analysis for Flood Damage Reduction Studies. Proceedings of a Hydrology and Hydraulics Workshop, October 20-22, Pacific Grove, CA. Davis, Calif.; U.S. Army Corps of Engineers, Hydrologic Engineering Center.
U.S. Army Corps of Engineers. 1997b. Project Modifications for Improvement of the Environmental and Aquatic Ecosystem Restoration. EC 1105-2-214 (September).
U.S. Congress. 1925. River and Harbor Act
U.S. Water Resources Council. 1973. Establishment of principles and standards. Federal Register 8(174):24778-24869.
U.S. Water Resources Council. 1973. Water and Related Land Resources: Establishment of Principles and Standards for Planning. Federal Register 38:24784, 248222-248223.
U.S. Water Resources Council. 1983. Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. Washington, D.C.: U.S. Government Printing Office.
Upper Mississippi River Basin Association. N.d. Meeting the Challenge: The Upper Mississippi River System Environmental Management Program. Vicksburg, Miss.: U.S. Army Corps of Engineers.
Van Houten, G., and M. L. Cropper. 1996. When is a life too costly to save? The evidence from U.S. environmental regulations. Journal of Environmental Economics and Management 30:348-368.
Vincent, M. K., D. A. Moser, and W. J. Hansen. 1986. National Economic Development

Procedures Manual—Recreation Vol. I: Recreation Use and Benefit Estimation Techniques. Fort Belvoir, Vir.: Institute for Water Resources.

Walters, C. 1986. Adaptive Management of Renewable Resources. New York: Macmillan Press.

Wescoat, J. L., Jr. 1999. Watersheds in regional planning. in: The American Planning Tradition: Culture and Policy. Fishman, R.L., editor. Baltimore: Johns Hopkins University Press, forthcoming.

Western Governors Association. 1997. An Action Plan for Reducing Flood Risk in the West Denver Western Governors Association.

White, G. 1957. A perspective of river basin development Law and Contemporary Problems 22 (2):157-184.

Yoe, C. E., and K. D. Orth. 1996. Planning Manual. IWR Report 96-R-21. Alexandria, Va.: Institute for Water Resources.

Yoe, C. E., and L. Skaggs. 1997. Risk and Uncertainty Analysis Procedures for the Evaluation of Environmental Outputs. IWR Report 97-R-7. Alexandria, Va.: Institute for Water Resources.

List of Acronyms

AAPA	American Association of Port Authorities
ACT/ACF	Alabama-Coosa-Tallapoosa/Apalachicola-Chattahoochee-Flint
AEAM	Adaptive Environmental Assessment and Management
AFB	alternative formulation briefing
ASA(CW	Assistant Secretary of the Army (civil works)
ASFPM	Association of State Floodplain Managers
CAP	continuing authority program
CEQ	Council on Environmental Quality
CV/CVM	contingent valuation/contingent valuation methods
EC	engineering circular
EEIRP	of Environmental Investments Research Program
EIS	environmental impact statement
EM	engineering manual
EMP	Environmental Management Program
EOP	Executive Office of the President
EPA	Environmental Protection Agency
EQ	environmental quality
ER	engineering regulation
ERR	ecosystem restoration report
ESA	Endangered Species Act
FCSA	feasibility cost-sharing agreement
FEMA	Federal Emergency Management Agency
FIARBC	Federal Interagency River Basin Commission
FPC	Federal Power Commission
FWS	Fish and Wildlife Service
GNF	general navigation feature
HEP	Habitat Equivalence Program
HQUSACE	Headquarters of the U.S. Army Corps of Engineers
ICWR	Interagency Committee on Water Resources
IWC	Inland Waterways Commission
IWR	Institute for Water Resources
LERRD	lands, easements, rights of way, relocations, disposal areas
MBIAC	Missouri Basin Interagency Committee
MRC	Mississippi River Commission
NAS	National Academy of Sciences
NAWQA	National Water Quality Assessment

