U.S. Army Corps of Engineers Water Resources Planning: A New Opportunity for Service

Coordinating Committee, Committee to Assess the U.S. Army Corps of Engineers Methods of Analysis and Peer Review for Water Resources Project Planning, National Research Council

ISBN: 0-309-53242-6, 122 pages, 6x9, (2004)

U.S. ARMY CORPS OF ENGINEERS WATER RESOURCES PLANNING

A NEW OPPORTUNITY FOR SERVICE

Coordinating Committee

Committee to Assess the U.S. Army Corps of Engineers Methods of Analysis and Peer Review for Water Resources Project Planning

Water Science and Technology Board

Ocean Studies Board

Division on Earth and Life Studies

NATIONAL RESEARCH COUNCIL
OF THE NATIONAL ACADEMIES

THE NATIONAL ACADEMIES PRESS
Washington, D.C.
www.nap.edu

THE NATIONAL ACADEMIES PRESS 500 Fifth Street, N.W. Washington, DC 20001

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Support for this project was provided by the U.S. Army Corps of Engineers under contract no. DACW72-01-C-0001. 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 the project.

International Standard Book Number 0-309-09222-1 (Book)
International Standard Book Number 0-309-53242-6 (PDF)

Additional copies of this report are available from the National Academies Press, 500 Fifth Street, N.W. Lockbox 285, Washington, DC 20055; (800) 624-6242 or (202) 334-3313 (in the Washington metropolitan area); Internet, http://www.nap.edu.

Printed in the United States of America.

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COMMITTEE TO ASSESS THE U.S. ARMY CORPS OF ENGINEERS METHODS OF ANALYSIS AND PEER REVIEW FOR WATER RESOURCES PROJECT PLANNING

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Foreword

In the early 1800s the U.S. Congress first asked the U.S. Army Corps of Engineers (which was created in 1775) to improve navigation on our waterways. From that beginning, the Corps began a program of public works that has reshaped virtually all of the nation's river basins and coastal areas. Today we share in the benefits of those works: a reliable water transportation network, harbors that help link our economy to global markets, previously flood-prone land that is productive for urban and agricultural uses, hydroelectric power, and widely used recreational facilities.

Now, at the beginning of the twenty-first century, the Corps' program is under intense scrutiny. Traditional constituencies press the Corps to complete projects that have been planned for many years and campaign for new projects to serve traditional flood control and navigation purposes. At the same time, environmental and taxpayer groups express concerns about these projects in Congress and in the courts. Some of these groups have exposed technical errors in analyses that have been used to justify projects. For these critics, the Corps' water project development program must be reformed and the budget reduced or redirected.

Some of these same groups are pressing the administration, Congress, and the agency itself toward a new Corps mission, broadly described as environmental restoration. However, the concept of restoration awaits more precise definition, and the science of ecosystem restoration is in its infancy. Nevertheless, it is clear that restoration is a call for water resources management that accommodates and benefits from, rather than controls, annual and multiyear variability in the patterns and timing of river flows and the extremes of flood and drought.

Meanwhile, the Corps is affected by a general trend in all federal agencies toward smaller budgets and staffs. As demands for reform mount, the Corps' current staffing and organization may have to be reconfigured to provide improved and more credible planning reports.

As a result of this national debate over the Corps' programs and the quality of its planning studies, the U.S. Congress in Section 216 of the

2000 Water Resources Development Act, requested that the National Academies conduct a study of procedures for reviewing the Corps' planning studies. In addition, Congress requested a review of the "methods of analysis" used in Corps water resources planning.

In response to this request, the Water Science and Technology Board of the National Academies' National Research Council (NRC), in collaboration with the NRC's Ocean Studies Board, appointed four study panels to assess (1) peer review, (2) planning methods, (3) river basin and coastal systems planning, and (4) resource stewardship and adaptive management, along with a coordinating committee to follow these panels' progress and to write a synthesis report.

Our study panels and coordinating committee held several meetings over the course of the study period beginning in 2001. We spoke with dozens of Corps of Engineers personnel, visited several Corps projects, and heard from different groups with interests in Corps projects. We came away with an appreciation for the dedication of Corps personnel and the complications and challenges they face in trying to be responsive to local project sponsors and the nation's taxpayers.

This is not the first study of the Corps by the National Academies. However, past studies were often focused on specific projects or on particular planning aspects. The reports in this series address the agency's programs in a wider context. Because we appreciate the importance of the U.S. Congress and the sitting administration in directing Corps programs, many of our recommendations are directed to them.

The Corps has a long history of serving the nation and is one of our oldest and most recognized federal agencies, but it is today at an important crossroads. The nation, through the administration and Congress, must help the agency chart its way for the next century.

Leonard Shabman
Chair, Coordinating Committee

Preface

The U.S. Army Corps of Engineers has planned for and built many of the dams, levees, and channels that today control the flow of the nation's rivers and that maintain navigable depths for its ports and harbors. Today, inland and deep-draft navigation contributes to the U.S. and international economies. Projects that mitigate flood flows and coastal storm surges allow human activity in areas that were once uninhabitable. Corps projects generate hydroelectric power, provide water supply storage for rural and urban areas, and support extensive water-based and coastal recreation opportunities. In the past three decades, the Corps has included environmental protection and aquatic ecosystem restoration objectives in its water project planning and development program. There is widespread recognition and appreciation of the benefits provided by Corps of Engineers programs. However, at the turn of twenty-first century the Corps finds itself with a shrinking budget and in the midst of numerous water planning and management controversies, even as many members of the public and in the Congress continue to hold the agency and its programs in high regard.

In Section 216 of the Water Resources Development Act of 2000, the U.S. Congress asked The National Academies to review Corps planning and project review practices (the Foreword to this report explains the overall structure of the "216 studies"). This report recommends a new planning authority that will allow the Corps to better meet emerging national water management challenges. This authority, if executed according to this report's recommendations, will help ensure that operations of the engineering works along the nation's rivers and coasts are integrated with new project investments and are responsive to emerging demands on the nation's aquatic environment. Planning in accord with this authority should help streamline decision making processes that are today often bound with conflict.

In developing this report, the coordinating committee benefited from participation in the deliberations of the panels on Peer Review, Planning

Methods, River Basin and Coastal Systems Planning, and Adaptive Management. We especially thank the study panel chairs, who also served on the coordinating committee and who kept us apprised of the status of each panel's progress: Gregory Baecher, Donald Boesch, James Mitchell, and Peter Wilcock. Larry Roesner of Colorado State University served as chair of the River Basin and Coastal Systems Planning Panel during the early phases of the study and provided several important insights to the coordinating committee's work. Chapter 1 of this report is a summary of the four panel reports.

We are grateful to the many individuals who shared their time and insights with this committee. From the administration, Fred Caver, Deputy Director of Civil Works, U.S. Army Corps of Engineers, Dominic Izzo, former Principal Deputy Assistant Secretary of the Army for Civil Works, and Rick Mertens of the Water and Power Branch, Office of Management and Budget made helpful presentations. John Anderson and Art Chan of the House Committee on Transportation and Infrastructure and Ben Grumbles of the House Committee on Science provided congressional staff perspectives on the scope and purpose of the 216 studies. We were also honored by the opportunity to meet with U.S. Representative Wayne Gilchrest (D-MD). General Vald Heiberg, former Chief of Engineers, presented a useful historical perspective on the Corps program. General Robert Griffin, Director of Civil Works and James Johnson, former Chief of Planning, U.S. Army Corps of Engineers gave their time generously in speculating honestly and openly on the challenges now facing the agency. William Werick, of the Corps Institute for Water Resources, in partnership with Eldon James of the Rappahannock River (Virginia) Basin Commission, provided an informative tutorial on the Corps' Shared Vision Modeling package.

The coordinating committee acknowledges the National Research Council's Water Science and Technology Board (WSTB) staff for its steadfast effort in organizing the committee's activities during and between meetings throughout the study process. Their assistance has been both tireless and encouraging. In particular, the willingness of Jeffrey Jacobs, senior staff officer, to debate and challenge the arguments being made and then to edit drafts with great care made it possible for the committee to prepare a concisely-written, substantive report. Ellen de Guzman, research associate at the WSTB, expertly attended to administrative details and also assisted with editorial, referencing, and graphics needs. The advice and counsel of Stephen Parker, director of the Board, helped keep all the 216 panels focused on their individual tasks. We also thank the staff from the Ocean Studies Board—especially

Dan Walker—who oversaw the Panel on River Basins and Coastal Systems. Our thanks also go to Patricia McAdams, who provided able assistance and a fresh perspective in helping to prepare the summary of the panel reports.

This report was reviewed in draft form by individuals chosen for diversity of 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 institution in making its 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 review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We thank the following for their reviews of the report: Lillian Borrone, Port Authority of New York and New Jersey (retired); Robert Frosch, Harvard University; Thomas Graff, Environmental Defense; Henry Hatch, U.S. Army Corps of Engineers (retired); Walter Lynn, Cornell University; Robert Perciasepe, National Aududon Society; Peter Rogers, Harvard University, and; James Wescoat, University of Illinois. Although these reviewers provided many constructive comments and suggestions, they were not asked to endorse the conclusions or the recommendations, nor did they see the final draft of the report before its release. The review of this report was monitored by Richard Conway, Union Carbide (retired). Dr. Conway was appointed by the National Research council and was responsible for ensuring that an independent examination of the report was carefully carried out in accordance with NRC institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the NRC.

Leonard A. Shabman
Chair

Contents

EXECUTIVE SUMMARY 1

1 OVERVIEW OF INDIVIDUAL PANEL REPORTS 11
Review Procedures for Project Planning 14
Methods of Planning and Analysis 18
River Basin and Coastal Systems Planning, ... 20
Adaptive Management 23
Summary and Prospects 26

2 CONTEMPORARY CONTEXT OF NATIONAL WATER PLANNING 28
The National Academies' 216 Studies 28
Recurrent Themes 29
Portfolio Planning: New Realities and Opportunities 32
Report Organization 33

3 TRENDS AND MILESTONES IN CORPS HISTORY 34
Origins of the Corps 34
Water Resources Planning 36
Contemporary Challenges 41

4 THE CORPS PLANNING PROCESS: A NEW OPPORTUNITY 48
Introduction 48
Conceptual Bases of Portfolio Planning 49
Executing Portfolio Planning 56
A New Planning Approach and Authority 62
Summary 65

5 SUPPORTING PORTFOLIO PLANNING 67
Enhancing Planning Capabilities and Report Quality 67
A New Setting for Decision Making 75

Streamlining Water Resources Decision Making 78

6 EPILOGUE 84

REFERENCES 86

APPENDIXES

A Water Resources Development Act 2000 93
B Committee Meetings and Presenters at the Committee's Information Gathering Meetings 96
C Rosters 99
D Biographical Information of Coordinating Committee and Staff 104

Executive Summary

For nearly 200 years the U.S. Army Corps of Engineers has constructed, operated, and maintained many of the nation's dams, levees, and navigation channels. The Corps has a long history and many accomplishments in its traditional programs that have provided benefits in the form of flood control, coastal protection, supporting inland and port navigation, water supply, hydroelectric power, and recreation. In the past three decades, the Corps has sought to broaden its water program in response to environmental concerns and legislation, and today the agency lists environmental protection and aquatic ecosystem restoration as among its principal missions. The most publicized of its restoration efforts has been in the Florida Everglades; however, many other smaller and less publicized efforts are currently under way. There are some concerns that the current Corps planning and construction budget has not kept pace with expanding national water management needs for flood risk management, water transportation, and other purposes. At the same time, others question the wisdom of and budgetary prospects for the continuation of a traditional water project construction program. Debates about water use and funding priorities now include intense scrutiny of Corps of Engineers planning, investment, and project operations programs.

One result of this high level of scrutiny was passage of Section 216 of the Water Resources Development Act of 2000 (WRDA 2000; Section 216 is listed in Appendix A),which requested that the National Academies review Corps peer review procedures and methods of analysis. In response to this request, the National Research Council convened five study committees. Four of these panels considered different dimensions of Corps planning (Peer Review; Adaptive Management; Analytical and Planning Methods; River Basins and Coastal Systems; This report's Foreword explains the study panels in greater detail, and Chapter 1 summarizes those panel reports. The panels were collectively referred to

as the "216" study panels), and one served as an overarching "coordinating committee." Chairmen of the four study panels were all members of the coordinating committee, which facilitated discussions within and among the study panels. Each panel operated independently and in accord with National Research Council guidelines. The coordinating committee also issued its own report, which was subjected to standard National Research Council procedures. In doing so, it considered the draft reports from the panels (in the case of the Panel on Peer Review Procedures, its final report was used; see NRC, 2002b), as well as discussions among panels, panel chairs, and other coordinating committee members. This report from the coordinating committee is in accord with its statement of task, which requested that the committee "produce a synthesis document that includes the panel's findings and recommendations and provides advice on implementation of the panels' recommendations" as well as "identify overarching themes, issues, or recommendations that emerge from the panels' studies, including possible future roles for the Corps in sustainable management of coastal and inland waters in the United States" (the coordinating committee's full statement of task is listed in Chapter 1). The Corps of Engineers water resources infrastructure is extensive (it is located in all 50 U.S. states), the agency's water projects impound some of the nation's largest reservoirs, and its operations and maintenance activities support some of the nation's great harbors and inland waterway systems. Corps infrastructure and operations, however, represent only a subset of a much larger national water resources infrastructure that includes projects from other federal agencies (e.g., the Bureau of Reclamation), state and local governments, and the private sector. This larger national water infrastructure includes dams, reservoirs, and water treatment and distribution systems. This report does not apply to all national water infrastructure, but rather focuses on the portion that is owned, operated, and maintained by the Corps of Engineers.

Following this Executive Summary, Chapter 1 summarizes and synthesizes the findings and recommendations of the other four study panels. The coordinating committee's own study is then presented in Chapters 2-6.

PORTFOLIO PLANNING

A key theme that emerged from the 216 study panels was the need for authorities, planning approaches, and guidelines that better match the

contemporary management challenges facing the Corps. In particular, many of the authorities and much of the planning guidance were enacted when federal water infrastructure investment was a higher priority and when there were significant opportunities for constructing civil works projects on large interstate rivers. These conditions have changed, however, and today the Corps is in a situation in which it must maintain and operate an extensive water resources infrastructure to serve both traditional purposes and a new restoration mission, while the prospects for constructing new civil works structures have diminished. This contemporary setting, recognized in the reports from the 216 study panels, suggests a need for some reorientation of emphasis within the Corps of Engineers civil works program for water resources planning.

The Corps has constructed, and in some cases operates and maintains, a large share of the nation's physical water management infrastructure of dams, reservoirs, locks, levees, and port and inland navigation channels. Construction spending, however, has declined over the past three decades, while the backlog of authorized (but unfunded) projects has grown. The near-term future thus appears to be one of increasing importance of and emphasis on maintaining, rehabilitating, and better operating existing infrastructure, with a reduced emphasis on and limited prospects for constructing new projects for flood control and navigation purposes. A stronger emphasis on more efficient operations of existing infrastructure will entail significant demands on the federal budget, given the importance of ensuring the continued utility and viability of these substantial past investments. These investments will require careful attention for another reason: Corps projects control the hydrologic and geomorphic processes in most of the nation's large rivers and along vast stretches of coastline.

Public support for individual projects to serve traditional mission areas remains, but today there are also calls to reallocate storage and flows in order to better serve a broader set of users and sectors (including recreation and environmental considerations). One example of this reallocation would be releasing water in order to restore some degree of preregulation flows and processes that were purposely disrupted by the original projects. Another example may be increasing the use of existing storage for municipal and industrial water supply, especially in watersheds where Corps projects occupy potential storage locations. Limited budgets and shifting views and knowledge of water management needs have spawned long-standing debates about future roles and responsibilities of the Corps. Over the past few decades, federal legislation, executive orders, and other directives that guide and constrain Corps decision

making have been enacted. Most parties agree with the need for continued management of flood and storm risks, and for the need to maintain some inland navigation and port systems. However, as Congress' request for this set of studies from The National Academies demonstrates, the justification for new water projects is questioned by many. Furthermore, the means by which the Corps justifies its maintenance, operation, and structural modifications of existing projects continue to be carefully scrutinized.

In recognition of these trends, this report focuses on a central organizing principle: in the near term, the Corps should center its planning activities on "portfolio planning." The term "portfolio" is used in the Corps' own planning documents, and its meaning is extended herein to consider both the water and the related land resources of the nation's rivers and coastal areas (natural capital), as well as the physical water management infrastructure in these river and coastal systems. The term "planning" includes analytical approaches and decision-making processes that govern investment and management strategies. Portfolio planning does not mean that there is no longer a need for new investment, but it does mean evaluating new investments in the context of the condition and operations of existing physical infrastructure. Portfolio planning does not mean that the Corps program will no longer serve traditional navigation and flood risk management needs, but it does mean that these needs can no longer primarily determine how past project investments are operated and new project investments evaluated.

The Corps has been experiencing reductions in professional staff and budget, along with an imperative to emphasize its military mission and its homeland security responsibilities. Yet competent management of the federal water infrastructure demands technical competence. If the Corps cannot provide its traditional technical services to the nation, another way to secure these capabilities will have to be found. The Corps (or any agency) cannot unilaterally ensure this capability. Executive and congressional actions are necessary, as well. So that it can fulfill its portfolio planning responsibilities, this report offers recommendations to provide the Corps authority to do so and to clarify the analytical concepts that will promote portfolio planning.

Recommendations 1-3 (as listed below) are presented and further discussed in Chapter 4, while recommendations 4-11 (also listed below) are presented and discussed in Chapter 5.

Clarifying the Ecosystem Restoration Mission

The Corps' traditional program areas of flood control and navigation were broadened in the 1990s when Congress requested the Corps to also pursue ecological restoration as a mission area. Details regarding the scope and purposes of the Corps' roles within ecosystem restoration, however, are not clearly defined. For example, it is not clear whether the Corps' mission in ecosystem restoration projects should be to focus solely on hydrology and water system operations, or if the Corps should also be involved in duties such as reintroducing species. Increasing scientific and public interest in the restoration of aquatic ecosystems offers an opportunity to clarify the Corps' restoration mission. The Corps is currently involved in a variety of activities focused on restoring some degree of pre-settlement hydrologic and geomorphic processes. It follows that formulating and evaluating alternatives focused on hydrologic and geomorphic components within aquatic ecosystem restoration efforts are appropriate roles for the Corps. This should, in turn, help other federal agencies, with whom the Corps cooperates in restoration projects and programs, focus on other important restoration program elements such as habitat preservation, reintroduction of species, and pollution control. A focus on restoring hydrologic and geomorphic processes will not exhaust the scope of the Corps' environmental program because the agency is also obliged to mitigate project environmental impacts. A beneficial use of dredged material, for example, may be used to create wetlands that can become wildlife habitat. In any case, clarification of the Corps' roles within ecosystem restoration will enhance its efforts and expenditures in executing a portfolio planning mission.

1. The Corps' primary environmental mission should be to restore hydrologic and geomorphic processes in large river and coastal systems.

Expanding Economic Analysis for Portfolio Planning

The benefit-cost (national economic development, or NED) analysis that underpins Corps of Engineers planning studies rests on principles documented in the "Principles" section of the federal *Principles and Guidelines (P&G)*. The economic analysis principles included in current guidance should continue to be the foundation of NED analysis. With regard to the Corps' ecosystem restoration projects, and in contrast to its traditional civil works program, the Corps does not rely solely on NED

analysis for making a final recommendation of an ecosystem restoration plan, relying instead primarily on nonmonetary measures. This approach has its merits, but there are important economic issues that often are not part of current evaluation procedures.

For example, economic issues of primary importance to elected officials and citizens, such as employment, regional economies, and international commercial competitiveness, are not reflected in a NED analysis. The absence of such information, however, can cloud debates regarding the merits of and methods in Corps planning studies. In addition, although restoration studies are usually viewed in environmental terms by most interested parties, the Corps has not adequately emphasized the fact that restoration measures often yield traditional NED benefits (e.g., when wetland rehabilitation reduces flood peaks and thus provides NED flood damage reduction benefits).