NED	national economic development
NEPA	National Environmental Policy Act
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council
NRCS	Natural Resource Conservation Service
NRPB	National Resources Planning Board
NWF	National Wildlife Federation
NWS	National Weather Service
O&M	operation and maintenance
OASA(CW)	Office of the Assistant Secretary of the Army, Civil Works
OMB	Office of Management and Budget
OSE	other social effects
OSTP	Office of Science and Technology Policy
P&G	Principles and Guidelines
P&S	Principles and Standards
PCA	project cooperation agreement
PED	preconstruction engineering and design
PRP	preliminary restoration plan
PSP	project study plan
RED	regional economic development
TVA	Tennessee Valley Authority
UMRBA	Upper Mississippi River Basin Association
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
WES	Waterways Experiment Station
WRC	Water Resources Council
WRDA	Water Resources Development Act
WSTB	Water Science and Technology Board

Appendix A

Planning Guidance Letter 97-10, Shortening the Planning Process

DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
WASHINGTON, D.C. 20314-1000

REPLY TO
ATTENTION OF:

CECW-PE 26 MAR 1997

MEMORANDUM FOR MAJOR SUBORDINATE COMMANDS

SUBJECT: Planning Guidance Letter 97-10, Shortening the Planning Process

1. Purpose. The purpose of this guidance letter is to implement new procedures and requirements for shortening planning studies. This guidance will be incorporated into the next revision of ER 1105-2-100, Guidance for Conducting Civil Works Planning Studies.

2. Background. In the Fiscal Year 1997 budget testimony, the Assistant Secretary of the Army for Civil Works (ASA(CW)) stated that the U.S. Army Corps of Engineers will review current processes and will find ways to produce quality feasibility studies more quickly and at less cost. To this end, guidance has already been implemented on expediting the reconnaissance phase of planning studies, Planning Guidance Letter 96-3. In addition, a task force composed of experienced field staff was convened to examine our planning/design process and to identify alternatives to implement projects in a more expeditious manner. The task force completed its work in October 1996. The task force identified several process, policy, and legislative changes that, if implemented, could significantly reduce study time. The task force recommendations were reviewed and three major changes to existing procedure and policy were approved. These changes can shorten the time and reduce the cost of feasibility studies and be implemented quickly and without new legislation. These changes fall into three categories:

(a) Procedural changes that provide for each feasibility study effort to be focused and tailored to meet specific needs and objectives;

(b) Policy changes that, in certain cases, provide for categorical exemptions from requirements to develop and recommend the NED plan; and

(c) An additional change encouraging flexible Federal/non-Federal funding of cost shared feasibility studies.

CECW-PE
SUBJECT: Planning Guidance Letter 97-10, Shortening the Planning Process

3. Procedural Change. Each feasibility study effort will be focused and tailored to meet the site-specific objectives and constraints. Although, most of the expedited reconnaissance study phase effort is devoted to preparation of the Project Study Plan (PSP), it is recognized that the PSP will be based on limited information and will reflect the complete range of studies required by regulations. Therefore, to ensure that the feasibility studies are focused and tailored to meet specific objectives, an in-progress-review meeting will be convened early in the ~~feasibility~~ study, after National Environmental Policy Act scoping has been accomplished. Convening an in-progress-review meeting early in the feasibility study will bring the Corps headquarters, division and district staffs, the non-Federal sponsor, and resource agencies together to revise the PSP to focus the feasibility study on key alternatives, to further define the depth of analysis required and to refine study/project constraints. Accordingly, the PSP developed during the reconnaissance phase will be revised to document the changes agreed to at the in-progress-review meeting. The agreed-to changes will be documented in a memorandum to be approved by CECW-P. The revised PSP will then form the basis for subsequent conduct and review of the feasibility report and development of the report of the Chief of Engineers.

4. Policy Change. This is a key policy change dealing with identification and recommendation of the National Economic Development (NED) plan. Currently, the NED plan must be recommended unless an exemption is granted by the ASA(CW). In an effort to use our limited resources as efficiently as possible, this policy change provides, in certain cases, for categorical exemptions from the requirements to develop and recommend the NED plan. For flood damage reduction studies, where the non-Federal sponsor has identified a desired maximum level of protection, where the with-project residual risk is not unreasonably high, and where the plan desired by the sponsor has greater net benefits than smaller scale plans, the requirement to analyze and present in the feasibility report project plans providing higher levels of protection than the plan desired by the sponsor is suspended. As an example, if a sponsor desires a levee of sufficient height to meet Federal Emergency Management Agency flood insurance requirements and it is determined that the levee to accomplish this has higher net benefits than smaller levees,

CECW-PE
SUBJECT: Planning Guidance Letter 97-10, Shortening the Planning Process

then the levee desired by the sponsor could be recommended without having to analyze larger levees to identify the NED plan. For harbor and channel deepening studies, where the non-Federal sponsor has identified constraints on channel depths, the requirement to detail deepening projects greater than the plan desired by the sponsor is also suspended. As an example, if a sponsor only desires to deepen a channel to -40 feet and it is determined that the -40 foot channel is economically justified and has greater net benefits than a -39 foot or -38 foot channel, etc., then the -40 foot plan could be recommended without having to analyze deeper channel plans in an attempt to identify the NED plan. However, in all cases, the recommended plan must have greater net benefits than smaller scale plans, and the formulation must analyze enough alternatives to insure that net benefits do not maximize prior to the sponsor's preferred plan.

In accord with the Principles and Guidelines formulation process, alternative plans are normally composed of incrementally justified elements. If the plan proposed to be recommended contains uneconomical increments an exception from the ASA(CW) must continue to be obtained. In cases where the non-Federal partner can and does identify constraints to the maximum physical project size or costs because of limited financial resources, analysis of project sizing will continue in the traditional way, (i.e., adding increments so long as the increment has positive net benefits) until the physical size or budget constraint has been reached. If the NED plan is identified at a physical size or costs less than the defined constraint, then the NED plan requirement is satisfied and the NED plan should be recommended unless an exception is requested. However, should net benefits be increasing when the physical size or budget constraint is reached, there is no longer a requirement to detail larger scale plans in an effort to identify the NED plan, and the constrained plan should be recommended. In any case, an essential element of any flood damage reduction recommendation will be the identification of residual risk for the sponsor and flood plain occupants, including residual damages and potential for loss of life, due to exceedence of design capacity.

Agreements effecting the limit and scope of the NED plan analysis will be fully documented in the revised PSP. In all cases it must be assured that the analysis of alternatives is

CECW-PE
SUBJECT: Planning Guidance Letter 97-10, Shortening the Planning Process

comprehensive enough to meet the requirements of the National Environmental Policy Act.

5. Additional Changes. In order to minimize potential delays in initiating a cost shared feasibility study associated with the timing and availability of Federal/non-Federal funds, the district and the sponsor may consider flexible Federal/non-Federal funding arrangements when negotiating the Feasibility Cost Sharing Agreement (FCSA). For example, with a signed letter of intent, a cost shared feasibility study could be initiated with a greater than 50 percent proportion of Federal, or of non-Federal funds, in lieu of attempting to obtain an equal Federal/non-Federal match. In this case, subsequent funds would then be contributed in accordance with a specific schedule of payments so that the ultimate contributions equaled the required 50 percent of the study cost during the period of study. The existing model FCSA accommodates flexible Federal/non-Federal funding arrangements. CECW-P approval is required to deviate from a funding schedule requiring proportional contributions.

6. Implementation. This guidance letter is effective immediately.

FOR THE COMMANDER:

RUSSELL L. FUHRMAN
Major General, USA
Director of Civil Works

Appendix B

Cost Analysis of Selected Studies, 1986-1996

		Average Cost ($1,000s)	
Project Purpose	Number of Projects	Reconnaissance	Feasibility
Shoreline beach Protection	2	442.5	1,346.0
Navigation/shallow draft	5	196.2	602.0
Navigation/inland waterways	3	126.7	1,991.7
Navigation/deep draft	10	268.8	1,861.6
Navigation/other	1	220.0	660.0
Hurricane damage protection	4	503.8	1,026.5
Flood damage protection	27	301.0	1,548.2
Environmental	2	225.0	1,830.0
Total Average	54	291.6	1,830.0

Source: Corps data.