2. Corps economics analyses for portfolio planning should (a) explicitly evaluate and report on how a new project, or changes in operations, may affect national and regional economies and its implications for national and international economic competitiveness; (b) explicitly evaluate and report on the magnitude and incidence of foregone benefits associated with any modifications to the current system of projects or their operations; and (c) explicitly evaluate and report on traditional categories of NED benefits that accrue from restoration measures.

A New Study Authority

The Corps currently has "continuing authorities" that allow operations of existing infrastructure to be reviewed and revised. Two commonly invoked Corps continuing authorities, for example, are from the 1970 Flood Control Act and the 1986 Water Resources Development Act. Current Corps continuing authorities, however, were not enacted in order to help reorient the agency's planning processes and priorities toward an emphasis on managing a huge existing physical infrastructure. These existing authorities are therefore insufficient for helping the Corps reorient the agency's mission to encompass portfolio planning.

3. A new study authority should be enacted and structured according to the following principles, which will help effect portfolio planning within the Corps:

a) It should focus on existing Corps-built infrastructure

(both single projects and systems) and related water and land resources in determining when operational changes, project decommissioning, or new project investments would yield economic or environmental improvements of national significance.

b) Study cost-sharing would be with federal agencies and affected states, which would cooperate with the Corps in executing management and operational changes.

c) Planning studies under this authority should reconsider the original project authorization of existing Corps water control projects and their operations.

d) Planning studies under this authority should identify at least one nonstructural alternative to current project operations that seeks more efficient use of existing investments, or that may help achieve a goal without altering the hydrologic regime (e.g., purchase of flood flowage easements to reduce flood damages).

e) Planning studies should report not only traditional NED analysis, but also the extent to which water project investment and operations may affect jobs, income, competitiveness of industries among regional economies, and international trade.

f) Recommendations that would entail modest expenditures for changes of physical infrastructure or project operations could be authorized under this study authority.

g) Recommendations that would entail significant expenditures for changes of physical infrastructure, or that would entail further study time and resources regarding potential shifts in project purposes, should require additional congressional authorization. In addition, all authorization requests for new project investments having significant budgetary requirements or having the potential for significant controversy should be evaluated under this authority's planning procedures and methods.

h) Along with environmental mitigation, alternatives should consider economic mitigation in the form of cash payments or in-kind replacement for economic services lost from significant physical or operational changes.

i) A unit at Corps Headquarters should be responsible for selecting portfolio planning studies, and for assigning priorities and responsibilities for their execution, such as a study's analytical and regulatory aspects.

EXECUTING A PORTFOLIO PLANNING AUTHORITY

The move toward a portfolio planning paradigm represents a challenge to the Corps' planning capabilities because there will be a need to plan over large areas, to accommodate differing values, and to explicitly incorporate the complexities and uncertainties of the interactions of hydrologic processes and human activities. These factors will need to be considered while recognizing the water management responsibilities of state and local governments and other federal agencies. The agency will have to keep abreast of conceptual and analytical developments. Several changes are necessary to facilitate successful portfolio planning. Among the most significant are the importance of focusing planning expertise and the need to expeditiously resolve federal interagency conflicts. Brief discussions of these two topics are presented below, followed by a summary of other recommendations to help effect successful portfolio planning.

Focusing Planning Expertise

Although the Corps clearly faces personnel and staffing pressures, the agency can make better use of available staff (especially in regard to executing a new portfolio planning authority) by ensuring that its most knowledgeable staff are given leadership responsibilities for complex and controversial portfolio planning studies. In accord with agency tradition, Corps of Engineers planning studies are conducted by agency staff from a given district office. Increasing complexities and the interdisciplinary breadth of Corps planning studies, however, combined with limits in the agency's budget, make it impractical for the Corps to employ a full suite of analysts at every district office. Moreover, personnel needs vary across studies, and planning for smaller, less expensive projects will likely require less analytical sophistication than will portfolio planning studies.

4. The Chief of Engineers should assign responsibility for conducting the agency's more complex and controversial studies to specially-chartered teams that draw upon the best expertise available within the entire agency, as well as other federal and state agencies, rather than relying solely on staff from a given district or division office.

Resolving Protracted Interagency Disputes

Many of the current water project and planning controversies in which the Corps is involved stem from laws and agency authorities that are often difficult to reconcile, and the absence of a process for formally elevating conflicts among federal agencies and stakeholders to a higher authority. Many of these conflicts cannot be resolved by technical means alone.

5. A process for reviewing and resolving conflicts that cannot be resolved through planning methods or federal interagency agreements, and that elevates conflicts over applications of economic and environmental evaluation procedures and other water management activities, should be created within an existing governmental body.

Furthering Portfolio Planning

Several other actions will promote the effective and efficient execution of the portfolio planning authority, and will enhance planning and decision making in support of all Corps programs. These actions and recommendations include the following:

6. A program of continuing regional assessments can serve as the basis for setting portfolio planning program priorities. These regional assessments, which could include comparisons of water issues between regions and longitudinal studies in select regions, should be periodically conducted in order to help identify key water resources issues of federal-level importance.

7. The Secretary of the Army should report within one year to the Congress on projected professional staffing, skill, and related budgetary needs for implementing portfolio planning.

8. Computer-aided decision making is a promising approach to helping clarify and resolve conflicts over water management priorities. A "community of practice" in computer-aided decision making that facilitates discussions between Corps staff and outside experts should be established.

9. Portfolio planning may result in disagreements among agencies, levels of government, and stakeholders, which are most appropriately resolved by the president and Congress. In such cases, a Chief's Report should include a full reporting of alternatives that

were not recommended, relevant supporting analyses, and a clear explanation of the recommendation made for the most controversial decisions. In addition, recommendation of a preferred plan by the Chief of Engineers should not be compulsory.

10. Portfolio planning will be most effectively and appropriately conducted over large spatial scales and extended periods of time. Current reconnaissance study and study cost share guidelines, however, may inhibit studies that will entail these more comprehensive perspectives. A review of the applicability of reconnaissance study cost limitations, of the importance of distinguishing between the reconnaissance and feasibility study stages, and possible modifications of study cost-sharing requirements, should thus be undertaken, with subsequent adjustments made to advance portfolio planning.

11. The presence of "backlogged" Corps projects—those that have received congressional authorization but have not yet received financial appropriations—could limit the utility of portfolio planning. When assessing potential new projects and alternative operations of existing projects, this backlog can confuse the setting of priorities that will derive from execution of the new study authority. Congress should develop a process for inventorying and ranking the funding priority of authorized, but unfunded, Corps projects that constitute the current project backlog. This process of prioritization can both inform and benefit from portfolio planning.

1

Overview of Individual Panel Reports

U.S. Army engineers trace their history to Revolutionary War battlefields. Congress established the U.S. Army Corps of Engineers in 1802 during the presidency of Thomas Jefferson. It was the era of the Louisiana Purchase and the Lewis and Clark expedition. By 1824, the U.S. population had grown to almost 10 million people—about the size of New York City today. It was in that year that Congress first charged the Corps with improving navigation on the Ohio and Mississippi Rivers. These directives launched the Corps into the first of thousands of projects that reshaped virtually all of the nation's river basins and coastal areas. In recent decades, budgetary constraints, additional laws, and shifting social preferences have affected the agency's water resources program. Traditional constituencies press the agency to complete projects that have been authorized for years, and campaign for new projects to serve flood control and navigation purposes. Simultaneously, environmental and taxpayer groups express concerns about these projects in Congress and in the courts, pressing for reformation and budget cuts.

In connection with national-level debates over the Corps' programs and planning studies, in Section 216 of the Water Resources Development Act of 2000, the U.S. Congress requested that the National Academies conduct a study of the Corps' methods of project review and analytical methods. In response to this request, the Water Science and Technology Board of the National Research Council (NRC), in collaboration with the NRC's Ocean Studies Board, appointed four study panels on (1) peer review; (2) methods of planning and analysis, (3) river basin and coastal systems planning, and (4) adaptive management— and a coordinating committee to follow these panels' progress and write a synthesis report. This chapter of the coordinating committee report summarizes findings and recommendations of the four panel reports.

Several themes emerged from two or more of the 216 panel reports. These themes included the importance of increased flexibility of management and planning regimes; more active roles for the administration,

Congress, and the states; Corps internal organizational structures and arrangements; post-construction monitoring of projects; and changes in planning guidance. A review of federal and Corps planning guidelines identified several procedures that might be revised to better accommodate social and ecologically sustainable considerations. Among the problems identified in some of these reports was that the Corps is hampered by sometimes conflicting legislation, a lack of clear policy directives, and the lack of a central body to coordinate its mission and programs with other federal agencies with water management responsibilities. A broad observation was that the development and execution of Corps planning methods are closely entwined with broader, federal-level organization policy structures and processes that frame and guide those methods, and that improvements in planning methods should thus be linked with appropriate changes in larger, policy-relevant structures.

Other overarching themes identified by one or more of the study panels included:

- A need for an increased emphasis on and resources for post-construction evaluations, or *ex post* studies, at Corps projects. This increased emphasis will require support from the administration and the Congress;
- The value of more thorough analyses during the early stages of Corps planning studies (the so-called "reconnaissance phase"). Recommendations on this topic included the need for more resources for reconnaissance studies, the need to more actively include stakeholders during study reconnaissance, the prospects for independent review in a planning study's early stages, and the possibility of eliminating the current distinction between initial reconnaissance and subsequent "feasibility" studies;
- The need to carefully consider the implications of study "cost sharing" (the contribution of a local sponsor to a Corps civil works project). All panels discussed cost sharing for Corps studies, and generally noted that increased cost sharing requirements resulted in a complex mix of positive and negative outcomes. Further investigations into and advice on this topic were beyond the scope and resources of the study panels, but it was generally felt that Congress and the Corps should carefully investigate cost sharing's implications.
- A need for a greater degree of centralization and streamlining of Corps planning programs and studies. The Corps is a highly decentralized organization, with dozens of district-level offices spread across the

United States. This arrangement may be inadequate for the Corps' more complex and larger planning studies, and it may inhibit the sharing of information, and subsequent learning from experience, throughout the agency. It was also noted that Corps planning studies are often extremely lengthy and do not always clearly convey key assumptions, methods, costs and benefits, environmental problems and concerns, and primary stakeholder differences and conflicts. A small, summary document within every Corps planning study that reviews key issues and thus makes them more understandable by stakeholders, other agencies, and congressional staff should thus be included in every Corps planning study.

- One observation made by most of the study panels was that the Corps and other U.S. federal water resources management agencies today rely on a diverse collection of policies, regulations, and case law that comprise the *de facto* national water policy. The Corps is immersed in mandates, being governed by no fewer than 219 public laws, some of which date back to the late 1800s. Many of these laws have only limited relevance to contemporary water resources needs and, in some cases, are not fully consistent with more recent laws. Because the Corps operates under a body of laws that contains some internal inconsistencies, their directives are often confusing and inconsistent. The situation occasionally results in confusion, or worse, conflict, between federal agencies. There is a need for better coordination among federal agencies with water resources-related responsibilities, as well as a better means for addressing inter-agency conflicts. Inter-agency coordination in itself represents a challenge, but it is made more difficult by an incoherent framework of laws, guidance, and other directives. All the study panels discussed these issues, with their ultimate recommendations sometimes presented in slightly different ways. Recommendations included, for example, the specific assignment of inter-agency coordination responsibilities to a governmental body (Panel on Analytical and Planning Methods), and for clarification from the administration and Congress in sorting out inconsistencies within the *de facto* body of national water policy (Panels on River Basins and Coastal Systems and Adaptive Management). The coordinating committee recommended that in order to address planning controversies that executing agencies like the Corps and others could not legitimately resolve by themselves, that a process for elevating those conflicts to higher authorities within an existing governmental body be created.
- Another important theme within the studies was the need to create more flexible management regimes for the Corps. These discussions

manifested themselves as comments regarding cost sharing, available resources, *ex post* studies and other post-construction evaluations, relations with federal agencies and other stakeholders, and planning guidance. The topic of a new planning and management strategy, consistent with current budgetary, infrastructure, and social realities, is discussed extensively in this report and is framed with the term "portfolio planning." The coordinating committee defined this planning metaphor as one that emphasizes better management of existing infrastructure, with a focus on those natural resources historically managed by the Corps—hydrologic (water) and geomorphic (sediment) processes. Portfolio planning allows for the construction of new infrastructure; even though new, future construction will occur, budgetary constraints and trends suggest that it will be at a slower pace. Portfolio planning recognizes the magnitude of past investments and the need for continued resources to ensure their vitality and operational utility. It recognizes the importance and challenge of balancing the needs of traditional flood control and navigation sectors with emerging social preferences such as ecosystem restoration. An emphasis on portfolio planning will require guidance from the administration and Congress to clarify the Corps' ecosystem restoration mission, to broaden and streamline economic analyses within planning studies, and to provide the Corps a new study authority that will help reorient the agency's planning emphases to help provide better and more relevant services to the nation.

Congress was particularly interested in the process by which the Corps reviews its planning studies. This report was granted some priority within the "216 studies," and in 2002, findings and recommendations from that study panel were presented in *Review Procedures for Water Resources Project Planning* (NRC, 2002b).

REVIEW PROCEDURES FOR PROJECT PLANNING

Increased concerns regarding environmental impacts, economic evaluations, political pressures, and shifting water management paradigms have led to increased criticism of Corps of Engineers planning studies and projects. The complexity and sophistication today within large water resources planning studies suggests that some degree of independent review by technical experts is valuable. There is a strong and direct correlation between the independence of reviewers—in terms of both knowledge and association with a project and organizational affilia-

tion—and the credibility, both real and perceived, of external review. A carefully designed review process for Corps planning studies can help increase credibility, deflect criticisms, and help ensure planning studies of the highest quality. An administrative group to coordinate planning studies within the Corps should therefore be created.

Internal and External Review

Independent, external experts should review the Corps' more expensive, complex, and controversial planning studies. These independent review panels should not include Corps staff, nor should panelists be selected by the Corps. These independent panels should be overseen by an organization independent of the Corps. Examples of such independent organizations include professional science and engineering societies, the National Academy of Public Administration, a specially constituted committee of the National Research Council, or an independent federal oversight group similar to the Department of Energy's Defense Nuclear Facility Safety Board. Internal reviews are appropriate for less complex and less costly planning studies, and for those that involve lower levels of risk. These internal reviews should be conducted by panels that include a balance of Corps staff and external experts.

Because the current state of scientific knowledge in the realm of water resources management is so vast, no one agency can possess the full range of engineering, ecologic, or social sciences expertise that might be required for a wide range of complicated, controversial projects. Although budget limitations may prevent the Corps from hiring experts from outside the agency to augment its expertise, independent experts would allow the agency to keep abreast of current thinking and practices across all aspects of water sciences and management. Participation of these experts will help ensure that methods employed are consistent with state-of-the-art thinking and practices.

Whatever type of review process is implemented within the Corps, the role of review panels should be to identify, evaluate, explain, and comment on key assumptions that underlie technical, economic, and environmental analysis. Panels should highlight areas of disagreement and controversies to be resolved by the administration and Congress. Panels should be given the freedom to comment on topics they deem relevant to decision makers, leaving it to the recipient of the review to decide whether those issues constitute technical or policy issues. Review panels, however, should not be requested to provide a final judgment on

whether a particular alternative from a planning study should be implemented.

Administrative Group for Project Review

Corps planning studies span a spectrum from small, relatively low-impact projects to large, complex studies that consider a range of potentially large economic and environmental impacts. The diversity of these studies requires a flexible and comprehensive review process. Effective execution of this responsibility requires a small, full-time, permanent body of professional staff—not to conduct reviews, but rather to decide the appropriate level of review. For all Corps planning studies, this body would determine whether review would be conducted externally (with all experts independent of the Corps), internally (which would include some Corps staff), or within the current review structure. This decision should be open to appeal by interested parties. To carry out these functions, Congress should direct the Corps to establish an Administrative Group for Project Review (AGPR), which should be located in either the Office of the Secretary of the Army for Civil Works or in the Office of the Chief of Engineers.

The AGPR should assist reviewers and panels in several ways by (1) helping reviewers clearly understand a study's key assumptions and methods; (2) compiling a document for each review panel that clearly summarizes and explains the content, assumptions, models, and methods contained within a planning study; (3) being available to the panel during its review to answer questions; and (4) helping review panels understand the implications of their findings. The AGPR also should serve as a liaison between review panels and appropriate federal agencies, interest groups, and the public. It should produce a document that explains the Corps' review procedures. These procedures should be flexible, amenable to change, and updated periodically. The AGPR should organize, publish, and disseminate reports authored by internal review panels (leaving publication of external reviews to a group outside the Corps).

Review Advisory Board

The AGPR would benefit by periodic, independent review of its mandate, structure, and decision-making processes. Periodic review and advice from an independent interdisciplinary group of experts—a Re-

view Advisory Board (RAB)—should be part of the agency's overall review program. This board may have to be established within a body that has a more comprehensive review mandate of Corps programs and studies. The Review Advisory Board should assess review processes to help ensure the consistency, thoroughness, and timeliness of reviews. It should also suggest changes for improving the review process. To ensure that review procedures are examined by well-qualified professionals, the functions of the Review Advisory Board may have to be part of the mandate of a body charged with more comprehensive review of Corps planning procedures.

Other Issues

Results of a review should be presented to the Chief of Engineers before the final decision is made on a planning study. The review panel's report should be a public document that appears in the water resources project planning studies submitted to Congress. To help ensure effective use of a review's results, the review's primary client—usually the Chief of Engineers—should respond in writing to each key point contained in a review. The Chief should either agree with the point and explain how it will be incorporated in the study, or rebut the comment and explain why it is being rejected.

Timing, continuity, and costs of review are key considerations. Planning studies are conducted in two phases—a reconnaissance phase and a feasibility phase—typically lasting one to two years. The point at which the review should be initiated is not always clear because much depends on a study's complexity and duration. If review was initiated early in the study however, findings and recommendations could be more easily incorporated into the feasibility study. In the case of highly controversial studies, reviews are best initiated early in the feasibility phase, or even earlier, during the reconnaissance phase. Periodic reviews conducted at various stages of planning studies may also have value, particularly in more controversial and challenging studies, some of which may require 10 years or more to complete. Reviewers should not become defenders of their recommendations, and periodically changing the composition of review panels will help guard against this concern. Further, encouraging some panelists to serve across multiple panels would help ensure a degree of consistency.

To help implement recommendations from the peer review panel report, Congress should provide the resources necessary to help the Secre-

tary of the Army reformulate and strengthen the Corps' review procedures for its water resources project planning studies.

METHODS OF PLANNING AND ANALYSIS

Some observers have suggested that the quality of Corps planning studies has declined over the past few decades. Reasons for this decline could include limited agency resources to effectively employ sophisticated analytical methods and models, increasing competition for engineering talent from the private sector, and a lack of clarity of planning objectives and policy direction. This panel reviewed Corps planning procedures as embodied within the federal *Principles and Guidelines for Water and Related Land Resources Implementation Studies ("Principles and Guidelines,"* or simply, *P&G)* and within the Corps' own *Planning Guidance Notebook*. These two documents contain the key planning concepts and methods employed in the agency's planning studies.

The Corps is hindered in its ability to define clear management directives because of inconsistencies that exist in the large body of *de facto* national water policy that guides the agency. To provide clearer direction to the Corps, the administration and the Congress, in cooperation with the states, should reconcile inconsistencies within this body.

The demise of the Water Resources council in the early 1980s resulted in the loss of a key forum for interagency collaboration on water management issues. As a result, administration-level coordination has been much less frequent, and today conflicts and loose ends abound. A body should therefore be specifically charged to coordinate water policies and activities among the administration, the Congress, the states, and federal agencies with water resources management responsibilities.