Appendix C

List of Conditional Authorization Projects in WRDA '96

The following projects were authorized by Section 101(b) of WRDA '96 subject to a final report of the Corps of Engineers (chiefs report), if the report is completed not later than December 31, 1996.

Name of Project	Type of Project	Actual Date of Chief's Report
Chignik, Arkansas	Navigation	
Cook Inlet, Arkansas	Navigation	
St. Paul Harbor Island, St. Paul, Arkansas	Navigation	December 23, 1996
Norco Bluffs, Riverside, California	Bluff stabilization	
Terminus Dam, Kaweah River, California	Flood control and water supply	December 23, 1996
Rehoboth Beach and Dewey Beach, Delaware	Storm damage reduction and shoreline protection	
Brevard County, Florida	Shoreline protection	December 23, 1996
Lake Worth Inlet, Florida	Navigation and shoreline protection	
Miami Harbor Channel, Florida	Navigation	
New Harmony, Indiana	Streambank erosion protection	
Westwego to Harvey Canal, Florida	Navigation	

Name of Project	Type of Project	Actual Date of Chief's Report
Chesapeake and Delaware Canal, Maryland	Navigation and safety improvement	December 23, 1996
Abseeon Island, New Jersey	Storm damage reduction and shoreline protection	

Appendix D

Beach Nourishment

The nation's beaches are prime destinations for tourists and provide national amenities ranging from bathing, surfing, and sunning to picnicking and fishing—all enhanced by outstanding aesthetic enjoyment. Beaches are the leading tourist destinations in the United States, with historical sites and parks being the second most popular (*USA Today,* 1993). For example, Miami Beach reported more tourist visits (21 million) than were made to any national Park Service property (Wiegel, 1992). Miami Beach had more than twice the combined tourist visits of Yellowstone (2.6 million), the Grand Canyon (4.0 million), and Yosemite (3.3 million). Beaches are America's playland and economic heartlands and were estimated to contribute $170 billion annually to the economy in 1995 (Houston, 1995).

Travel and tourism is by far the nation's largest industry. It contributed $746 billion to the U.S. economy in 1995 (*Wall Street Journal,* 1995). This amount was over 10 percent of the U.S. gross domestic product, and makes the contribution of travel and tourism second only to that of the total retail trade. Travel and tourism are providing increasing international trade *surpluses* for the United States that exceed the total for all agricultural products (*Wall Street Journal,* 1993; 1995). Worldwide, travel and tourism revenues were $2.9 trillion in 1993 (Miller, 1993).

The value of tourism, along with the contribution of beaches to the economy, is not lost on America's economic competitors. Germany, Japan, and Spain far outspend the United States on beach and coastal protection projects, even though their coastlines are much shorter (Kelletat, 1992; Marine Facilities Panel, 1991; Ministerio de Obras Publicas y Transportes, n.d.).

In the past, beach nourishment projects have primarily involved the restoration of beaches for recreation in regions that enjoyed large tourist populations. Such restoration has demonstrated outstanding benefit-cost ratios. The Miami Beach example illustrates both the problem and the benefits. Miami Beach had virtually no beach in the 1970s. As a result, tourist facilities had deteriorated and tourism was desultory. Rejuvenation of the beaches in the late 1970s and opening the beaches to the public produced a remarkable public response. Lifeguard counts and aerial surveys showed that beach use increased from eight million visitors in 1978 to twenty-one million in 1983 (*Wall Street Journal,* 1993). In 1995, more than two million foreign tourists visited Miami Beach, and spent over $2 billion (*World Alamanac,* 1994). Annual foreign revenue alone is about 40 times the $52 million cost of this beach nourishment project. The project has lasted 18 years, with a capitalized cost of about $3 million per year. Every dollar spent on nourishing the beach returns $700 in foreign revenue.

Beaches have been called "rivers of sand." Sand supplied by rivers and erosion of coastal rock and sorted by wave action slowly moves along a coast as ocean waves, approaching from an angle, suspend and move sand grains. Storm waves, however, attack beaches and often move sand offshore. A reduction in the supply of sand, such as that caused by damming contributing streams, storm waves, or the placement of an obstruction to the alongshore movement of sand, such as a jetty, will deplete a beach. Restoration may consist of moving sand to a beach from offshore deposits, providing sand from onshore sources, constructing control structures, or a combination of these means. As practiced for flood damage reduction, navigation, and other kinds of environmental restoration, evaluation of the costs of maintaining a beach relative to its benefits will determine the feasibility of a beach nourishment project.

As is the case for other kinds of Corps projects, not all proposed beach nourishment projects are feasible or desirable. Advocates of marsh restoration along the Louisiana coast have proposed restoration of deteriorating barrier islands offshore, for example, and the U.S. Geological Survey has identified a source of sand (Ship Shoal) further offshore that might be used for this purpose. The barrier islands are composed of sand from historic deltas and are no longer supplied with sand. That lack of supply, erosion by waves, and the continuing subsidence of the delta contribute to the deterioration of the islands. Restoration would require additions of sand in perpetuity that, combined with the subsidence of the marshes and lack of a supply of fine sediments to maintain their elevation, detracts from the feasibility of this proposed project. Where there are clear environmental, human, and economic benefits, however, beach nourishment may clearly meet the criteria of the *P&G*.

REFERENCES

Houston, J. R 1995. Beach nourishment Pp. 21-24 Nicholas Kraus (ed.) in Coastal Forum, Shore & Beach. Vicksburg, Miss.: Coastal and Hydraulics Laboratory.

Kelletat, D. 1992. Coastal erosion and protection measures at the German North Sea coast J. Coastal Research 8(3):699-711.

Marine Facilities Panel. 1991. U.S. Japan Wind and Seismic Effects Panel, 17th Joint Meeting, Tokyo.

Miller, M. L. 1993. The rise of coastal and marine tourism. Ocean and Coastal Management 20:181-199.

Ministerio de Obras Publicas y Transportes. N.d. Recuperando la costa. Serie Monografias. Madrid: Centro de Publicaciones.

USA Today. 1993. More plan vacations this year. March 17.

Wall Street Journal. April 2, 1993. Quiet boom, U.S. service exports are growing rapidly but almost unnoticed. A1.

Wall Street Journal. March 1, 1995. Travel, tourism will produce 10.5% of U.S. output this year. A8.

Wiegel, R. L. 1992. Dade County, Florida, beach nourishment and hurricane surge study. Shore and Beach 60(4):2-26.

World Almanac. 1994. Mahwah, N. J.: Funk & Wagnalls.

Appendix E

Biographical Information

DAVID H. MOREAU **(CHAIR)** has been a professor in the Departments of City and Regional Planning and Environmental Sciences and Engineering at the University of North Carolina since 1976. Until recently, he was the director of the university's Water Resources Research Institute. He received a B.S. in civil engineering from Mississippi State University, an M.S. in civil engineering from North Carolina State University, and an M.S. in engineering and a Ph.D. in water resources from Harvard University. Dr. Moreau has been active in water resources planning at the state, local, and federal levels. He chairs two commissions for North Carolina dealing with sedimentation control and environmental management (since 1991), and he chaired a governor's blue-ribbon panel on environmental indicators (1989-1990). He has been the executive secretary of the Urban Water Consortium of North Carolina since 1985. Dr. Moreau has published on a variety of topics on the planning and financing of water resources. He is a member of the National Research Council Committee on USGS Water Resources Research.

FRED P. BOSSELMAN is professor of law, Chicago-Kent College of Law. His major area of research is land use planning. He earned his B.A. from the University of Colorado, Boulder, and his J.D. from Harvard Law School. He is a member of the board of advisers of the American Law Institute's Restatement of Property and the board of director's of the Sonoran Institutes, on the editorial boards of the *Land Use and Environmental Law Reports, the Practical Real Estate Lawyer*, and the *Land Use Law and Zoning Digest*. He is cochair of the annual Land Use Institute sponsored by the ALI-ABA Committee on Continuing Legal Education. He is past president of the American Planning Association, past assistant chair of the National Policy Council of the Urban Land Institute, and was a member of the board of directors of the National Audubon Society and the American Society of Planning Officials. He was a member of the National Research Council's Committee on Characteristics and Boundaries of Wetlands.