The Corps (along with three other federal agencies) is mandated to follow the planning guidelines embodied within the federal *Principles and Guidelines.* This document, authored by the federal Water Resources Council, has not been updated for over 20 years. Over this period there have been changes and advances in planning and analytical techniques, such as valuation techniques, adaptive management, and shifting views of stakeholder participation. The *Principles and Guidelines* should thus be revised to better reflect contemporary management paradigms, analytical methods, legislative directives, and social, economic, and political realities. Regardless of whether the administration chooses to revise the *Principles and Guidelines* or not, the Corps should draft a revision to its *Planning Guidance Notebook* that is consistent with

this panel's report, and propose it to the administration.

When the Flood Control Act of 1936 was signed into law, conventional wisdom of the day dictated that a proposed water resources project would be considered viable only if its projected benefits exceeded the projected costs. Today, although the principle of benefit-cost analysis is still recognized as a vital component of sound decision making, it often is no longer is considered the sole criterion regarding public policy or investment decisions because such an analysis may contain substantial uncertainties and may not adequately reflect relevant, difficult–to-measure (often qualitative) factors such as stakeholder opinions, nonmarket values, and equity considerations. Benefit-cost analysis should thus not be used as the lone decision criterion in judging whether a proposed planning or management alternative should be approved.

Corps of Engineers planning studies are conducted in two phases, a preliminary reconnaissance study and a more detailed feasibility study. Reconnaissance studies are currently limited to $100,000 and are to last no more than one year. These limits, although often reasonable for some smaller, less expensive studies, are inadequate for the Corps' more complicated studies. The resources and time allocated for Corps of Engineers reconnaissance studies should be commensurate with the scale and complexity of the water resources issues at hand.

Among the changes in Corps planning studies projects in recent years are those mandated by the Water Resources Development Act of 1986. This act altered the participation of local communities by requiring larger financial contributions from local project sponsors. On one hand, this has resulted in co-sponsors and other special interest groups being more actively involved in project design and implementation. On the other hand, it may place limits on the conduct of more comprehensive planning because study cosponsors typically have a specific alternative in mind and thus have little interest in providing resources for evaluations of, for example, how their project might affect upstream or downstream areas. According to current guidelines, the Corps cannot conduct a feasibility study without a local sponsor. The effects of cost-sharing are multiple and complex. To help better understand the implications of cost-sharing, Congress should commission a study of its positive and negative effects.

Corps planning studies are routinely hundreds of pages in length. This volume of information often makes it difficult to identify and comprehend all important assumptions, alternatives, models employed, data sets, and other factors. A summary document that identifies the primary environmental and social issues, as well as key assumptions and alterna-

tives considered and evaluated in the investigation, would facilitate better understanding among all parties involved in a planning study. This document should also identify objectives sought, benefits and costs (monetized and nonmonetized), and trade-offs. This summary should be presented with a consistent format and should be a standard component of all Corps planning studies.

Periodic monitoring of completed projects should be a routine part of project planning and management. Congress should provide resources to conduct retrospective, or *ex post*, evaluations of water projects and systems, as these types of studies are essential to improving water resources planning and management. These retrospective reviews can serve as effective means for understanding how demands from particular projects may have changed over time or how closely a project has come to meeting its stated goals. The limited number of reviews of Corps projects may represent a missed opportunity to evaluate the strength and weaknesses of planning methods and how project operations have or have not changed to meet changing conditions. The monitoring of project outcomes is also a core adaptive management principle. Post-construction assessments should include the monitoring of ecological and economic variables, as well as broader evaluations of project or program effectiveness. These types of evaluations should become standard if adaptive management is to be implemented within individual project operations and within the agency.

RIVER BASIN AND COASTAL SYSTEMS PLANNING

Over the past 30 years, the objectives sought for water projects have shifted to include an increased emphasis on environmental and recreational objectives, which has increased the complexity of water project planning. To meet these demands, the Corps is being asked to undertake integrated water project planning, adopt a watershed or regional approach, and include ecosystem perspectives in its planning processes. Integrated water resources planning is endorsed within the academic and engineering communities, and is supported by Corps policy and in statements from Corps leaders. Integrated water resource planning at the river basin and coastal system scale provides a framework within which trade-offs among competing objectives can be evaluated; multiple stressors, unintended consequences, and cumulative effects can be identified; and the true costs and benefits of a project can be examined in a context that incorporates the interests of all those with any substantial stake.

Such efforts represent a challenge not only because of the complexity of the contemporary multiobjective, multistakeholder planning environment, but also because of the complex and conflicting mix of legislation, congressional committee language, administrative rulings, and legal precedent that defines the nation's water policy. The clear policy guidance and consistent funding and authority that would support integrated planning at the scale of river basins and coastal systems does not presently exist.

When given the necessary authority and funding, the Corps has been able to carry out multistakeholder, multiobjective studies that incorporate a diverse range of economic and environmental issues over the necessary spatial and temporal scales. The lack of consistent national policy guidance and coordinated authority and funding, however, together with pressures to quickly develop water projects with well-defined local benefits, has hampered the Corps' ability to consistently plan water resources projects within a broader and integrated systems context. Furthermore, efforts to more fully integrate water resources planning across relevant spatial scales must compete with pressures to focus on local projects advocated by local interests and their congressional representatives.

Toward More Effective Integrated Water Resources Planning

Integrated water resources planning requires effective guidance on evaluating non-commensurate objectives and determining the appropriate time and space scales of the study. Corps planning guidance has not been substantially revised for 20 years and is weighted heavily toward analytical benefit-cost analyses that are more appropriate for traditional water resources projects than for complex, multi-objective water and ecosystem projects. Planning guidance should be updated to provide more balanced and complete information on conducting integrated water systems planning within river basins and coastal systems.

The Water Resources Development Act of 1986 significantly modified project planning procedures by introducing equal cost-sharing between a local sponsor and congressionally authorized Corps funding. This arrangement gives local sponsors a greater role in project selection, design, and scoping. Although this has made the Corps more responsive to local needs, it has also led to a project-by-project approach to water planning that can work against broader evaluation of water resources and ecosystem needs, with the possibility that undesired impacts or more desirable or equitable projects at a broader scale are not adequately consid-

ered. Planning studies concerned with a broader evaluation of benefits and costs are a federal interest and should be fully federally funded. To maintain local accountability and interaction, equal cost-sharing should be maintained for those portions of planning studies concerned directly with project development, including design, land acquisition, and construction. Approval of planning studies should be contingent on the judgment, informed by peer review, that an appropriate study plan of the salient social, economic, and environmental factors—at the appropriate spatial and temporal scales—has been defined, along with a cost-sharing plan that clearly identifies those portions of the study that will be federally funded.

Uncertainty is an inherent part of the management of all natural systems, and its presence is especially particularly obvious when ecological attributes are included in the list of project objectives. In the face of such uncertainty, water resource planning and management require an adaptive approach in which management actions are framed as experiments that are used, in part, to inform and enhance future decisions. In this context, it is necessary to identify key elements of the system whose monitoring will indicate the success of the project in meeting its objectives. Persistent monitoring provides the opportunity to change project features in ways that can correct for unintended or inferior results. Ongoing evaluations of project performance are critically important when dealing with increasingly complex and highly interactive systems.

Project evaluation should be a required component of all water projects and should be cost-shared with the local sponsor. Because the complexity and potential consequences will vary from project to project, current cost limits on project evaluations should be replaced with a flexible system in which the scope, tasks, standards, and costs of project planning and evaluation are determined on a case-by-case basis within a feasibility study. The decision to proceed with a project should be contingent on the judgment, subject to peer review, that the project evaluation plan is sufficient to document the achievement of project objectives, as well as identify unintended consequences and undesired cumulative effects associated with the project.

Looking Ahead

An ideal water planning environment—or even a reasonably good one—will require the support and cooperation of Congress, the executive branch, and the U.S. citizenry. Although general policy guidance man-

dating watershed, regional, and ecosystem analysis is clear and publicly supported by Corps leadership, political support for true watershed or coastal systems planning has been neither consistent nor unanimous. Changes in planning guidance and institutional procedures of the Corps can allow it to more effectively and consistently perform integrated water resources planning and environmental stewardship in a river basin and coastal systems context. Effective changes need not require wholesale—and politically controversial—changes in the Corps' organization or its relations with local clients and federal sponsors.

ADAPTIVE MANAGEMENT

The traditional operating mode of the Corps of Engineers has been to plan for and construct a new project, then identify and begin planning for the next project. There are limits to such an approach, however; for example, project goals may change over time (necessitating operational adjustments), and important feedback and lessons from project outcomes may not be adequately incorporated into revised operational regimes. Moreover, in the water resources setting at the beginning of the twenty-first century, resources and available sites for new projects are limited, and many sectors of the U.S. economy are seeking to better manage existing infrastructure (as opposed to building more and more civil works projects).

The concept of "adaptive management" gained attention during the late twentieth century as an approach that could help increase natural resources management flexibility and project and system benefits. Adaptive management calls for policies that can be adjusted as new information is gathered and discovered. It calls for the monitoring of outcomes to advance scientific understanding and to help adjust policies or operations within an iterative learning and management process. Adaptive management recognizes the biological value of natural ecosystem variability. It calls for stakeholder collaboration in a process that seeks to learn more about natural and social systems and their linkages. The true measure of adaptive management is how well it helps meet environmental, social, and economic goals, and the extent to which it increases scientific knowledge and reduces tensions among stakeholders.

Adaptive management is an evolving concept, and its implementation represents a challenge for a construction- and operations-oriented agency like the Corps of Engineers. The core principles of adaptive management emphasize uncertainty, surprise, and resilience, which run

counter to traditional engineering planning concepts of deterministic systems, precision, and model predictions. The key elements of adaptive management are the establishment of a process for reviewing and revisiting management objectives, a range of management options, monitoring and evaluating outcomes, a framework for incorporating new knowledge (e.g., economic, engineering, ecological) into management decisions, and stakeholder collaboration. Adaptive management provides a means of responding to changing conditions through revised management actions, while seeking to avoid costly or irreparable mistakes and unintended consequences. It allows for operational changes that respond to changing social preferences and new scientific information.

A word of caution with regard to adaptive management is in order, however. Despite its promise, it remains a largely untested concept, and its successful implementation will entail not only patience in working with this sophisticated concept, but also a degree of willingness among stakeholders to find some common ground. Stakeholders must at least agree on some fundamentals within adaptive management, such as the key scientific or other questions that they would like to pursue using adaptive strategies. Absent any degree of cooperation, adaptive management—which may not be appropriate in all circumstances—will not be viable.

New Emphasis in Corps' Water Project Planning and Operations

The Corps began experimenting with adaptive management approaches in the early 1990s in an effort to increase operational flexibility, restore environmental benefits in some areas, and reduce conflicts. With support from its military and civilian leaders, the agency is moving forward with adaptive management in selected areas and with varying degrees of authorization and resources from Congress. At this time however, the Corps has no mandate from Congress to implement these management principles throughout the agency and in all projects that could benefit from its use. Congress should strengthen the Corps' continuing authorities to enhance the Corps' ability to monitor operations outcomes and make necessary adjustments to the relevant project.

For a number of reasons, there is a shifting, national-level emphasis from new project construction to a stronger emphasis on better management of existing infrastructure and related assets. An adaptive approach to managing this infrastructure entails proactive, science-based, collaborative water management, an approach that would require some

changes within the Corps. It also requires that the administration and Congress provide resources and additional legislative guidance and clarity to the Corps.

The Corps should implement adaptive management at different scales and in different settings, track progress, and aim to learn from successes and setbacks. There is a spectrum of possible adaptive management approaches. More "passive" programs generally focus on monitoring the results of management actions, while more "active" programs may design specific actions to test multiple models of system behavior. The Corps should consider the full spectrum of possible adaptive management approaches, and begin developing guidance regarding suitable approaches in different circumstances. Adaptive management strategies may be particularly useful in large, complex ecosystem restoration projects, which often entail high degrees of risk and uncertainty, along with multiple objectives and phases. The Corps should also promote adaptive strategies based on lessons learned from previous, smaller-scale efforts.

Although adaptive management strategies are closely linked with natural resources management projects, they can be used in other systems as well. The Corps should consider ways in which adaptive management or similar strategies could be applied to its navigation and flood risk management programs, as well as to ecological restoration.

Adaptive management programs should systematically incorporate means for stakeholder collaboration into planning and management decisions. The administration and Congress should ensure that adequate resources are provided to promote sustained, meaningful participation within adaptive management initiatives. The monitoring of physical, biological, and economic aspects of natural systems often poses substantial water resources management challenges. The ambiguities that often attend the monitoring of complex ecosystems can hinder adaptive management's cycle of action, observation, evaluation, learning, and new action. Independent expert review (discussed in the report from the peer review panel; NRC, 2002b) can identify inadequacies in modeling, monitoring, and assessment and can help resolve scientific disputes, and should therefore be a standard in adaptive management programs.

A Center for Adaptive Management

The U.S. Army Corps of Engineers is a decentralized organization, with staff disbursed in 41 district offices across the country. These local district offices conduct the planning studies that provide the analytical

groundwork for Corps projects. Although adaptive management practices must be tailored to local circumstances, district office personnel should also have a common understanding of adaptive management principles and best practices. No mechanism currently exists to facilitate comparison of adaptive management strategies and best practices from across the agency. Moreover, implementation of adaptive management requires interdisciplinary expertise.

Congress should thus establish and provide appropriate resources for a Corps of Engineers Center for Adaptive Management. This Center should provide agency-wide guidance on adaptive management concepts where none currently exists, supplying training, facilitation, and assistance in developing management schemes and monitoring designs. It also could facilitate information sharing from within and outside the Corps, including the promotion of inter-agency collaboration with other agencies that are pursuing adaptive management.

SUMMARY AND PROSPECTS

The U.S. Army Corps of Engineers is one of the nation's oldest and most recognized federal agencies, with a long history of national service. However, the Corps is experiencing challenges to its authority, its competence, and even its future existence. By recommending procedures that aim to increase the Corps' decision making flexibility, these 216 study reports may provide a small contribution toward helping the Corps move into a new national water management era. There will have to be increased emphases on post-construction monitoring and subsequent operational adjustments. This increased emphasis should reflect a clear recognition of inevitable uncertainties and surprises associated with Corps projects, as well as shifting social preferences for the benefits of civil works projects. The preliminary stages of Corps planning studies should be strengthened for more complex and costly studies; this strengthening in a study's early stages could take the form of additional resources, time, stakeholder input, and independent review. Cost-sharing has clearly had benefits for Corps planning studies and projects, but it has also had unintended and perverse consequences that may hinder progress toward more spatially integrated water resources planning. Cost-sharing should thus be reviewed and its details reconsidered. There is clearly a need for the administration, the Congress, and the states to play more active roles in defining the Corps' missions and programs. This is necessary to coordinate the Corps' efforts with other agencies, to provide

clearer direction within a complex and sometimes inconsistent body of *de facto* water policy, to provide adequate resources for the Corps to make necessary transitions and changes, and to forward to a higher authority conflicts that the Corps and other line agencies cannot legitimately resolve. Finally, there is a need for a greater flexibility of Corps management and planning regimes, which includes an increased ability to monitor post-construction outcomes and make necessary adjustments. This concept is captured in the coordinating committee's "portfolio planning" metaphor and is explained in further detail in the following chapters.

The updating of planning guidelines, and the linkage of more flexible planning and analytical procedures to broader federal-level organizational and policy changes, will allow the Corps to be better prepared to provide a third century of service to the nation. These and other overarching themes reappear in this report's subsequent chapters, which elaborate on them and which identify additional considerations for improving Corps planning procedures.

2

Contemporary Context of National Water Planning

For nearly 200 years the U.S. Army Corps of Engineers has constructed, operated, and maintained many of the nation's dams, levees, and navigation channels. These projects have controlled the flows of major rivers, deepened and stabilized navigation channels, and deepened coastal harbors. Corps projects generate hydroelectric power, provide water supply storage, support water-based and coastal recreation opportunities, and help stabilize coastlines. In the past three decades, the Corps water project planning program has broadened in response to environmental concerns and legislation, and today includes environmental protection and aquatic ecosystem restoration. The most publicized of these efforts has been its role in the Comprehensive Everglades Restoration Program; however, many other smaller and less publicized restoration activities were undertaken during the 1990s.

In reflecting on the past, present, and future of the Corps program, there are concerns that the Corps construction budget has not kept pace with expanding national water management needs in flood hazard management, water transportation, and other areas. At the same time, others question the wisdom of continuing a historical emphasis on new water project construction for traditional purposes as a focus for the agency's contribution to national water management. Debates about national management objectives and priorities and by extension, future roles of the Corps, set the context for the congressional legislation that mandated this evaluation and report on Corps planning processes.

THE NATIONAL ACADEMIES' 216 STUDIES

The Executive Office of the President, during both Democratic and Republican administrations, has criticized Corps project analyses and sought to limit the Corps' mission. Proposals from the administration, in turn, are challenged and sometimes modified by Congress. There are

divergent views among members of Congress—views which often transcend party lines—about both the quality of the Corps' analytical methods and findings and the agency's future roles. Some congressional representatives strongly support the Corps and its traditional programs and activities, while others call for fundamental changes to the agency. Some in Congress have promoted "Corps Reform" initiatives and have drafted multiple legislative reform proposals. Congress has passed none of these proposals, but one result of these congressional debates was the passage of Section 216 of the Water Resources Development Act of 2000. That section requested that the National Academy of Sciences ("The National Academies"[1]) to review the Corps' peer review procedures and methods of analysis (section 216 appears in Appendix A).

In response to that authorization, the Corps provided the resources for this study. In turn, The National Academies' Water Science and Technology Board, in collaboration with its Ocean Studies Board, appointed four study panels and a coordinating committee to review various dimensions of Corps planning guidance and decision making (additional discussion of this activity can be found in this report's Foreword and Preface, and Appendix C lists the coordinating committee and panel membership rosters). The chairs of the four panels served on the coordinating committee, and some coordinating committee members participated in various panel meetings. In addition, a plenary meeting of the coordinating committee and all four panels was held in Irvine, CA in November 2002. The coordinating committee thus prepared this report while also considering progress of the four study panels in its own deliberations (the coordinating committee's statement of task is listed in Box 2-1).

RECURRENT THEMES

The Corps of Engineers' traditional primary activity has been to construct civil works projects that control and modify hydrologic and geomorphic processes in rivers and along coastal areas, and that maintain navigation channel depths. Corps flood control, navigation, and other projects have traditionally been expected to contribute to national and regional economic growth. The Corps has constructed, and in some

[1] The National Academies consists of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The National Research Council is the operating arm of The National Academies.

BOX 2-1
Coordinating Committee Statement of Task

This study will review the U.S. Army Corps of Engineers' analytical approaches and methods for implementing water resources projects. As defined in the Water Resources and Development Act 2000, this includes projects for "navigation, flood control, hurricane and storm damage reduction, emergency streambank and shore protection, ecosystem restoration and protection, or any other water resources project carried out by the Corps."

In carrying out this study, a coordinating committee will be responsible for the overall coordination, organization, and oversight of the work of four focused panels on 1) Peer Review, 2) Planning Methods, 3) River Basin and Coastal Systems Planning, and 4) Adaptive Management. The coordinating committee will formulate general guidelines for the panels' reports to help ensure consistency in presentation and to minimize substantive gaps or overlaps. Liaisons from the coordinating committee will attend the first meetings of each panel, as well as selected subsequent meetings. When appropriate, the coordinating committee may wish to facilitate joint meetings or workshops among different panels with overlapping interests.

After completion of the four panel reports, the coordinating committee will produce a synthesis document that includes the panels' findings and recommendations and provides advice on implementation of the panels' recommendations. The synthesis report will also identify any overarching themes, issues, or recommendations that emerge from the panels including possible future roles for the Corps in sustainable management of coastal and inland waters in the United States.

cases operates and maintains, a large share of the nation's physical water management infrastructure of dams, reservoirs, locks, levees, and port and inland navigation channels. A sense of the program scale is reflected by this fact: since passage of the Flood Control Act of 1936, the Corps has constructed approximately 400 major lake and reservoir projects, built more than 8,500 miles of levees and dikes, and implemented hundreds of smaller local flood protection projects that have been turned over to non-federal entities (USACE, 2001). In addition, substantial investments have been made to deepen approach channels to coastal ports and to manage shoreline erosion.