RICHARD T. CARSON JR. is professor of economics at the University of California, San Diego, research director for international environmental policy at the University of California's Institute for Global Conflict and Cooperation, and a senior fellow at the San Diego Supercomputer Center. Dr. Carson received a Ph.D. in resource economics from the University of California, Berkeley, in 1985. He has extensive experience in the assessment of the benefits and costs of environmental programs and has served as principal investigator for several major natural resource

damage assessments, including the Exxon *Valdez* oil spill. Dr. Carson previously served on the National Research Council's Committee on Oil Spill Research and Development.

JEANNE NIENABER CLARKE is a professor of political science at the University of Arizona and an adjunct professor in the School of Renewable Natural Resources. She received her Ph.D. from the University of California, Berkeley, in 1973. Professor Clarke has been a consultant to several federal and state agencies, and she is the author of four books and a number of articles on environmental policy.

LEO M. EISEL is president of McLaughlin Water Engineers in Denver. He received his Ph.D. in engineering from Harvard University in 1970. From 1971 to 1973, he was a staff scientist with the Environmental Defense Fund in New York. He later became director of the Illinois Division of Water Resources, and from 1977 to 1980 he was the director of the U.S. Water Resources Council. Dr. Eisel was a member of the Water Science and Technology Board and a member of the Committee to Review the Metropolitan Washington Area Water Supply Study, the Committee on Flood Control Alternatives in the American River Basin, and the Committee on Western Water Management. Dr. Eisel is broadly experienced in water supply and planning, flood control, and hydrologic engineering.

WILFORD R. GARDNER is dean emeritus at the College of Natural Resources, University of California at Berkeley. He was a physicist at the U.S. Department of Agriculture in Riverside, California, and a faculty member at the University of Wisconsin. He was also with the Department of Soils, Water, and Engineering at the University of Arizona, Tucson. Presently, he is an adjunct professor at Utah State University. He has been a National Science Foundation senior fellow at Cambridge University and a Fulbright lecturer, University of Ghent. He received a Ph.D. in physics from Iowa State College in 1953. His research has involved measurement of soil moisture by neutron scattering, soil physics, movement of fluids in porous media, soil-water plant relations, soil salinity, plant biophysics, and environmental physics. A member of the National Academy of Sciences, Dr. Gardner chaired the National Research Council's Committee on the Future of Irrigation in the Face of Competing Demands and is a former member of the Water Science and Technology Board.

RICHARD F. GORINI is executive vice president and chief operating officer of the J. Simmons Group in Houston. He holds a bachelors degree in architecture and urban planning from the University of Washington in Seattle. He was also the environmental affairs manager for the Port of Houston Authority and continues to serve in the same capacity under contract to the port, which includes the development and adoption of a revised long-term disposal plan for the Bayport Ship Channel. Since 1988 he has managed environmental and health and safety compliance at the Port of Houston. He is currently the chairman of the American Association of Port Authorities' Committee on Harbors, Navigation, and Environment. He has been involved with planning and implementation of large

(multimillion dollar) port facility infrastructure and environmental projects. His experience in planning and development of water resources projects at large and small ports spans more than twenty years.

CONSTANCE E. HUNT is the director of Freshwater Ecosystem Conservation in the World Wildlife Fund's U.S. program. She is involved in restoration and conservation in the Mississippi River basin, South Florida, and the southeastern United States. She is also involved in national water resources policy issues and international river conservation efforts. Previously, she coordinated interagency projects on wetland evaluations and delineations, permit processing, and environmental impact analysis while on the staff of the U.S. Environmental Protection Agency and the U.S. Army Corps of Engineers. She received a B.S. in wildlife biology from Arizona State University, and an M.A. in public policy from the University of Chicago.