The Corps' net capital stock—the net investment that the Corps put in place through 1993, minus the accumulated retirement of investments and depreciation—is estimated at $119.1 billion (USACE, 2001). Construction spending has been declining over the past three decades, how-

ever, during both Republican and Democratic administrations and Congresses. Meanwhile, the "backlog" of authorized but unfunded projects has grown to approximately $50 billion, with additional project authorizations being contemplated. During the same period, the share of the Corps budget allocated to operating and maintaining its physical infrastructure has grown. Based on these trends, the near-term future appears to be one of increasing importance of operating, maintaining, and rehabilitating existing infrastructure, with a decreasing emphasis on new project construction for flood control and navigation purposes. More recently, the Corps budget for general investigations (planning) has declined by more than 50 percent from year 2000 levels. Despite decreasing emphasis on new project construction, the Corps will continue to require appropriations from the federal budget, given the importance of ensuring the continued utility of past investments. New projects will continue to be proposed and constructed as incremental additions to existing infrastructure and systems.

Past investments will also have to be attended to for another reason: Corps projects control the hydrologic and geomorphic processes in most of the nation's large rivers and along long stretches of coastline. For example, Corps of Engineers' lakes store more than 300 million acre-feet of water. Although support remains for individual projects to serve traditional mission areas, there are now strong advocates for reallocating storage devoted to various uses (e.g., flood control, water supply) and/or modifying operations in ways that serve a broader suite of users. One new use is releasing water to restore some degree of pre-regulation flows and processes that were purposely disrupted by Corps projects. Another use that may be served by existing Corps projects is to increase the use of existing storage for municipal and industrial (M&I) water supply, especially in watersheds where Corps projects already occupy many potential storage locations. Advocates of more traditional roles for the Corps fear that a new "restoration mission," or attention to providing M&I water supplies, will divert limited resources from project construction for traditional flood management and navigation demands, will challenge the operations and maintenance of existing projects, or will unfairly harm current project beneficiaries.

Limited budgets and new visions of water management needs have spawned debates over future federal—and Corps of Engineers—roles in water management. These debates have been under way for more than three decades and have resulted in expanding federal legislation, executive orders, and other directives that guide and constrain Corps decision making. This in itself is not necessarily a problem, but guidance has

tended to accumulate at an accelerating pace. Moreover, few steps have been taken to ensure that new legislation is consistent with existing legislation. The result is that the Corps is often bound by conflicting mandates and often must, in effect, choose which to violate. The following quote from General David Fastabend (2002), former Commanding General of the Corps' Northwestern Division, reflected this situation well:

> …the challenge is that the people of the United States have—over time—told us to do many, many things. In the 1930s and 1940s the American people told us to build, operate and maintain the Missouri River mainstem system for multiple project purposes. Since that original mission, the American people have given us additional instructions. In the 1970s they gave us the Endangered Species Act and the National Environmental Policy Act… As you can well imagine, no one was able to "deconflict" the multiple instructions given to the U.S. Army Corps of Engineers. Our guidance is sometimes contradictory and the resolution of those contradictions is extremely problematic.

It is in this context of conflicting visions of national water management needs and the future mission of the Corps in which questions have been raised about Corps planning methods and the quality and credibility of its planning studies. The need to continue managing flood and storm risks and to maintain inland navigation and port systems is not in dispute. However, as Congress' request for these 216 studies demonstrates, questions about the justification of new and individually proposed and evaluated projects have been increasing. Also, the procedures through which the Corps justifies its maintenance, operation, and structural modifications to existing projects is carefully scrutinized. Meanwhile, planning and analysis to support the Corps' emerging restoration mission remain under development.

PORTFOLIO PLANNING: NEW REALITIES AND OPPORTUNITIES

This report's findings and recommendations are centered on an organizing theme: in the near term the Corps can best contribute to national water management by framing its planning activities around a concept termed "portfolio planning." The term "portfolio" is used in Corps plan-

ning documents, but it is extended herein to consider both the water and related land resources of the nation's rivers and coastal areas (natural capital), and the attendant physical water management infrastructure. This report focuses on Corps-built physical infrastructure, although it is recognized that in many places, Corps projects are part of larger systems that include privately funded projects, as well as projects of other federal and state agencies. The term "planning" includes both analytical approaches and decision-making processes that govern investment and management strategies for the "portfolio" of natural and infrastructure assets. The portfolio planning metaphor suggests that the nation must strive to make the best use of existing Corps-built physical infrastructure, rivers, and coastlines (recognizing that the term "best" invites debate). The metaphor also applies to governance issues (in which the infrastructure in the portfolio is the Corps' responsibility) and to financial issues, as the Corps may decide to invest or divest itself of some responsibilities and thus change the composition of portfolio assets. The Corps' portfolio of assets and concerns, as described here, should be broadened such that it not only focuses on traditional benefits of flood control and navigation, but also encompasses natural resources conservation and environmental values. Chapter 4 further discusses the portfolio planning metaphor and its relevance to managing the Corps existing water resources infrastructure.

REPORT ORGANIZATION

Chapter 3 reviews important historical events in the national approach to water management, focusing on roles of the Corps. This history is essential to understanding current national water management debates and to set the stage for this report's findings and recommendations. Chapter 4 contains findings and recommendations for advancing portfolio planning. Chapter 5 includes recommendations on professional staff requirements and the planning and decision process. The report concludes with an epilogue in Chapter 6.

3

Trends and Milestones in Corps History

The Corps' programs of river and coastal project development and the agency's planning methods have often prompted controversy. As explained in Chapter 2, these discussions have reached high levels of intensity in contemporary debates regarding national water resources management priorities and appropriate roles for the Corps in meeting those priorities. This chapter places these current controversies in the context of important historical trends and events in federal water resources planning and management.

ORIGINS OF THE CORPS

From Forts to Navigation Enhancement

Early influences on the Corps of Engineers can be traced back to eighteenth century Europe, as many initial Corps engineering methods drew on engineering theories developed in France (Shallat, 2000). The Corps' earliest activities were the construction of Bunker Hill fortifications and of Forts Norfolk and Nelson on Chesapeake Bay in 1774 to 1775. A permanent Corps of Engineers was organized in 1802. During the same year, a military academy at West Point, which the Corps relied heavily upon for many years, was also established. After the War of 1812 the agency began to carve out a civilian role that matured in the late nineteenth century. Prior to the Civil War, the Corps' roles and activities were shaped largely by great national debates over the federal responsibility for "internal improvements." There was considerable opposition to the Corps (as a federal agency) becoming involved in road, canal, and navigation improvement projects. However, improving the flow of commerce through harbors and inland rivers (via removal of obstructions) promoted interstate commerce, and such activities thus became accepted as a federal responsibility. In 1866, Congress directed the

Corps to begin dredging, snagging, removing sunken vessels, and clearing overhanging trees on the Upper Mississippi River (Anfinson, 1993). In the same period, the Corps removed thousands of snags on the Upper Missouri River, where snags and other navigation hazards and impediments claimed almost 1,000 steamers, ferries, and snag boats before the railroads supplanted navigation there (Schneiders, 1999).

Today, the Corps' water transportation missions extend to the nation's coastlines and inland rivers. Engineering in the interests of promoting water transportation has moved far beyond removing naturally occurring obstacles in rivers and harbors. To support modern ocean-going shipping, continuous dredging is necessary at coastal ports to maintain approach channels and berthing facilities. On inland rivers and waterways, continuous dredging and the operation and maintenance of water control structures of locks and dams maintain a minimum 9-foot channel throughout the nation's inland water transportation network. The Corps has also promoted efforts to be responsive to the needs of ecosystems, as in its efforts to fluctuate the levels of navigation pools on the Upper Mississippi River so as to increase hydrologic variability and ecosystem vitality (see USACE, 2004a).

From Navigation to Flood Control

The Corps' navigation mission to support commerce led to the agency's involvement in flood control. Congress appropriated money to the Corps as early as 1850 to survey the Mississippi River in the interests of reducing flood damages. The Corps came to view floods as natural events that could be predicted with reasonable accuracy and that could thereby be controlled through engineering practice and investment. Flood control would allow lands unsuited for agriculture to be made productive and would allow cites to grow up along the river transportation system. Flood control was deemed essential to national economic prosperity. The Corps' early flood control program focused on levees; only later were channel and dam projects integrated into the control of flood waters. In 1879, Congress created the Mississippi River Commission. The commission promoted a "levees-only" policy for managing Mississippi River floods. This policy was based on the premise that levees were sufficient for the control of floods, as it was believed that by constricting a river's flow and increasing the speed of its current, levees would create a self-scouring process that would allow a river to dredge its own bottom. The levees-only policy remained the basis of Corps

flood control program policies despite continued major floods and associated damages, and despite the successes with some flood control dams, such as those built by the Miami Conservancy District in Ohio in the early twentieth century (*http://www.miamiconservancy.org/Who_We_Are/MCD_History/MCDs_Founders.htm*; last accessed April 28, 2004).

Professional debates regarding the agency's levees-only approach to flood control promoted increased understanding in the hydrologic sciences. For example, engineer Charles Ellet, Jr., published a report (Ellet, 1852) that dismissed the levees-only theory, describing it as "a delusive hope" (quoted in Barry, 1997). Ellet felt that in order to control Mississippi River floods, a comprehensive approach that included levees, natural outlets, and artificial outlets and reservoirs was required. An 1861 report by General Andrew Humphreys and Henry Abbott represented a milestone in hydraulic studies of the river and "became the single most influential document ever written about the Mississippi River" (Barry, 1997). In that document, Humphreys and Abbot dismissed most of Ellet's theories, stating that Mississippi River floods could be controlled through the construction of levees alone.

Over the ensuing years, elements of Ellet's and Humphreys' flood control theories became part of federal and Corps approaches to flood hazard management. Alternative views of the primacy of engineering structures in controlling floods emerged in the early twentieth century, as arguments for changing the patterns of human occupancy of floodplains and coastal areas were offered (e.g., White, 1945). In fact, the 1938 Flood Control Act authorized the Chief of Engineers to propose floodplain evacuation projects as a flood risk management strategy. Until relatively recently, however, the Corps has emphasized flood risk minimization through water control projects, with other agencies (e.g., the Federal Emergency Management Agency) implementing programs related to human occupancy of floodplains.

WATER RESOURCES PLANNING

The Corps and Progressive Conservation

The Progressive Conservation Era (1890-1920) saw the origin of the ideals of "rational" and "efficient" uses of water that continue to exert a powerful influence on approaches to water resources planning and management. This era coincided with the rise of the modern university system and with humanities, sciences, and professional schools. Engineer-

ing was a prestigious profession that reflected the period's optimism of using technology and scientific methods to promote material and social progress (Hays, 1959). For the first time in the United States, a holistic vision of river basins as integrated natural and social systems was articulated. The idea that hydrologic processes did not respect political boundaries, which the Supreme Court had earlier endorsed in its definitions of navigability, eventually formed the basis for what one author called the "pure doctrine of river basin management" (Wengert, 1981): federal construction and management of comprehensively planned and related water control dams, levees, channels, and other works that would serve multiple purposes including navigation, flood control, hydropower generation, and water supply storage. All projects would be planned with river basins as the planning area and constructed to promote national and regional economic prosperity (ibid.). States, with few exceptions, invested little in such projects. Private investment was limited to places in which power production could be profitable, extending the logic that supported the widespread development of mill dams decades earlier.

Gilbert White observed that three key ideas are central to the concept of river basin development: the multiple-purpose storage reservoir, the basin-wide program, and comprehensive regional development (White, 1957). Although the first two elements were realized in many parts of the United States, the notion of comprehensive regional development as part of unified basin management "has not been fully realized in any part of the earth" (ibid.). Some officials in the newly-organized Bureau of Reclamation, created to administer the Reclamation Act of 1902, enthusiastically endorsed the river basin planning concept, but in the end, influential members of Congress never embraced the implication that executive branch expert planners would select the projects to be built and the purposes to be served. At the same time, the Corps found that an emphasis on local levees, river clearing, and channel projects to serve regional interests in flood control and navigation, protected its autonomy and maintained its support in Congress (Hays, 1959; Pisani, 2002).

The Corps adopted the notion of multiple-purpose planning in the twentieth century. The Great Mississippi flood of 1927 was a monumental event in both U.S. political history and national water policy (Barry, 1997). President Coolidge's characterization of the flood as an act of God and his refusal to support federal flood relief were consistent with early twentieth century thinking, but that viewpoint was soon undermined by the emerging progressive vision of scientific management of water resources (Hays, 1959). Prior to the Mississippi River floods,

Congress had authorized studies to address multiple-purpose river basin planning (largely for hydropower generation), which were published in 1927 in House Document No. 308. The belief that the federal government was responsible for supplementing the levee program (originally designed to benefit navigation) with programs designed to protect the valley from future floods, became a pillar of water management policy after the 1927 flood. In 1936, the Corps was instructed to plan for and build dams, along with other water control infrastructure, to serve multiple purposes that included navigation and flood control, as well as water supply, hydropower, and recreation.

The Flood Control Act of 1936 expanded the Corps' planning roles and remains the current foundation for the agency's current efforts to apply engineering, physical, and social sciences in project planning. The Corps had always planned in the sense that it studied a structure's technical feasibility, as well as its cost justification. With an increase in the size and scope of its mission, Corps activities became more controversial. Cost overruns were a persistent problem, and in 1936, Congress instructed the Corps to propose projects only when ". . . the benefits to whomsoever they may accrue are in excess of the costs and the lives and social security of the people will be otherwise affected." These words are often cited as the modern origin of water resources planning practice.

Rational Planning

The expansion of the Corps' missions required more formal project planning processes. The development of many of the Corps' analytical means and methods in the middle of the twentieth century can be characterized as a search for more "rational" planning. So-called rational planning would provide an objective process for identifying the best projects. Experts would draw from the full range of physical and social sciences in this rational process. Rational planning was seen as a scientific alternative to an unfiltered and politicized project planning and funding process. This ideal of rational planning was advocated for more than water resources decision making. Urban planning, for example, evolved from a purely architectural or engineering discipline into a scientific process of information assembly and problem solving (Scott, 1971).

In the early twentieth century, water resources planning was expected to maximize hydrologic control, not maximize net benefits. The rational plan was one in which an integrated set of water projects would eliminate the "waste" of water and control the vagaries of nature. The

founding of the U.S. Geological Survey (USGS) in 1879 was important because the USGS initiated a shift of hydrological research from a diffuse private sector to the government. Under leadership of pioneers such as Robert E. Horton, the focus of hydrology was on "the conservation of water mass at the scale of the river basin" (NRC, 1991), which supported the concept of large-scale, integrated, technical planning. By 1934, the National Resources Planning Board stated the challenge of water management as follows: "In the interests of national welfare there must be maximum control of water resources, from the desert trickle that might make and acre or two productive to the raging flood waters of the Mississippi."

The Truman administration's 1950 report, *Water in America's Future*, included a sketch of a well-managed watershed of the era. In the watershed's broad upper reaches, land treatment and reforestation programs slow runoff. In some upstream areas, water detention projects have been constructed. Multiple-purpose storage projects and mainline levees and channels control (remove the variability in) the river system's hydrologic regime. In the estuary and along the coastlines, a river transportation network feeds freight to a bustling commercial port. Technically sound project designs would draw on an understanding of the hydrologic connections within river basins. These projects were expected to serve multiple purposes such as drinking water, recreation, hydroelectric power, and navigation. Were these benefits, however, warranted by the costs incurred in securing them?

This question, as embodied in the 1936 Flood Control Act, was the foundation for a different understanding of rational water planning. In fact, the Corps had long conducted different forms of benefit and cost analysis as a basis for selecting projects for funding, predating the 1936 act (Porter, 1995). Also, beginning shortly after World War II, the executive branch issued a series of guidance documents for the conduct of benefit–cost analysis. From the end of World War II through the early 1960s however, criticisms of the justification for the continuing construction of new water projects grew (Holmes, 1979). In response, water resources planning became an important academic subject (Maass et al., 1962). In 1955, the Rockefeller Foundation funded the Harvard Water Program, a water resources system design seminar located in the Harvard Graduate School of Public Administration (Maass et al., 1962). The Harvard team, led by Arthur Maass and Maynard Hufschmidt, published *Design of Water Resources Systems* (ibid.), which created the foundation for the 1972 federal *Principles and Standards*. Professor Maass was also well-known for his landmark book *Muddy Waters* (Maass, 1951), in

which he was sharply critical of the Corps of Engineers and its relationship to Congress. Maass' book was the prototype for succeeding generations of criticisms of the Corps and its civil works projects (e.g., Reisner, 1986). The Harvard program was for both graduate students and government personnel, and the Corps provided support to the program from 1961 to 1965 (Kneese and Smith, 1966). The Harvard Water Program combined engineering, systems analysis, and economics into a planning framework that was expected to rationally guide identification and construction of only those projects that would serve the national interest, as described by the language of the 1936 Flood Control Act.

In 1965 the Congress passed the Water Resources Planning Act, which represented a commitment by both the executive and congressional branches to rational water resources planning. That act created a three-part planning approach to national water resources management to be administered by a federal Water Resources Council (WRC) and by regional river basin commissions. Water projects were to serve and be evaluated according to multiple criteria set forth by the WRC. Federal objectives for water management were to be equally balanced between national economic development (NED) and environmental quality (EQ), although considerations of regional economic effects and other social effects could be evaluated and reported in a planning document. The principles for benefit-cost analysis in the National Economic Development account were drawn from economic theory and literature on efficiency analysis. The grounding of formal benefit-cost analysis procedures in the principles of contemporary economic theory represented a significant shift in planning requirements, which can be attributed to economists and other students of river basin development and their questions about the Corps' technical methods used to compute costs and benefits. More generally, the assumption that economic development was advanced by water project construction was being challenged (the meaning and measure of EQ outcomes did not receive a similar degree of intellectual and professional attention).

The Water Resources Council was zero-funded in 1981, and the federal objective for water projects has since been redefined to be to maximize NED benefits (net benefits) subject to compliance with all relevant environmental laws, but the ideas that it adopted form the bases of contemporary Corps planning. The economic evaluation principles articulated by the Harvard Water Program and other economists remain the foundation of NED analysis. Environmental considerations are defined as legal constraints, however, not as objectives to be achieved. Furthermore, the operational meaning of "environmental quality" in the context

of the Corps program and planning model remains ill-defined. Through these periods and regardless of the theoretical foundations for benefit and cost measurement, the assumptions and calculations in Corps planning studies were increasingly questioned. Today, the public and Congress no longer necessarily defer to the Corps as the preeminent expert on all water resources planning matters.

CONTEMPORARY CHALLENGES

Changing Visions of Water Management

During the twentieth century, rivers came to be viewed by many of the nation's citizens, elected leaders, and federal agency heads as objects of an imperfect nature to be improved and managed for human progress through science and engineering applications. Opposition to projects that controlled hydrologic and geomorphic processes in the nation's rivers and coastlines increased after the 1960s, however, and in so doing challenged the fundamental premise of water management and the Corps program. The "environmental argument" against water projects was led by environmentalists such as David Brower. It arose from a longing to preserve a vanishing wilderness, but in the trenches of public debate, economic arguments (e.g., Krutilla and Eckstein, 1958) were increasingly enlisted to slow the construction programs of the Corps and other federal agencies. These interests were often allied with those who also opposed these programs, but for other reasons (e.g., railroads, private power companies).

The initial motivation for critics of large-scale water development was aimed at preserving natural environments, with opposition to the proposed Echo Park Dam in Dinosaur National Monument in the 1950s representing one of the early national-level "dams-versus-the-environment" controversies. One legislative victory for water project opponents was passage of the Wild and Scenic Rivers Act in 1968. This act was followed by a series of laws that in one way or another were designed to limit development in some areas and to protect plant and animal species from dams, other water projects, and various stresses. Opponents of water projects soon could rely on new laws and agencies empowered to apply those laws, as well as their growing political influence, to oppose water project construction.

Passage of the 1972 Federal Water Pollution Control Act Amend-

ments offered a vision for water management that was focused not on protection and preservation, but instead on restoring what had been lost. The act's goal was stated as ". . . restoring the chemical, physical and biological integrity of the nations waters." It was not certain then (NCWQ, 1976) or even today (Adler, 2003) what the act itself or what its authors specifically meant by the term "restoration." However, as the restoration concept was studied and advanced in the 1990s (NRC, 1992), aquatic ecosystem restoration has emerged as a vision for modern water management. Instead of controlling hydrologic and geomorphic process in rivers and coastal areas, restoration seeks to relax some of the controls that have been put in place by 200 years of water development activities.

The scientific, social, and ethical arguments for restoration are complex. Many people today view rivers as integral parts of a natural landscape that can provide socially valued services. Others, however, see restoration as a search to reclaim part of our wilderness heritage, in which rivers are natural ribbons of awe and grandeur to be enjoyed in their natural state.

Because Corps projects have modified so many of the nation's rivers and coastlines, aquatic ecosystem restoration has brought past Corps project development activities, as well as proposals for new projects, to the center of the national debate over water management. In 1986, Congress directed the Corps to consider how operations of existing projects might be altered to achieve environmental purposes. Subsequent special legislative provisions and omnibus rivers and harbors development acts have authorized environmental projects to mitigate past damages and to restore areas that had been degraded in the past. As one example, the Coastal Wetlands Planning, Protection and Restoration Act of 1990 (P.L. 101-646) authorized the Corps to cooperate with other agencies and the State of Louisiana to identify and construct wetlands projects. "Ecosystem protection and restoration" is a relevant element in Corps watershed and river basin assessments (33 U.S.C.Section 2267a(a)), and the agency may "carry out an ecosystem restoration and protection project if it will improve the quality of the environment and will be cost effective" (33 U.S.C.Section 2330).

Meshing the traditional Corps water management approach with a restoration vision that, in some ways, contradicts the foundation of 200 years of national water management policies is a challenge only now being recognized. The values to be served by restoration and the redistribution of benefits and costs that may be required make restoration far more than a scientific or engineering challenge. It is a planning challenge that usually involves fundamental differences in values and per-

spectives that must now be faced by the nation and the Corps, while the agency continues to heed its continuing responsibilities to provide flood protection and water transportation.

Competing Visions, Competing Decision Authorities

The Corps has sought to respond to its critics while still accommodating traditional constituencies. The agency has added more environmental analysis to its planning studies (as required by many laws), and it has opened up the planning process to more interagency comment. The Corps has been at the forefront of engaging citizens in its planning process. (Mazmanian and Nienaber, 1979). The Corps recently introduced a planning objectives called "national environmental restoration" (NER) to complement its NED economic accounting process (USACE, 2000). In the end, however, all Corps activities are place specific and focuss on projects and project operations. In any locale, it is difficult to make decisions that simultaneously serve traditional constituencies and placate critics who may prefer no project at all or who favor ecological restoration rather than water control. Meanwhile, executive branch budget authorities maintain long-held skepticism toward the justification offered for projects conceived and planned by the Corps.

Critics see recommendations for actions that are not to their liking and charge that the agency's planning and decision-making processes remain insular and unresponsive. Criticisms extend to planning procedures that derive from the rational planning model, and there are calls for new and "more modern" procedures. Creation of the NER objective is a step in that direction. Others are concerned about the technical quality of analytical practices, and thus call for independent review of study reports (calls for independent review of studies have been made on a recurring basis at least since the mid-twentieth century). At the same time, supporters of traditional Corps project have been frustrated by what they see as inordinate delays in the construction or maintenance of important infrastructure. These supporters generally want to streamline the Corps' planning and decision-making process and want to agency to have increased authority to make decisions (after perspectives of other agencies and the public are considered).

Although the Corps has been inclined to move toward a new mission and approach to water management, other forces have operated to maintain the agency's focus on local and individual water control and harbor projects. As one example, the Corps can find itself being asked by local

communities to provide flood protection at the "100-year protection level" because these levels are just adequate to relieve the communities from having to comply with the land-use control and insurance purchase provisions of the National Flood Insurance Program (NRC, 1995, 2000). The results of a benefit-cost (NED) study may suggest that higher levels of protection are economically warranted, but because of cost-sharing requirements, local communities resist the NED plan.

The Corps has argued that the cost-sharing requirements attached to its planning since 1986 make it imperative that local sponsors concerns be paramount in the planning and decision process. Non-federal beneficiaries of Corps projects had long borne some of the costs on an ad hoc basis, primarily in the form of land and easement transfers and dredged material disposal areas. Leading up to 1986, a coalition of fiscal conservatives and environmentalists agreed that increasing local sponsor cost-sharing responsibilities was desirable because it would eliminate projects of marginal value. The 1986 Water Resources Development Act (WRDA) authorized more stringent cost-sharing requirements that increased financial responsibilities of local sponsors. More stringent cost-sharing requirements altered the demand for large projects (Shabman and Dickey, 1986). On the other hand, the Corps has argued that cost-sharing requirements, especially for studies (versus projects), have increased the power of local sponsors and their congressional representatives to limit the scope of what is studied and to influence project selection.

The contemporary setting of U.S. water management is one in which the Corps alone cannot always resolve contrasting visions of what is appropriate. Today, a welter of environmental laws passed in the later part of the 1960s and 1970s, in combination with incremental additions to the Corps' own authorities, have created multiple and highly specific planning goals and constraints (e.g., protection of a particular fish or plant species listed under the Endangered Species Act). These laws, added to the existing milieu, define multiple and often-conflicting goals that must be evaluated against one another as decisions are made. Authority for executing the intent of these laws, however, is assigned to different agencies that use different planning models and different decision criteria. Even within the Corps itself, its mission and its evaluation framework differ from what applies to its permitting authority under Section 404 of the Clean Water Act (CWA). At a general level, the traditional planning process aims to create decisions to be governed by a rule to maximize net benefits. Under such a rule, a wetlands fill permit would be issued whenever an analysis showed that benefits of permitting the fill

exceeded costs. The Section 404 program goal, however, is an extension of the logic of the Clean Water Act—to prevent to the maximum extent possible the discharge of pollutants to U.S. waters. There is little room for the application of benefit-cost analysis in the Clean Water Act and hence in a wetlands permit decision (*Weyerhaeuser Co.* v. *Costle*, 590 F.2d 1001, D.C. Cir. 1978). Instead, the decision logic is that unless costs are deemed unreasonable, the permit should be denied as being inconsistent with the goals of the act.

As the Corps, other agencies, environmental groups, and the general public seek to independently exercise their powers and authorities, persistent conflict may ensue (Stakhiv, 2003). Interestingly, the term "watershed management" has been revived as another way to describe a decision process that will accommodate the diffusion of goals and of water governance authorities. Although justifications for a revival of interest in watershed management often are scientific in origin, watershed management is also understood as a new way to make decisions. The call is for collaborative processes in which power is shared among agencies and the stakeholders they represent. These collaborative processes range from information sharing forums to those designed to solve specific physical and regulatory problems (NRLC, 2000) and rely upon stakeholder consensus to create plans that will secure the approval of all parties to a collaboration. However described, the current national water governance system begs for more effective collaboration and cooperation. In this setting, the Corps and the nation should reconsider the role of the rational planning practices and procedures that were designed to serve a more hierarchically structured and federally focused decision process.

Looking to the Future

Planning for and funding of water control is a job that the nation has given to the Corps. Over time, the purposes planned for have changed and the kinds of projects have changed, as well. In addition, there have always been struggles over what branch of government will set spending priorities for the program, and critics of how projects are selected and funded have existed for decades (Maass, 1951). If there has been a constant (at least until recently), it was that projects were expected to control hydrologic and geomorphic process in the nation's rivers and along its coastlines.

The future national water policy landscape may hold important

changes from today's conditions, but these prospective future changes were discussed by some water policy analysts and scholars years ago. For example, a 1973 report from the (former) National Water Commission (NWC), *Water Policies for the Future: Final Report to the President and to the Congress of the United States* (lost in the furor over the Watergate scandal) presciently described many of subsequent major developments in water policy. For example, in a finding that remains relevant today (and which is emphasized in this report), it was noted that "federal water planning today is now oriented toward construction of water resources projects, an orientation that made sense 50 years ago but that does not relate to today's water problems" (NWC, 1973). The NWC could not have foreseen: the relatively rapid collapse of political consensus for continued water development; the rise of the ecosystem restoration "movement"; the redirection of federal fiscal policy from domestic spending to budget reduction, and; a diffusion of federal authority in setting water policy. The 1973 NWC report assumed that federal water resources project development would continue at a lesser rate than post-World War II activity, but would continue to be the primary federal water resources function, and thus, there was a need to continue to refine project planning and selection techniques.

Water Policies for the Future contained additional foresight regarding water resources decision making. It addressed the problem of competition and duplication among agency functions and called for a centralized data collection agency. The NWC stopped short of calling for a Department of Natural Resources because it forecast the Bureau of Reclamation's long-term role as resource manager rather than project construction agency and saw a similar role for the Corps of Engineers. The NWC called for careful review of all federal projects and for the creation of "an independent review board . . . to keep a check on the project evaluation biases of the Federal construction agencies."

The significance of the NWC report is not that it predicted future conditions or that its recommendations should be adopted today. The point is that the commission's sense that an ebbing of water development programs and a shrinking of agency budgets and staff was likely came to pass (and underpins today's national water management policies and decisions). In the following chapters, the current status of the Corps' program and its planning capability is reviewed, and recommendations for reinvigorating and reorienting the program are presented. The nation needed an agency of government to do what the Corps did in the past. Water resources planning and management remain important challenges, and there will continue to be federal roles in addressing them. This re-

port examines ways in which the Corps of Engineers might best contribute to the nation's water resources needs in the twenty-first century. The following chapter discusses ways in which the Corps' planning functions might be reoriented to tailor them to existing and future conditions and needs.

4

The Corps Planning Process: A New Opportunity

INTRODUCTION

The Corps of Engineers has traditionally had access to the planning, expertise, and resources necessary to construct projects for controlling the vagaries of the hydrologic regime. Although state and local governments participated in federal water project planning and decision making, their participation was limited. Over the second half of the twentieth century, federal budget support for Corps-built projects declined steadily. At the same time, significant responsibilities for water allocation decisions remain organized around water laws and administrative rules of individual states. In many states, these legal and administrative responsibilities are now focused on balancing demands for instream flow with municipal, industrial, and agricultural demands. For example, the National Research Council has recently had study committees conducting two state-sponsored studies on these topics (one for the State of Texas on instream flow standards, the other for the State of Washington on water withdrawal permitting decisions, the latter of which has been published; see NRC, 2004). In this current setting, what roles are appropriate for the Corps, and what planning approaches best support those roles? The Corps can continue to make important water resources management contributions, but this will entail a general planning reorientation and a complementary strengthening of the agency's planning capabilities. This chapter explains that role–captured in the "portfolio planning" metaphor—and provides the conceptual foundation for a complementary planning program. Following this chapter, Chapter 5 identifies specific actions required for implementing the decision-making processes in support of this water resources planning reorientation.

CONCEPTUAL BASES OF PORTFOLIO PLANNING

Promoting efficient transport of interstate and foreign commerce, and providing protection from flood and storm hazards, continue to define federal interests in water resources management and key missions for the Corps. The Corps water resources program is, however, experiencing budgetary decline. For many years in the early twentieth century, Corps water programs represented approximately 3 percent of total annual federal spending (Figure 4-1). Today, however, these programs represent less than two-tenths of 1 percent of the budget—a roughly twenty-fivefold decrease. Within that budget, the Corps spends less than 20 percent for new construction, and there is a "backlog" of authorized, but unfunded, project spending of around $50 billion. Equally important is that a significant share of construction dollars is allocated to structural rehabilitation of older projects, while another share is devoted to a relatively new and broadly defined ecological restoration mission.

One explanation for the current situation is that the original mission of harnessing the flows of major interstate rivers has been mainly accomplished. Indeed, the nation's physical landscape has been forever altered by thousands of projects, constructed by the Corps (and several

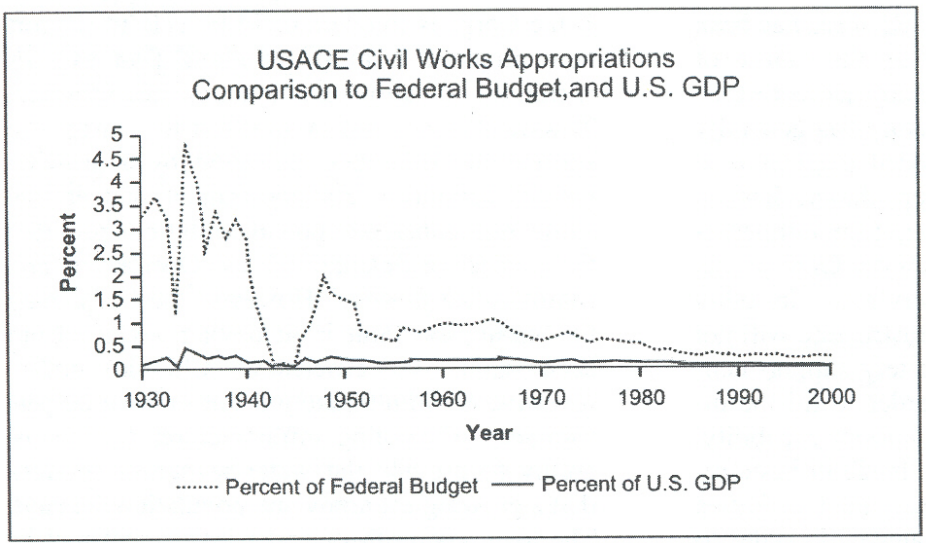

FIGURE 4-1 Corps civil appropriations as percentages of federal budget and of U.S. gross domestic product. SOURCE: USACE (2001).

other agencies and private investors). For example, the Corps itself has built about 1,000 harbor projects, of which 929 are still being maintained. In addition, there are about 12,000 miles of channels that support navigation, 230 lock and dam projects for navigation and related purposes, 377 dam and reservoir projects, and hundreds (if not thousands; there is no inventory) of channel modifications, small levees, coastal and riverine floodwalls, diversion channels, and ice control structures. The Corps (and others) has thus constructed a vast physical infrastructure. Although these assets (part of the Corps "portfolio") will be added to in the future, the large amount of past construction means that future construction prospects are limited. The possibilities of serving a different mix of purposes with this massive investment, in light of changing national needs, are today being considered (Holliday, 2002).

Meanwhile, the relaxation of hydrologic and geomorphic controls (under the rubric of "ecological restoration") is being promoted by some as a new focus for the Corps' water management program. Aquatic ecosystem research conducted during the 1980s and 1990s supports theories demonstrating the importance of natural hydrologic and geomorphic variability in maintaining river system biodiversity and productivity (Koel and Sparks, 2002). Restoration of some degree of hydrologic variability and natural geomorphic processes to the nations' rivers and coastal areas is thus viewed by many as central to achieving a variety of environmental objectives. In places such as Florida's Kissimmee River, for example, the Corps has removed a multipurpose water control project in order to restore some degree of the pre-settlement hydrologic regime. In other places the Corps is pursuing new opportunities for such restoration with the promise of benefiting most or all stakeholders (see Box 4-1). At other times, hydrologic and geomorphic restoration may entail difficult choices and trade-offs of national-level importance that will have to be addressed by the president and Congress if they are to be resolved (see Box 4-2). As another example, the Corps has had to address different perspectives regarding the viability of the navigation system of the Appalachacola River (Holliday, 2003). Finally, in instances such as with the Comprehensive Everglades Restoration Plan, significant new investments are expected both to meet restoration goals and to serve more traditional purposes such as municipal and industrial water supplies.

These two factors—a mature physical infrastructure that controls vast amounts of water and related resources, and an emerging interest in relaxing controls on hydrologic and geomorphic processes across large watersheds—suggest the need for an authority that will enable the Corps

BOX 4-1
New Operational Regimes

The Corps is involved in various efforts across the nation to implement some changes to dam and reservoir system operations schedules. For example, in the Sustainable Rivers Project, the Corps and the Nature Conservancy signed an agreement in 2002 to help restore some natural flows and processes on several rivers across the nation, while also providing services such as flood management and hydropower generation. Within this program there are currently fourteen candidate sites on ten rivers in eleven states (see:*http://nature.org/success/dams.html;* accessed July 12, 2004).

In the Upper Mississippi River basin, the Corps St. Paul District and the Chippewa National Forest Service signed an agreement in early 2003 to cooperate on the Mississippi River Headwater's Reservoir Operations Plan Evaluation, or ROPE, study. The program aims to develop a new operating plan for the region's reservoir system. The program is to include dialogue among federal and non-federal dam operators and stakeholders representing interests in flood control, environment, tribal interests, recreation, and hydropower generation. The study, which is to be cost-shared by the Corps and the U.S. Forest Service, represents the first time since the 1950s that the region's reservoir operating plan has been updated (see *http://www.mvp.usace.army.mil/print/default.asp?pageid=676&subpageid=0;* accessed July 12, 2004).

The Sustainable Rivers Project and the ROPE study are examples of the Corps' recognition of the importance of ecological conditions in the nation's watersheds, comprehensive water management at the watershed river basin scale, and cooperation and dialogue with fellow agencies and stakeholders.

to focus its planning functions and capabilities on these new realities. The Corps currently has planning authorities that provide some latitude to review project operations and make appropriate adjustments. Perhaps the two most frequently invoked authorities for this purpose are an authority from Section 216 of the 1970 Flood Control Act and another from Section 1135 from the 1986 Water Resources Development Act (WRDA, 1986; see Box 4-3; also see the 216 study panel on river basins and coastal systems).

As illustrated in Box 4-3, these existing authorities provide little detail on how the Corps might evaluate and implement a program for ad-

BOX 4-2
Operating the Missouri River Dam and Reservoir System

The Corps of Engineers sets the operations schedule for the Missouri River mainstem dams and reservoirs that the agency constructed during the middle of the twentieth century. The system consists of six dams and reservoirs extending from Fort Peck Dam in Montana downstream to Gavins Point Dam on the Nebraska-South Dakota border. The system is important for many reasons: the storage capacity in the Missouri River basin is the largest of any river system in North America; it is the site of protracted upstream-downstream, interstate conflict regarding proper operations of a multiple-reservoir system; and it is a prime example of how the Corps can be caught between conflicting obligations and legislation.

Two pieces of federal legislation are at the heart of the system's construction and operations. The 1944 Flood Control Act contained the Pick-Sloan Plan, which divided construction and operations responsibilities for the tributaries and mainstem between the Bureau of Reclamation and the Corps. The 1945 Rivers and Harbors Act contained the Missouri River Bank Stabilization and Navigation Project, which authorized the Corps to construct a navigation channel 9 feet deep and not less than 300 feet wide.