RAY B. KRONE is professor emeritus, Department of Civil and Environmental Engineering at the University of California, Davis. He served as department chair from 1968 to 1972 and as associate dean for research of the College of Engineering from 1972 to 1988. He has provided consulting services to the Corps of Engineers Waterways Experiment Station Hydraulics Laboratory since 1960 and to the Corps' committee on tidal hydraulics since 1975, primarily in the areas of coastal and harbor engineering. His areas of expertise include environmental engineering, hydraulics, hydrology, and waterway, port, and coastal engineering. His research interests are in the areas of theoretical development and experimental verification of cohesive sediment dynamics and its application to design of facilities to control sedimentation rates. He holds a B.S. in soil science and an M.S. and Ph.D. in sanitary engineering from the University of California, Berkeley. He was chair of the National Research Council's Committee on Sedimentation Control to Reduce Maintenance Dredging of Navigational Facilities in Estuaries. Dr. Krone is a member of the National Academy of Engineering.

ANN L RILEY is the executive director of the Waterways Restoration Institute. Dr. Riley is active in the area of river management and restoration. She has extensive experience working in different aspects of government, land use planning for county governments in the Midwest, and river restoration and floodplain management for the California Department of Water Resources. She has taught courses in environmental science and floodplain management at several colleges and has been active in community organizing. She has a M.L.A. and a Ph.D. in environmental planning from the University of California, Berkeley, specializing in floodplain and watershed management, river restoration, hydrology, and water policy. She was a founder of the Urban Creeks Council of California, and the national Coalition to Restore Urban Waters. Related experience includes serving as an instructor at the U.S. Army Corps of Engineers Waterways Experiment Station and Army Corps district workshops on the design of flood control and river restoration projects. She was a member of the National Research Council's Committee on Flood Control Alternatives in the American River Basin.

RICHARD E. SPARKS is Director of the Water Resources Center at the University of Illinois in Champaign-Urbana where he is also currently a Visiting Professor in the Department of Natural Resources and Environmental Sciences. He is also Associate Director for Research of the Illinois-Indiana Sea Grant. Previously, he directed the River Research Laboratory of the Illinois Natural History Survey. Dr. Sparks's interests include the ecology of large floodplain rivers and the restoration of degraded aquatic ecosystems. He received his Ph.D. in biology from Virginia Polytechnic Institute and State University in 1971. He was a member of the National Research Council's Committee on the Restoration of Aquatic Ecosystems.

BORY STEINBERG is the cofounder of Steinberg and Associates, a consulting firm established after his retirement from the U.S. Army Corps of Engineers in 1992. He consults for local governments on projects that are cost-shared with the federal government. While in the Corps he served as chief of the Project Management Division from 1989 to 1992. Before that he was chief of the Policy, Review, and Initiatives Division in the Directorate of Civil Works from 1985 to 1989. He was also chief of the Programs Division from 1980 to 1985. Dr. Steinberg received a B.S. in civil engineering from Rutgers University and an M.S. in public financial management and budgeting and a doctorate in public administration from The George Washington University. He is a member of Army Engineer Association, the Society of American Military Engineers, and the Association of the U.S. Army.

DOUGLAS C. WOOLLEY is a professor of economics at Radford University. From 1984 to 1995, he was a consultant to the Office of the Assistant Secretary of the Army for Civil Works where he reviewed the Corps' operation and maintenance budget that was sent for OMB approval. He also reviewed numerous civil works project and rehabilitation reports. He earned a B.A., an MA, and a Ph.D. in economics from the University of Connecticut. His areas of interest are public finance, implications of cost sharing, comparative systems and planning, microeconomics, and international institutions.

STAFF

JEFFREY W. JACOBS is a staff officer with the National Research Council's Water Science and Technology Board and served as this committee's study director. Dr. Jacobs's research interests include institutional and policy arrangements for water resources management and international cooperation in water development. He has studied these issues extensively in the Mekong River basin of Southeast Asia and has also conducted comparative studies in water policy in the Mekong and Mississippi River systems. Dr. Jacobs received his Ph.D. degree in geography from the University of Colorado-Boulder.

ELLENA DE GUZMAN is a senior project assistant at the National Research Council's Water Science and Technology Board. She received a B.A. from the University of the Philippines and is studying economics at the University of

Maryland University College. She had worked with a number of studies including *Issues in Potable Reuse* and *Valuing Ground Water*.