Post-1945 environmental legislation—namely the Endangered Species Act (ESA) of 1973—has created new management obligations and have complicated system operations. Pursuant to the ESA, once a species is "listed" as endangered or threatened by the Department of the Interior, no federal agency may take actions jeopardizing its continued existence. On the Missouri River, two listed bird species—the least tern and the piping plover—and one listed fish—the pallid sturgeon—have been the source of controversies and conflicts involving the navigation industry, environmental groups, basin states, the U.S. Fish and Wildlife Service, and the Corps.

justing post-construction project operations. Most importantly, these authorities were not created to fundamentally reorient Corps planning, beginning with consideration of the condition and purposes being served by existing Corps-built infrastructure at a regional scale (i.e., "portfolio planning"). As noted in Chapter 1, "portfolio" includes the water and related land resources of rivers and coastal areas, as well as Corps-built projects in these rivers and coastal areas. "Planning" includes both the analysis and the decision-making processes that govern investment and management strategies within the portfolio. Traditional Corps missions,

In the 1945 legislation, Congress instructed the Corps to maintain a 9-foot navigation channel. In the 1973 Endangered Species Act, Congress instructed the Corps not to jeopardize the existence of endangered species. Consistent with scientific knowledge, the Fish and Wildlife Service (which consults with the Corps on operating plans) maintains that these endangered bird and fish species require some degree of presettlement hydrologic and geomorphic conditions and processes (e.g., shallow-water habitat; sandbars and islands for nesting) in order to survive. These two acts are not fully consistent: one authorizes the Corps to maintain a stable channel; the other suggests that more variable flow and depth regimes are needed to protect federally-endangered species.

One manifestation of the ensuing confusion and criticisms is that the Corps has been attempting—unsuccessfully—to revise its Master Manual for mainstem system operations since 1989. Some have blamed the Corps for failing to come up with a revised Master Manual that satisfies the demands of ecology and commerce after 15 years of effort. An example of the fundamental ambiguities that can attend contemporary river flow management is the following sequence of events. Within a four-week period in July 2003, a federal court in Washington, D.C., ordered the Corps to lower summer releases in order to protect endangered species, while a federal court in the Midwest ordered the Corps to release flows to support Missouri River commerce. Responsibility for sorting out these conflicting directives was subsequently assigned to a federal district court in the State of Minnesota, which ordered the Corps to reduce Missouri River flows in accord with the injunction from the Washington, D.C., federal court (*http://www.newsday.com/news/nationworld/wire/sns-ap-river-fight,0,5514673.story?coll=sns-ap-nationworld-headlines*; accessed August 7, 2003). As this report was going to press, the Corps released its final Master Manual environmental impact statement (USACE, 2004b).

opportunities for meeting emerging water demands, and new interests in hydrologic restoration can all be well served by the portfolio planning concept. Indeed, as Boxes 4-1 and 4-2 illustrate, the Corps appears already to be engaged in portfolio planning in many places, but on an ad hoc basis.

The portfolio concept has also been offered to help the Corps place a greater emphasis on better management of the agency's existing infrastructure and related natural assets. Like many economic and social

BOX 4-3
Key Corps of Engineers "Continuing Authorities"

1970 Flood Control Act, Section 216

The Secretary of the Army, acting through the Chief of Engineers, is authorized to review the operation of projects, the construction of which has been completed and which were constructed by the Corps of Engineers in the interest of navigation, flood control, water supply, and related purposes, when found advisable due to the significantly changed physical or economic conditions, and to report thereon to Congress with recommendations on the advisability of modifying structures or their operation, and for improving the quality of the environment in the overall public interest.

1986 Water Resources Development Act, Section 1135

Subsection 1135(a) authorizes the review of existing water resources projects to determine the need for modifications in the structures and operations of projects constructed prior to the authorization of this Act for the purpose of improving the quality of the environment in the public interest. Subsection 1135(e) authorized maximum annual appropriations of $25 million for this section. Corps guidance on implementing this section is provided in EC 1105-2-206 and ER 1105-2-100 (subsection 1135(b) initially authorized a two year demonstration program, and Section 304 of the Water Resources Development Act of 1990 (33 U.S.C. 2309a) amended this section to make it a continuing program.

sectors across the nation, the Corps is being asked to make better use of their current assets. This reflects larger debates regarding other elements of public and civil works infrastructure across the nation. For example, the transportation sector, universities and public school systems, and military installations are all being asked to increase efficiencies, properly maintain past investments, and minimize resource consumption and environmental impacts. The Corps is not alone in finding itself in a setting of limited and declining resources, competing goals, broadening mandates, and important environmental priorities. Given these circumstances, the nation should seek unrealized efficiencies from its existing water infrastructure portfolio. In some instances, this will require difficult decisions regarding priorities. Decision making agencies like the Corps must have the direction, analytical means, organization, and resources to provide credible analytical support to elected leaders and others. Portfolio plan-

ning does not mean there is no longer a need for new investments, but rather that new investments should be evaluated in the context of the state of existing infrastructure and operational priorities. Technical analysis is an important part of this concept, but it alone cannot be looked to resolve fundamentally different priorities for often competing uses of the portfolio's infrastructure.

Current Corps planning guidance consists of many documents, some of which apply to all federal agencies, and some of which are authored by the Corps itself. A detailed review of this voluminous body of material was beyond the scope of this study. All the 216 study panels noted, however, that some components of this planning guidance have not been updated for many years. The Corps has taken a strong lead in advancing "public involvement processes," and including stakeholders and other agencies in some of its planning processes (see, for example, comments on stakeholder collaboration from the 216 study panel on Project Planning and from the 216 study panel on Adaptive Management). In the end, however, the Corps has generally adhered to its own internal practices, and its own internal policies were used to define priorities that best serve the national interest. A future planning challenge for the Corps will be to adapt its planning processes to ensure that its planning activities and reports help clarify and resolve, rather than exacerbate, conflicts over national priorities.

Another planning challenge is at the technical level. Professionals in multiple disciplines have pressed the Corps to plan and make decisions at larger spatial scales in order better recognize economic and environmental interdependencies among past and proposed future activities (see the report from the 216 study panel on River Basins and Coastal Systems). The agency has also been encouraged to more explicitly incorporate scientific and forecasting uncertainties into planning and management (e.g., adopting "adaptive management" practices). The larger spatial and temporal scales that the Corps is being urged to consider in its planning can be addressed within the portfolio planning rubric (also see the report from the River Basins and Coastal systems panel).

Are the Corps and its water resources planning processes up to these challenges? As a result of budgetary declines, the Corps is experiencing a shrinking professional staff, along with an imperative to execute its military mission in connection with homeland security responsibilities. Yet, competent management of the federal water infrastructure demands that the nation retain technical competence within water resources planning within the Corps. If the Corps cannot provide this service, the nation must find another way to secure these capabilities. The Corps (or

any agency) cannot, however, act alone on this front; executive and congressional actions are needed to develop new study authorities, to clarify the focus and the limits of the Corps' responsibilities and priorities, and to the shift the locus of decision making on fundamental federal policy matters from Corps staff and leadership to the Administration and the Congress. The portfolio planning metaphor is not offered in order to fully replace the Corps' many water resources planning obligations. The Corps will continue to be expected to address new problems and opportunities that emerge beyond the operation of its existing investment infrastructure. Traditional flood risk management planning studies will continue to be requested. In some instances the Corps may be asked to participate in revisiting the operations of projects that have been constructed by others. In some urban areas, the Corps, in partnership with the EPA, is developing urban river programs that seek to address water and related environmental issues to complement to other urban revitalization efforts. However, even as these and other planning activities are being pursued, the budget for new investments will be limited. A portfolio planning program that increases operational efficiency of existing infrastructure, and that continually adjusts these operations to meet emerging demands, will help ensure that new projects will fit smoothly into current systems of infrastructure and their operations.

EXECUTING PORTFOLIO PLANNING

Economic and Environmental Analysis

Clarifying the Restoration Mission

One conceptual adjustment entailed by a portfolio planning approach is a need to clarify the Corps' roles in ecosystem restoration. In the Water Resources Development Act of 1990, Sections 306 and 307 authorized the Secretary of the Army to include environmental protection as a primary mission of the Corps. To reflect this change, the Corps has sought a new approach to planning that would integrate the multiple objectives of environmental and economic enhancement. An initial step in this realm was the issuance of Ecosystem Restoration in the Civil Works Program (EC 1105-2-210) in June 1995 (USACE, 1995). Under these guidelines, it was determined that Corps planning should explicitly rec-

ognize opportunities for environmental restoration. In the agency's *Planning Guidance Notebook* (USACE, 2000), the Corps issued planning guidance in which it formally adopted national ecosystem restoration (NER) as a planning and evaluation objective of parallel and equal importance to national economic development. Then in May 2003, the Corps issued field guidance titled *Planning Civil Works Projects Under the Environmental Operating Principles* (USACE, 2003a) for use in formulating and evaluating measures to serve NED and NER. These have been positive steps, but Corps activities within the broad and multidisciplinary realm of ecosystem restoration remain somewhat unfocused.

Efforts to add ecosystem restoration as a primary water resources planning account (the NER account) to its traditional NED planning and evaluation process demonstrate the Corps' appreciation of a new context for water planning. However, in efforts to develop a framework for evaluating these benefits, the Corps has relied strongly on difficult-to-define conceptual terms such as "sustainability" and "ecosystem health" (Lackey, 2001). Although such terms signal a new emphasis, they must be made operational in order to be meaningful and to provide specificity to planners, decision makers, and other stakeholders. A lack of clarity regarding the Corps' ecosystem restoration mission may be resulting in the agency's limited budget being devoted to non-traditional (for the Corps) projects, which are typically the province of other bodies (e.g., local and state governments). The possible value of these types of non-traditional investments is not at issue. The use of limited planning capacity and budget to fund such projects, however, diverts the Corps from pursuing its restoration (and other) goals. A clear definition of the Corps' restoration mission is consistent with the portfolio planning approach, and is necessary to focus the Corps resources on traditional mission areas and its professional competencies and strengths.

Increasing scientific and public interest in hydrologic and geomorphic restoration offers an opportunity to enhance the clarity of the Corps' environmental mission. As explained in Chapter 3, the Corps' long history of controlling hydrologic and geomorphic process in rivers and coastal areas has served as the traditional engineering principle governing its approach to water management. It follows that the Corps' restoration mission should focus on these types of traditional emphases. The Corps' restoration mission within the portfolio planning concept should focus on hydrologic and geomorphic processes in places and over areas or regions where Corps projects have significantly altered those processes. Adjusting hydrologic and geomorphic processes can be as simple

as re-operating reservoirs as a system at little opportunity cost (see Box 4-1), or it could entail significant changes and controversies regarding the operations of systems of projects (see Box 4-2). Examples of restoration measures that affect hydrologic and geomorphic processes include removing artificial obstructions to river flows, reestablishing wetlands that had been drained, inserting crevasses in levees to reconnect rivers and their floodplains, and allowing for the silting of river channels. Such measures would allow the Corps to focus on its traditional hydrologic and geomorphic concerns, which are often the key processes in ecosystem restoration. For example, a 2002 report from a National Research Council committee that reviewed ecosystem science and conditions in the Missouri River and floodplain ecosystem concluded the following: "Degradation of the Missouri River ecosystem will continue unless some portion of the *hydrologic and geomorphic processes* that sustained the pre-regulation Missouri River and floodplain ecosystem are restored" (NRC, 2002a, emphasis added).

An emphasis on restoring hydrologic and geomorphic processes will not exhaust the scope of the Corps' environmental program. The agency is obliged to mitigate adverse environmental effects of its new projects. Beneficial uses of dredged material may mean the creation of wetlands in confined disposal areas that can become wildlife habitat. Programs in urban settings, in partnership with other agencies, will also constitute part of the agency's environmental activities. Portfolio planning to serve large-scale restoration creates a unique and important environmental opportunity for the Corps because it combines the Corps' historical program with extensive and continuing responsibilities for water projects operations and new investments.

The Corps could help operationalize its national ecosystem restoration evaluation account by developing hydrologic and geomorphic outcome measures. Appropriate measures will be site specific and a function of project goals. For example, in some cases, acres of wetlands reconnected to the floodplain may be the measure of NER output. Other measures could be imagined for other study locations, suggesting that measures may well be site specific and driven in part by the central problems of concern. For example, given concerns over the infilling of backwater areas along the Upper Mississippi River, a key measure there could be reconnecting acres of backwater with the main channel (Koel and Sparks, 2002). Given concerns over dwindling salmon populations on the Columbia River, a key measure could be the degree to which a more natural flow regime is restored and contributes to healthy salmon populations; and given concerns regarding the alteration of flows through

Florida's Everglades National Park, a key measure could be a metric that represents patterns and timing of flows that are expected to meet biological goals. This emphasis on hydrologic metrics is increasingly being adopted as a guide to formulating and evaluating river system scale restoration projects (Richter et al., 2003).

Defining the restoration mission and restoration measures in ecologically meaningful hydrologic terms can link the Corps' efforts in this new realm to its traditional areas of expertise in hydrology and engineering. It also directs attention to the management and operation of existing projects. Further, the concept of restoration mission and restoration measures requires that the Corps place its restoration program in the broader context of federal, state, and local programs. For example, hydrologic restoration may promote biodiversity. The Corps' restoration responsibilities, however, would not be directed toward ensuring biodiversity or other biological goals. Other programs and agencies (e.g., the U.S. Fish and Wildlife Service, U.S. Geological Survey, U.S. National Park Service), working in cooperation with the Corps, can address other important issues such as habitat preservation and pollutant runoff controls that, together with hydrologic restoration, can promote a greater degree of biodiversity. For this reason, portfolio planning places a premium on meaningful interagency program collaboration.

The Corps' primary environmental mission should be to restore hydrologic and geomorphic processes in large river and coastal systems (Recommendation 1).

Expanding Economic Analysis

In addition to ambiguity regarding the Corps' ecosystem restoration mission, there are also differences of understanding regarding economic criteria for evaluating Corps activities. The term "national economic development" (NED) is used to describe the economic consequences of water investments. There is, however, some disagreement among those who use the "NED" concept regarding its meaning. These differences of perspective may confuse public debate over Corps planning reports and their analytic content (the 216 study panel report on methods of analysis for project planning offers advice regarding revisions to economic analyses conducting according to the *Principles and Guidelines* (*P&G*) framework).

The *P&G* analytical framework promotes conventional benefit-cost analysis of water resources investments. This analysis must demonstrate

how a water resources infrastructure investment represents a justified response to economic changes sparked by market forces. For example, in planning navigation capacity for bulk commodity movements, the *P&G* requires an analysis documenting an increased demand for bulk commodity transportation without the project in place, to show that additional navigation capacity is justified. In fact, the Office of Management and Budget requires (and some professional economic reviewers of Corps planning studies advocate) such an analysis for calculating benefits and costs. In contrast, many supporters of the Corps' water resources investment program have a different understanding of the role of economic analysis. These supporters hypothesize a link between water infrastructure investment and the economic prosperity of the nation and its various regions. They often expect that economic analysis will determine whether and by how much a particular investment in water infrastructure will stimulate economic change, thereby advancing economic prosperity. For them, when evaluating increases in water transportation, they are interested in an analysis that determines whether an investment will, for example, increase the international competitiveness of producers of bulk commodities, thus stimulating demand for waterborne transportation.

Other economic information is also critical to portfolio planning. If new storage allocations are made or if operations are changed, an estimate of the costs of any change will be required. Costs are of two types. First, new federal expenditures will have to be allocated for project purposes, with appropriate cost-sharing arrangements. Second, costs may be in the form of benefits forgone to existing project users. In this case there may be a need to accurately estimate the value of the forgone benefits so that appropriate levels of compensation, if warranted, might be made. In any event, there are many economic implications of Corps projects that are important to citizens and to elected officials that are not consistently presented in the National Economic Development account.

Corps economics analyses for portfolio planning should thus: a) explicitly evaluate and report on how a new project, or changes in operations, may affect national and regional economies and its implications for national and international economic competitiveness; b) explicitly evaluate and report on the magnitude and incidence of forgone benefits associated with any modifications to the current system of projects or their operations; and c) explicitly evaluate and report on traditional categories of NED benefits that accrue from restoration measures (Recommendation 2).

Evaluation for Restoration

Although restoration measures generally seek to relax hydrologic controls, it is also true that restoration as a planning objective for the NER account defines a direction of change, not a desired end state. Only careful analysis of the NER and NED consequences of alternatives can inform decisions on whether any restoration measures are justified. More generally, both the formulation and the evaluation of alternatives will be influenced by the presence of these twin objectives.

Through adoption of the NER account, the Corps has decided to not attempt to quantify all ecosystem outcomes using NED metrics. The Corps has adopted a two-criterion evaluation approach and plans to apply an "incremental analysis" approach to decision making. In principle, incremental analysis evaluates how costs (both financial outlays and NED benefits forgone) increase with increasing levels of restoration outcomes (e.g., additional acres of floodplain hydrologically reconnected to a river's main channel).

Incremental analysis does not provide a justification for selecting any specific restoration level. Rather, justification rests on demonstrating the "significance to the nation" of the level of restoration recommended (USACE, 2003). As applications of these measures are extended, there will be an increase in both the costs (net of calculated NED benefits) of the measures and the measured level of hydrologic restoration. The question is: How much restoration is enough? Put another way: When is spending another dollar on restoration no longer justified? The Corps does not propose to answer such questions with a single benefit-cost calculation—but such questions must nonetheless be addressed. In portfolio planning, this question will be answered by negotiations among local sponsors, other stakeholders, and federal budget decision makers (see Chapter 5 for more discussion) in recognition of the significance of the resources being restored. In that analysis, ecological models might be relied on to forecast (acknowledging the existence of some degree of uncertainty) the effects of hydrologic change on certain biologic metrics. Monetary measures of people's values for the predicted habitat or other environmental services forecast to result from hydrologic restoration may be reported to document significance, as may physical habitat quality or legal and policy recognition of significance of the waters or areas where restoration is realized (for example, the area may be critical habitat according to the Endangered Species Act).

The Corps has chosen to not rely solely on benefit-cost analysis for making the final selection of an ecosystem restoration alternative, opting

to also employ nonmonetary measures. In a desire to ensure that restoration is not framed solely in economic terms, however, the agency has not adequately emphasized the fact that restoration measures can also yield traditional NED benefits (USACE, 2003). For example, restoration measures such as wetland rehabilitation or removing obstacles from a stream can reduce flood peaks and thus yield NED flood damage reduction benefits. Such benefits, however, are not reported or considered in justifying restoration measures. Planning guidelines should recognize that restoration and nonstructural measures often yield benefits traditionally understood as NED benefits, and these should be calculated and employed in project planning computations. For portfolio planning and for individual project operations and investment analysis, the Chief of Engineers should issue guidelines clarifying that traditional categories of NED benefits that accrue from restoration measures should be calculated and used in plan evaluation.

A NEW PLANNING APPROACH AND AUTHORITY

Portfolio planning would ideally support a structured and ongoing process for making decisions that over time ensures the greatest benefit from the national assets of water control infrastructure and natural capital (water and related land resources). Portfolio planning addresses questions such as: When does investment in a new project increase the value of the existing national water infrastructure portfolio? When are operational changes justified? What types of gains and losses might be realized?

The purpose of beginning planning with an explicit and open review of existing projects is not to critique past decisions, nor is it to suggest that there are no prospects for new investment. Instead, this approach seeks to enhance operational efficiency so that the benefits of flood management, navigation, water supply, hydropower, and other purposes of the existing physical infrastructure are maximized. It also seeks to ensure that new projects are constructed and then operated to be compatible with existing projects. This will enable some clarification of the Corps' roles in aquatic ecosystem restoration. Portfolio planning offers the opportunity to better anticipate operational changes of existing projects to meet legal obligations (e.g.., Endangered Species Act, Clean Water Act) and to adjust to changing economic realities and social preferences for river restoration. As an example, a portfolio planning process would create an opportunity for states, the Environmental Protection Agency,

and the Corps to integrate reservoir operations with the development of Total Maximum Daily Load (TMDL) plans.

Portfolio planning entails a continual, iterative process that will benefit from adaptive management principles (see the report from the 216 study panel on adaptive management). Of equal importance is that the spatial extent for portfolio planning will often extend beyond the immediate area affected by a project. That is, areas of study would be defined in relation to the problem or planning issue at hand, and would not be bound by conformance to fixed hydrologic or other boundaries (see Box 4-4). Portfolio planning starts by identifying and defining problems and then defining appropriate study regions. It does not assume that study boundaries are necessarily organized around watersheds, although watershed boundaries may ultimately prove to appropriately define the study area (see the 216 study panel on river basins and coastal systems planning for more details on planning across spatial scales). Finally, portfolio planning not only includes technical analysis, but also requires decision making by local, state, and federal agencies, as well as by the administration and Congress. For example, the Corps has built numerous reservoirs across the nation. Today, in the face of increased demands for municipal and industrial water supply, these reservoir projects may be considered possible water supply sources. However, many of the projects have limited storage allocated to water supply. Therefore, meeting water demands from existing reservoirs may require storage reallocation and changes in project operations. As such changes are considered, existing project purposes may be affected. Also, in considering reoperations and storage reallocation, water supply, flood control, such project purposes may have to be balanced with instream flow considerations. Given the limitations of the Corps' existing continuing authorities for conducting evaluations of post-construction project outcomes and adjusting project and system operations, along with the new realities of today's water resources planning context, the Corps should have a new authority with a stronger emphasis on promoting portfolio planning.

A new study authority should be enacted and structured according to the following principles, which will help effect portfolio planning within the Corps (Recommendation 3):

a) It should focus on existing Corps-built infrastructure (both single projects and systems) and related water and land resources in determining when operational changes, project decommissioning, or new project investments would yield economic or environmental improvements of national significance.

BOX 4-4
Portfolio Planning for Coastal Ports

The Corps' economic analyses for individual port project expansions have often been the focus of criticisms. At the same time, funds available for port projects have been limited and priorities must be set. Portfolio planning can provide a sound analytical foundation for such priority setting. For example, consider the contribution of portfolio planning in a region where one or more existing ports are being considered for deepening. Analytically, the evaluation would begin by reviewing all existing channels and their cargo flows in relation to projected future cargo flows to the region. Next, plan formulation would evaluate multiple scenarios in which different ports were considered for deepening to different depths. The analysis would report estimated NED benefits and how a plan might redistribute existing landings among ports. A risk assessment could be employed to consider the value of redundancy in capacity so that unanticipated shifts in cargo destinations or temporary loss of capacity at one port could be accommodated at other ports. Both dredge material handling problems and beneficial use opportunities for different alternatives would be reported and might usefully be considered in the context of a regional sediment management strategy (Martin, 2002). These analyses are computationally feasible with existing data bases, modeling tools, and computing power. However, the results will be sensitive to assumptions regarding national trade patterns, future locations of regional transfer facilities, and other such matters. Analysts may differ in the assumptions they make, so the sensitivity of the port development strategy analysis to such assumptions would have to be examined.

This kind of port planning will be complex and subject to dispute among experts. Portfolio planning for ports will highlight—and also inform—difficult choices that must be made when setting port spending priorities. Portfolio planning therefore does not lead to the Corps recommending a regional port development strategy. In the event of complex planning efforts, such as this example, the Chief of Engineers may choose not to make a recommendation. The Corps should aim to provide sound planning and technical assistance to the study sponsor (a port or group of ports) and to interested federal agencies. In the end, funding priorities and the federal interest are represented by the president's recommendations to the U.S. Congress.

b) Study cost-sharing would be with federal agencies and affected states, which would cooperate with the Corps in executing management and operational changes.

c) Planning studies under this authority should reconsider the original project authorization of existing Corps water control projects and their operations.

d) Planning studies under this authority should identify at least one nonstructural alternative to current project operations that seeks more efficient use of existing investments, or that may help achieve a goal without altering the hydrologic regime (e.g., purchase of flood flowage easements to reduce flood damages).

e) Planning studies should report not only traditional national economic development (NED) analysis, but also the extent to which water project investment and operations may affect jobs, income, competitiveness of industries among regional economies, and international trade.

f) Recommendations that would entail modest expenditures for changes of physical infrastructure or project operations could be authorized under this study authority.

g) Recommendations that would entail significant expenditures for changes of physical infrastructure, or that would entail additional study time and resources regarding potential shifts in project purposes, should require further congressional authorization. In addition, all authorization requests for new project investments having significant budgetary requirements or the potential for significant controversy should be evaluated under this authority's planning procedures and methods.

h) Along with environmental mitigation, alternatives should consider economic mitigation in the form of cash payments or in-kind replacement for economic services lost from significant physical or operational changes.

i) A unit at Corps Headquarters should be responsible for selecting portfolio planning studies and for assigning priorities and responsibilities for their execution, such as a study's analytical and regulatory dimensions.

SUMMARY

Federal budget support for water project investments has declined sharply. There are important national water resources planning services,

however, that can be met by the Corps. These needs authorize an ongoing planning process that evaluates current project operations and prospective new water project investments. This analysis would be conducted at large spatial scales, with explicit attention to maximizing the values derived from the existing built infrastructure, as well as related water and land resources. This chapter has defined a new planning authority and a conceptual approach to planning under that authority. Chapter 5 examines and presents the requirements for executing the portfolio planning authority.

5

Supporting Portfolio Planning

ENHANCING PLANNING CAPABILITIES AND REPORT QUALITY

There is currently a widespread perception, both within and outside the Corps, that the quality and the clarity of Corps planning studies have been declining. Leaders within the Corps acknowledge a need for strengthening the organization's planning capacities, and many groups call for routine, independent review of Corps planning studies. In making the transition to portfolio planning, the Corps' planning challenges will be even greater because there will be a need to plan over large areas, to accommodate differing values and interests, and to explicitly incorporate complexities and uncertainties of the interactions of hydrologic processes and human activities. The agency will have to keep abreast of and apply new conceptual and analytical developments to meet these challenges. This chapter discusses ways in which the Corps' planning capabilities can be strengthened and the quality of its planning studies improved.

Focusing Planning Expertise

The Corps of Engineers faces personnel and staffing pressures. At the same time, there has been a sharp reduction in its budget for general investigations (planning) in recent years. Nonetheless, the agency can take steps to make better use of available staff. Firstly, the Corps should ensure that its most knowledgeable and competent staff are assigned to its most complex and controversial planning studies. This is currently not always the case as deeply-established tradition calls for Corps of Engineers planning studies to be conducted by district offices. No matter the historical or current advantages this current arrangement confers, portfolio planning will often have to be coordinated and promoted differ-

ently. The increasing complexities and interdisciplinary breadth in Corps planning studies, combined with limits in the agency's budget and its ability to attract and retain highly-qualified personnel, make it impractical for the Corps to employ a full, interdisciplinary suite of experts at every district office. Moreover, personnel needs will differ across studies. Planning for smaller, less expensive projects entails fewer needs than portfolio planning studies that may extend across large, multijurisdictional river basins.

One of the 216 studies panels evaluated and commented on review procedures for Corps planning studies (Panel on Peer Review; NRC, 2002b). That panel's report recommended a process for identifying the agency's "more costly and controversial" studies. It also recommended creating a group that would track the progress of Corps studies, recommend whether studies should be reviewed by external experts only or whether a review panel should include Corps staff, and help appoint review panels for "internal" reviews (ibid.). That group was referred to as the Administrative Group for Peer Review (AGPR), and this committee supports the establishment of such a group. In addition to its review-related responsibilities, an Administrative Group for Peer Review could identify and assemble Corps study teams to lead the agency's largest portfolio planning studies, which will likely be the most complex, controversial, and costly.

Given that spatial scales of portfolio planning studies are often likely to be large, studies could be executed at a Corps division office(s) and could draw on expertise from across the entire Corps of Engineers, not just a particular division. Technical staff from other agencies could be engaged to supplement Corps staff capabilities. In addition, there would be a need for proactive participation by Corps Headquarters in matters related to study execution to ensure a uniform national approach and to effectively use planning expertise in the agency. The technical planning capacity available to Corps Headquarters may have to be expanded to serve this role. This arrangement would improve report quality and would help circumvent planning delays in Corps district offices that are attributable to uncertainties about planning methods and policies. Creating a means for drawing from Corps personnel across district lines and allowing Corps staff from its centers of expertise, such as the Corps Institute for Water Resources (IWR, in Alexandria, Virginia) and its Waterways Experiment Station (WES, in Vicksburg, Mississippi), would allow the Corps to bring its best minds to bear upon its more complex planning studies.

The Chief of Engineers should assign responsibility for their exe-

cution of the agency's more complex and controversial studies to specially-chartered teams that draw upon the best expertise available in the entire agency, rather than rely solely on staff from a given district or division office (Recommendation 4).

Resolving Protracted Interagency Disputes

The 216 study panels recognized the increasing number and severity of conflicts regarding Corps projects and studies. General policies and guidelines may have some value in resolving disputes, but most often they will be meaningful only when tailored to specific cases. For example, a case-specific determination might be made that a particular project to provide flood protection for subsidized crops is not in the federal interest. Based on that determination for a specific project, a more general policy regarding benefits of agricultural flood control projects in light of federal subsidies could be crafted.

The federal government needs a process through which conflicts over planning methods, values, and interests, which cannot be addressed through federal interagency agreements, can be forwarded to the appropriate decision making authorities—the administration and Congress. An existing body should be designated to review and reconcile agency conflicts over Corps activities and over economic and environmental evaluation procedures. Any federal agency with legal authority to comment on a Corps planning study, after making comments and receiving a response, should be able to seek formal review of areas of disagreement. That entity can agree to a review, offer comments without review, or send the issue back without comment for further interagency discussion.

Vesting such responsibility in these decision-making bodies is consistent with the spirit of Executive Order 12322 issued by President Reagan (Box 5-1), which requires that the Office of the President, not the Corps, make a final recommendation on all policy and budget matters that must be addressed by Congress. This executive order is less significant for its specific content than for the spirit in which it was issued. That executive order established two principles:

First, it is the president's responsibility to critically and independently review the analyses that are used for plan formulation and evaluation, before proposals are sent to Congress for its deliberations. Second, it is the ultimate responsibility of the Administration and Congress—*not federal agencies*—to make public policy decisions.

BOX 5-1
Reagan Executive Order

Executive Order 12322—Water Resources Projects

By the authority vested in me as President by the Constitution and laws of the United States of America, and in order to ensure efficient and coordinated planning and review of water resources programs and projects, it is hereby ordered as follows:

Section 1. Before any agency or officer thereof submits to the Congress, or to any committee or member thereof, for approval, appropriations, or legislative action any report, proposal, or plan relating to a Federal or Federally assisted water and related land resources project or program, such report, proposal, or plan shall be submitted to the Director of the Office of Management and Budget.

Section 2. The Director of the Office of Management and Budget shall examine each report, proposal, or plan for consistency with, and shall advise the agency of the relationship of the project to, the following:

(a) the policy and programs of the President;
(b) the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies or other such planning guidelines for water and related land resources planning, as shall hereafter be issued; and
(c) other applicable laws, regulations, and requirements relevant to the planning process.

[Section 2 amended by Executive Order 12608 of Sept. 9, 1987, 52 FR 34617, 3 CFR, 1987 Comp., p. 245]

Section 3. When such report, proposal, or plan is thereafter submitted to the Congress, or to any committee or member thereof, it shall include a statement of the advice received from the Office of Management and Budget.

Section 4. Executive Order No. 12113, as amended, is revoked.

SOURCE: The provisions of Executive Order 12322 of Sept. 17, 1981, appear at 46 FR 46561, 3 CFR, 1981 Comp., p. 178, unless otherwise noted.

A process for reviewing and resolving conflicts that cannot be resolved through planning methods or federal interagency agreements, and that elevates conflicts over applications of economic and environmental evaluation procedures and other water management ac-

tivities, should be created within an existing governmental body (Recommendation 5).

Setting Planning Priorities through Regional Assessments

In an era of limited resources, it is essential that the Corps budget be directed to the highest national water management priorities. Managers of the Corps' portfolio planning program would thus benefit from a continuing assessment of the water resources demands and conditions in the nation's watersheds as they establish study priorities. Interest in such a national assessment process is evidenced by the 2002 congressional request to the U.S. Geological Survey for a report on the design and execution of a continuing national water assessment (USGS, 2002) and by the Department of the Interior's Water 2025 Program (*http://www.doi.gov/water2025*; accessed September 29, 2003).

Nonetheless, there is no national (federal-state) cooperative program that periodically reviews water issues that may warrant national attention and that could serve as a means for setting priorities within portfolio planning. One possibility would be for the Corps to focus periodically on a different region of the country and/or an issue of concern, and report to the Congress on emerging water problems and opportunities. Another example would be for the Corps to conduct interregional comparisons. A third example could include studies of select interstate basins as longitudinal case studies with ex post evaluations of cumulative impacts. These types of reports could be used to help direct portfolio planning and to highlight other water problems and opportunities that may fall outside the agency's primary mission areas. To effectively execute this task, representatives from other federal agencies with water resources management responsibilities should be engaged. In addition, representatives from the states in the region being reviewed should be included. These regional assessments should highlight all water and related land resources management issues in the region deemed worthy of national attention.

A program of continuing regional assessments can serve as the basis for setting portfolio planning program priorities. These regional assessments, which could include comparisons of water issues between regions and longitudinal studies in select regions, should be periodically conducted in order to help identify key water resources issues of federal-level importance (Recommendation 6).

Staff Capacity

A typical Corps of Engineers planning study contains hundreds of pages and includes extensive data and results from complex economic and ecologic models. The conduct of credible and transparent planning studies in this setting requires competent, well-educated professionals. The Corps is experiencing challenges in maintaining this skilled capacity because of conditions that affect most federal agencies: better pay and better working conditions in the private sector, bureaucratic red tape and often excessive procedural requirements, and a general decline in the status of and respect for federal employees.

Leaders within the Corps recognize a need to improve internal planning capability (USACE, 2002). These leaders have also acknowledged the value of independent review, stating that they want models and analytical methods used in Corps planning studies to be able to withstand the scrutiny of external experts. This is a reasonable and commendable aim. To achieve it, the Corps should be staffed and directed by credentialed, competent individuals. As this task demands competence in a broad spectrum of fields including engineering, ecology, and social science disciplines, the Corps should possess some of the expertise from across this interdisciplinary spectrum. Finally, the public expects and deserves to have first-rank civil servants to ensure the highest level of quality in Corps planning studies.

One solution commonly proposed to ensure adequate technical skills is to transfer some of the agency's planning and analytical responsibilities to the private sector; in fact, there have been some proposals to "privatize" many of the Corps' water-related functions, and some of these proposals may have merit. Not all technical analyses in Corps planning studies must necessarily be conducted exclusively by Corps staff. There is a trend in the private sector (and to a lesser degree in the public sector) to seek talent for individual projects through recruiting experts and consultants from the private sector for a given period or contract (so-called "outsourcing"). The Corps is no different, and there will be increased reliance on technical specialists from outside the Corps, either as contractors or as advisors, to ensure that model assumptions are credible, that data sets are adequate, and that models represent the state of the practice. Shifting analytical tasks to the private sector, however, has its limits, as core, "in-house" competence is necessary for the Corps to commission, manage, and comprehend the advice of external experts. Moreover, effective use of the results of independent, expert review requires skilled staff in adequate numbers who not only understand the ad-

vice, but can tailor it to Corps regulations, budgetary realities, and local conditions.

The possibility of enhancing staff capabilities also should be considered in the context of the Corps' decentralized structure, a decentralization that has been advanced by recent reorganization (see *http://www.hq.usace.army.mil/stakeholders/Final.htm*; accessed March 5, 2004). Maintaining a core of in-house personnel at each of the Corps' 41 district offices, with the expertise to cover all dimensions of Corps planning studies, is impractical. Even under the most optimistic circumstances, full replacement of the planning capacity that was once dispersed throughout the district offices and at Corps Headquarters should not be expected. Indeed, maintaining staff capability is a problem that affects agencies beyond the Corps. This study did not include a detailed investigation regarding claims that the Corps has difficulty attracting and retaining talented personnel. Other bodies, however, have investigated the phenomenon of a dwindling pool of personnel in the middle to upper levels of the federal government, which will soon be needed to replace retiring senior staff. Box 5-2 summarizes the 2003 report from the National Commission on Public Service. The commission's chairman, former Federal Reserve Board Chairman Paul Volcker, stated the following in his preface: "Too many of our most competent career executives and judges are retiring or leaving early. Too few of our most talented citizens are seeking careers in government or accepting political or judicial appointments" (NCPS, 2003).

Few would deny that the Corps' ability to recruit and retain competent personnel is an important issue. Many of these types of personnel issues, however, transcend the Corps and must be addressed by Congress and the administration. In the meantime, it would be useful for the Corps to provide greater specificity regarding its current and future personnel needs. That is, many Corps staff have noted that the agency must have talented people to conduct credible planning studies and related investigations. Although one could scarcely argue with this, such assertions do not provide specifics on the skills and experiences that Corps staff should possess. Questions in this realm could include: Should the agency recruit more economists with advanced degrees? Does the Corps need more systems engineers? Should its engineers possess more advanced degrees and broader course work? Should the Corps hire more interdisciplinary specialists, such as policy analysts? Does it have enough ecological scientists? Does it need more in-house expertise in facilitation and conflict resolution skills? Although higher authority will be required to address fundamental personnel problems that stretch across much of the federal

BOX 5-2
The Report of the National Commission on the Public Service

This 2003 report was authored by a select panel charged to review the organization, leadership, and operations within the federal government. The group was chaired by former Federal Reserve Chairman Paul Volcker. The commission was a project of the Brookings Institution Center for Public Service and was sponsored by a grant from the Dillon Fund. Many of the report's recommendations, although aimed at the entire federal government, have direct implications for the Corps of Engineers. As an example, the report provided the following commentary on staffing issues within federal agencies that strongly applies to hiring and retention issues within the Corps:

> Within the next five years, more than half the senior managers of the federal government will be eligible to retire. Not all will, but the best estimates are that by the end of this decade, the federal government will have suffered one of the greatest drains of experienced personnel in history.
>
> That would be less worrisome if there were evidence that the middle ranks of government contained ready replacements and the entry levels were filling with people full of promise for the future. But the evidence, in fact, points in the opposite direction. Far too many talented public servants are abandoning the middle levels of government, and too many of the best recruits are rethinking their commitment, either because they are fed up with the constraints of outmoded personnel systems and unmet expectations for advancement or simply lured away by the substantial difference between public and private sector salaries in many areas. Some employees leave federal service because they can no longer tolerate the dismal facilities and working conditions in many agencies. Drab and tiny workspaces, inadequate room for storage and record-keeping, and aging lighting, heating, and air conditioning systems—too common in the federal government—seem to many employees emblematic of the low value in which they are held. The invasions of personal privacy resulting from financial reporting, background investigations, and public scrutiny in general also take a toll on morale. Increasingly, federal workers have real cause to be concerned about their personal safety.
>
> Too often, as well, federal employees depart before their time in frustration over the strangling organizational and procedural complexity of contemporary government decisionmaking. For too many, even their best efforts to be responsive and creative end up in organizational oblivion.

SOURCE: NCPS (2003).

government, more specific requests for Corps personnel would provide Congress with a clearer picture of the agency's needs.

The Secretary of the Army should report within one year to Congress on projected professional staffing, skill, and related budgetary needs for implementing portfolio planning (Recommendation 7).

A NEW SETTING FOR DECISION MAKING

Characterizing Water Resources Management Conflicts

The desire to resolve technical disputes is one reason Congress requested The National Academies to report on how an independent review process could be implemented for costly and controversial Corps projects (NRC, 2002b). Indeed, even without independent review, the Corps today has many technical experts looking over its shoulder and subjecting its analysis to critical comment. In turn, external critiques, and the agency's efforts in responding to such comments, usually add time and cost to studies. The confidence in and transparency of the analysis done by the Corps should therefore be renewed and fortified.

There are, however, reasons beyond technical credibility that warrant a more transparent planning process. In recent years there has been a diffusion of decision authority away from the Corps to other agencies (e.g., pursuant to the Clean Water Act, the U.S. Environmental Protection Agency; pursuant to the Endangered Species Act, the U.S. Fish and Wildlife Service and National Oceanic and Atmospheric Administration Fisheries). Multiple stakeholders have been empowered by these and other laws, and the sharing of decision making with these stakeholder groups is becoming increasingly frequent. Also, many of these environmental laws either explicitly or indirectly endorse some degree of hydrologic restoration. Given the Corps' history of building hydrologic control projects, some might question a Corps analysis that dismisses hydrologic restoration and nonstructural measures as unjustified. An open planning process can address such skepticism. In a setting of shared decision making, real and threatened vetoes of proposed actions abound, making compromise difficult to achieve. If a new portfolio planning agenda is to be successfully executed, conflicts must be managed, even if they cannot be eliminated, so that actions that best serve the nation's economy and environment can be identified and implemented. In order to make recommendations on how to manage conflict, it is first

necessary to characterize its sources.

In discussing conflict within the context of Corps projects and decision, it is useful to categorize the sources of contemporary conflicts. William Lord (1979) defined three types of conflicts about water management: "value," interest," and "cognitive" conflict. An additional source of conflict may derive from a diffusion of decision-making power and influence, which can be labeled as "authority conflict." This chapter's remaining recommendations are framed to address these four sources of conflict.

Value conflict stems from different assessments of the desirable goals of public action and is therefore ideological in nature. For example, water resources management decisions may result in conflict over the desirability of increased control of the hydrologic regime versus returning a river system to a more "natural" state. Stakeholders may thus agree on the physical and biological impact of certain actions, but disagree about the acceptability of this impact. For example, value conflicts may be at the source of the inability to reach agreement on Missouri River operation rules (Box 4-2). Although resolution of value conflicts may be facilitated by intergroup communication, value conflicts are typically resolved with one view prevailing over the other. In the end, portfolio planning may entail a need to choose among conflicting values. This should be the responsibility of the administration and Congress, not the responsibility of federal agencies such as the Corps. A properly structured portfolio planning process, however, should help articulate these value-based choices and facilitate discussion regarding trade-offs.

Interest conflict arises when a decision will have different effects on different groups, and the affected groups voice their support or opposition to a proposed decision. In portfolio planning, interest conflict may arise, for example, because a current benefit stream is threatened by interests in ecosystem restoration. Many stakeholders see a need for environmental mitigation when watersheds are altered toward more control, but do not see a similar need for economic mitigation when water controls are relaxed in the name of restoration. Further, some see hydrologic restoration activities coming at the expense of projects that they believe serve a compelling national interest in promoting economic and social well-being through traditional flood risk reduction and navigation objectives. Resolution of interest conflict will occur either through bargaining and compensation of those harmed, or through the exercise of power of one stakeholder over another. Environmental mitigation requirements are a form of compensation. Economic mitigation could also be a form of compensation if a portfolio planning decision favoring hydrologic res-

toration results in a loss of existing benefits, although the need for economic mitigation may be debated.

Cognitive conflict arises over the data, analyses, and models used in the planning process. For example, groups may have different perceptions of the effects of increased water withdrawals on lake levels or of the legality of water withdrawals. In general, cognitive conflicts are resolved when agreement is reached on the models and data used for analysis, and when details of the analysis are open to inspection. If technical analysts have differences of opinion (a common occurrence given the incomplete understanding of the interplay between numerous watershed ecological processes), multiple models and analyses may be required, and uncertainties may have to be explicitly presented to decision makers (NRC, 2001). Technical expertise, however, is not monolithic. There has been a rapid expansion of the disciplines, models, and analytical approaches of what might broadly be termed "environmental sciences," where once only engineers were looked to as experts. The fragmentation and diffusion of expertise is also occurring within disciplines. For example, there is a subdiscipline of wetlands science that holds its own professional meetings and has its own peer-reviewed journal. As the numbers of sub-disciplines has grown, so has the number of experts, as have differences among experts within and between disciplines. Nonetheless, it is more likely that agreement can be reached on cognitive conflicts than value or interest conflicts. The Corps can thus no longer (relative to past years) make a claim of having the most or the best technical experts. Even as the understanding of complex systems advances, competing claims of expertise are made, experts are diffused among increasingly fractured disciplinary programs, and more disciplines are claiming a voice in discussions on scientific matters. The portfolio planning process must accommodate this reality.

Authority conflict results from a post-1970 diffusion of powers created by the form and number of laws passed in that period (e.g., Clean Water Act, National Environmental Policy Act, Endangered Species Act) for making water and related land resources decisions. Citizens in coalitions with often different perspectives may claim to represent the "public interest" versus "special interests." There has been an irreversible diffusion of power and technical abilities among agencies and the public, accompanied by some degree of mistrust of Corps planning studies and their conclusions. This diffusion of power and expertise, coupled with an erosion of trust in Corps analyses, has paralleled an erosion of the Corps' internal planning capability, making it necessary to revisit how the agency plans and makes decisions.

STREAMLINING WATER RESOURCES DECISION MAKING

Computer-Aided Decision Making

Incorporating affected groups and individuals into a planning process (e.g., through formation of citizen or agency advisory committees) is becoming a more common means of addressing national water resources conflicts. Assembling all affected interests may aid in identifying and reconciling some sources of conflict. It also presents an opportunity to use computer simulation methods to enhance these deliberations. Mathematical (computer-based) simulation models can characterize and forecast the effects of different alternatives on fish and wildlife populations, the economy, or the income of a given group. These models, however, are only abstractions of complex systems, and approximations of some relationships are thus necessary in their construction. Model results are therefore likely to be sensitive to model-building judgments. Decision makers must have confidence in the soundness of a model's assumptions, relationships, and forecast outcomes. Agreement on these features will be necessary if they are to help forge consensus on complex planning issues among multiple stakeholders. Computer simulation models that are built, reviewed, and tested collaboratively with all stakeholders can be a foundation for such an effort. The Corps has been at the forefront of developing and using computer simulation as an assistant to collaborative decision making, and the agency uses the phrase "Shared Vision Modeling" to describe its initiatives in this realm. More generally, integrating simulation models with collaborative discussions might be termed "computer-aided decision making."

In this process, models and data are used to help stakeholders ask "what-if" questions of the models they helped to construct. This capacity can assist in reaching agreement in two ways. One is to test the sensitivity of model results to input data or other factors that might be in dispute. Given scientific uncertainties and room for different views, the ability to view the broad results of what-if simulations, under different sets of assumptions, may help participants agree on some planning objectives, alternatives that might be formulated, and how different alternatives might affect their social and economic interests. A second means by which what-if modeling can encourage agreement is to allow rapid assessment of trade-offs by letting stakeholders "experiment" with different alternatives, see the consequences immediately, and search for bases of agreement to discover and discuss trade-offs.

Several challenges attend the use of computer-aided decision mak-

ing, however, which are not unique to this approach. First, if decision making is to be truly collaborative, decisions must be made in a process that engages and draws on the expertise of federal and state agencies, as well as stakeholders with different perspectives (other 216 panels made similar observations regarding stakeholder collaboration). Second, computer-aided decision making will not resolve differences among agencies and other stakeholders if they are unwilling to negotiate in the absence of computer-assisted approaches. Third, stakeholders must agree to be part of the computer-aided decision making process and to abide by its outcomes if they are satisfied that the process has provided an equitable and technically-credible consideration of alternatives.

The Corps has applied its Shared Vision Modeling decision support approach and has applied it to good effect in some instances. This type of decision support system holds promise in promoting discussion among stakeholders, highlighting areas of technical agreement and unknowns, explaining probabilities of outcomes, and framing questions for further investigation. This type of approach is not likely to resolve all water resources conflicts. In settings of sharp and protracted water resources conflicts (in several of which the Corps is currently embroiled) however, the use of decision support approaches such as Shared Vision Modeling is merited. Only a few Corps staff members have knowledge of and experience in applying the Shared Vision Modeling package, and it has not been applied in prominent water resources controversies, such as those that currently exist on the Missouri and Upper Mississippi Rivers, for example.

Computer-aided decision making is a promising approach to helping clarify and resolve conflicts over water management priorities. A "community of practice" in computer-aided decision making that facilitates discussions between Corps staff and outside experts should be established (Recommendation 8).

Chief's Report

The end product of a Corps planning study is a report that contributes to a political determination of which values and interests are to be served. For the Corps' costly and controversial activities, however, results from technical analysis alone will rarely offer a compelling resolution of value- and interest-based differences. Because the resolution of differences in values and interests often transcends the ability of technical analysis to do so, the appropriate role of planning reports in water

project decision making should not necessarily be to identify the best decisions. This is especially true when many of the authorities that will be required to execute a preferred alternative reside with state and local governments and other federal agencies.

Corps planning studies should identify a range of alternatives and their respective assumptions, uncertainties, consequences, strengths and weaknesses, and benefits and costs—an evaluation that may not necessarily suggest clearly a preferred alternative. For more traditional planning studies that address smaller-scale (in terms of area, costs, and conflicts) problems, the Chief's Report is an appropriate means of recommending a preferred alternative. However, for a larger, more expensive, and more controversial portfolio planning efforts, responsibility for selecting preferred alternative actions over time should ultimately rest with elected leaders, especially when policy dimensions involved outweigh technical concerns (portfolio planning processes may at times extend over many years and would thus benefit from the application of adaptive management principles as discussed in the report from the 216 panel on adaptive management, and those identified in the professional literature (Anderson et al., 1999; Gunderson, 2002; Lee, 1999)). Accordingly, the selection of a preferred alternative will rest with the administration, Congress, and the states. In these instances, it may be appropriate for the Chief of Engineers, as a line agency, to provide technical information regarding alternatives, but not attempt to reconcile fundamental value and interest conflicts.

Portfolio planning may result in disagreements among agencies, levels of government, and stakeholders, which are appropriately resolved by the president and the Congress. In such cases, a Chief's Report should include a full reporting of alternatives that were not recommended, relevant supporting analyses, and a clear explanation for the recommendation made the most controversial decisions. In addition, a recommendation of a preferred plan by the Chief of Engineers should not be compulsory (Recommendation 9).

Reconnaissance Studies and Study Cost Sharing

Reconnaissance Studies

Portfolio planning can extend over several years and will often consider multiple projects and activities across large watersheds and river basins. Portfolio planning thus does not fit neatly into the reconnais-

sance and feasibility report hierarchy used by the Corps; different study budgeting and cost-sharing arrangements may have to be considered. The Corps presently conducts its planning studies in two phases: an initial reconnaissance phase, followed by a project feasibility phase. Reconnaissance studies are currently limited to a cost of no more than $100,000, are not cost-shared, and are to be completed within one year. These limits may be well suited for smaller, single-purpose studies and may be useful in minimizing costs and ensuring that planning studies progress with due speed (the report of the 216 panel on methods of analysis and project planning also notes the current limitations of reconnaissance studies).

The Corps, however, should focus some of its planning on large systems, make planning a continuous process over extended periods, and involve multiple stakeholders. Under current arrangements, superficial assessment during study reconnaissance may preclude the consideration of viable alternatives during the feasibility study phase. This may ultimately contribute to cost increases and to continuing stakeholder conflict during and after the feasibility study. A portfolio planning process should be a thoughtful, comprehensive, and continuing study process to reach agreement on problems and opportunities, definitions, data and modeling approaches that will be used, and the range of alternatives that will be studied. Sound reconnaissance studies for these latter types of complex systems simply cannot be accomplished within the $100,000 and one year limits.

The Secretary of the Army should review reconnaissance study cost limitations and should report to the Congress with a proposal to match study time and costs to the scale and complexity of the water resources issues at hand. Congress, in authorizing a portfolio planning authority, should consider whether reconnaissance study cost limitations should apply and whether the distinction between reconnaissance and feasibility study stages should be reconsidered and possibly eliminated.

Study Cost-Sharing

There is a long history of employing cost sharing arrangements (in which a local sponsor provides partial funding) in Corps planning studies and projects. Despite positive effects of study cost sharing (e.g., the imposition of some discipline on the demand for planning studies), the same cost-sharing arrangements have apparently directed the Corps away from a responsibility to consider problems and opportunities that extend

beyond the interests of the study cost-share partner. Anecdotal evidence exists to support this assertion, but conclusive evidence is not at hand. Concerns regarding study cost-sharing, however, if documented, would warrant changes to ensure that the broader planning perspectives expected with the new portfolio planning authority are not undercut by the disincentives of study cost-sharing (most of the 216 study panels identified and considered similar issues related to cost-sharing).

Portfolio planning will be most effectively and appropriately conducted over large spatial scales and over extended periods of time. Current reconnaissance study and study cost share guidelines, however, may inhibit studies with these more comprehensive perspectives. A review of the applicability of reconnaissance study cost limitations, the distinction between the reconnaissance and feasibility study stages, and modification of study cost sharing requirements, should thus be undertaken, with subsequent adjustments made to advance portfolio planning (Recommendation 10).

Backlog of Authorized, Unfunded Projects

Debates about funding individual "backlogged" projects—those projects that have been authorized, but which have not yet been appropriated resources—may diminish opportunities for the Corps and the nation to benefit from portfolio planning. Today, there are widespread disputes regarding the current and future values of projects that were authorized many years, sometimes decades, ago. For example, projects that raised opposition by the "Corps Reform" caucus were often authorized many years ago. There is a need for a process to review and rank funding priorities for projects in this backlog (this process could be informed by planning done under the new study authority called for in this report). One option is that Congress, in cooperation with the administration, appoint a panel to evaluate and prioritize the projects in the backlog. Such a panel could also suggest candidate projects for deauthorization. That panel's recommendations might be reported openly, although neither Congress nor the administration would be bound by its recommendations. As the portfolio planning program matures, and as the regional assessment process conducts its work, it is likely that new work might be authorized and that priorities would have to be reordered. The panel could be reconvened periodically.

The presence of "backlogged" Corps projects—those that have received congressional authorization but have not yet received finan-

cial appropriations—could limit the utility of portfolio planning. When assessing potential new projects and alternative operations of existing projects, this backlog can confuse the setting of priorities that will derive from execution of the new study authority. Congress should develop a process for inventorying and ranking the funding priority of authorized, but unfunded, Corps projects that constitute the current project backlog, which can both inform and benefit from portfolio planning (Recommendation 11).

6

Epilogue

Through its history of managing national water resources, the U.S. Army Corps of Engineers has been charged primarily to construct channels, levees, and reservoirs to serve navigation, flood control, and other purposes. As noted in this report, the overarching goal of these projects was to control the control hydrologic variability and geomorphic processes in the nation's rivers and coastal areas. Over time, however, the Corps project construction program has receded in national importance, and national water priorities beyond flood control and navigation have emerged. Federal funding for water projects has generally declined since the 1950s. In many of the nation's watersheds, there is little room left to construct more projects, with the headwaters of some reservoirs and navigation pools backing up to the tailwaters of upstream dams. There is a need to ensure that existing Corps-built projects are managed to meet future navigation and flood management needs, as well as emerging water needs. There is also a need to ensure that new projects will be evaluated in terms of how much they contribute beyond the benefits to be derived from the existing system of projects. In sum, the planning challenge for the Corps is to respond substantively to an emerging vision of water management—a vision referred to in this report as "portfolio planning."

Portfolio planning will be best advanced by clear instruction through a new study authority, by strategies that deploy Corps technical staff capability to maximize their value to the nation, and by procedures that elevate fundamental policy decisions to responsible decision- making authority within the administration, Congress, and the states. There is a need to refocus the Corps planning process and then support it via the means and procedures presented in this report. The current planning process, which is still largely oriented toward planning for new projects on a case-by-case basis, has not halted the long-term decline in federal funding, nor has it effectively addressed the increasing criticisms of Corps reports on such projects.

The importance of the administration and Congress in effecting these shifts cannot be overstated, as only they can provide the resources and authorities to allow the Corps to move aggressively to address a diverse and changing suite of national water-related needs. This report and the reports of the 216 study panels are the latest in a long line of reviews requested to comment on Corps programs and national water management. These reviews date back (at least) to the early twentieth century and include the National Resources Planning Board in the 1930s, the Cooke Commission of the middle twentieth century, and the National Water Commission of the 1960s and 1970s. Although the setting of Corps projects and operations has changed markedly over the years, a key message that has emerged from the 216 studies parallels findings from these previous distinguished groups: clear direction and support from the administration and Congress are necessary to enable the Corps to serve the nation's water management needs and to adjust its efforts in response to shifting national water management priorities.

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Appendixes

Appendix A

Water Resources Development Act 2000
Public Law No. 106-541, of the 106th Congress

SEC. 216. NATIONAL ACADEMY OF SCIENCES STUDY.

(a) DEFINITIONS—In this section, the following definitions apply:

(1) ACADEMY—The term "Academy" means the National Academy of Sciences.

(2) METHOD—The term "method" means a method, model, assumption, or other pertinent planning tool used in conducting an economic or environmental analysis of a water resources project, including the formulation of a feasibility report.

(3) FEASIBILITY REPORT—The term "feasibility report" means each feasibility report, and each associated environmental impact statement and mitigation plan, prepared by the Corps of Engineers for a water resources project.

(4) WATER RESOURCES PROJECT—The term "water resources project"' means a project for navigation, a project for flood control, a project for hurricane and storm damage reduction, a project for emergency streambank and shore protection, a project for ecosystem restoration and protection, and a water resources project of any other type carried out by the Corps of Engineers.

(b) INDEPENDENT PEER REVIEW OF PROJECTS—

(1) IN GENERAL—Not later than 90 days after the date of enactment of this Act, the Secretary shall contract with the Academy to study, and make recommendations relating to, the independent peer review of feasibility reports.

(2) STUDY ELEMENTS—In carrying out a contract under paragraph (1), the Academy shall study the practicality and efficacy of the independent peer review of the feasibility reports, including—

(A) the cost, time requirements, and other considerations relating to the implementation of independent peer review; and

(B) objective criteria that may be used to determine the most effective application of independent peer review to feasibility reports for each type of water resources project.

(3) ACADEMY REPORT—Not later than 1 year after the date of a contract under paragraph (1), the Academy shall submit to the Secretary, the Committee on Transportation and Infrastructure of the House of Representatives, and the Committee on Environment and Public Works of the Senate a report that includes—

(A) the results of the study conducted under paragraphs (1) and (2); and

(B) in light of the results of the study, specific recommendations, if any, on a program for implementing independent peer review of feasibility reports.

(4) AUTHORIZATION OF APPROPRIATIONS—There is authorized to be appropriated to carry out this subsection $1,000,000, to remain available until expended.

(c) INDEPENDENT PEER REVIEW OF METHODS FOR PROJECT ANALYSIS—

(1) IN GENERAL—Not later than 90 days after the date of enactment of this Act, the Secretary shall contract with the Academy to conduct a study that includes—

(A) a review of state-of-the-art methods;

(B) a review of the methods currently used by the Secretary;

(C) a review of a sample of instances in which the Secretary has applied the methods identified under subparagraph (B) in the analysis of each type of water resources project; and

(D) a comparative evaluation of the basis and validity of state-of-the-art methods identified under subparagraph (A) and the methods identified under subparagraphs (B) and (C).

(2) ACADEMY REPORT—Not later than 1 year after the date of a contract under paragraph (1), the Academy shall transmit to the Secretary, the Committee on Transportation and Infrastructure of the House of Representatives, and the Committee on Environment and Public Works of the Senate a report that includes—

(A) the results of the study conducted under paragraph (1); and

(B) in light of the results of the study, specific recommendations for modifying any of the methods currently used by the Secretary for conducting economic and environmental analyses of water resources projects.

(3) AUTHORIZATION OF APPROPRIATIONS—There is authorized to be appropriated to carry out this subsection $2,000,000. Such sums shall remain available until expended.

Appendix B

Committee Meetings and Presenters at the Committee's Information Gathering Meetings

COORDINATING COMMITTEE

Meeting 1 (September 24-25, 2001, Washington, D.C.)

Dominic Izzo, Principal Deputy Assistant Secretary of the Army for Civil Works
Fred Caver, Deputy Director of Civil Works, U.S. Army Corps of Engineers (USACE)
James Johnson, Chief of Planning, USACE
Benjamin Grumbles, House Committee on Science
Arthur Chan, House Committee on Transportation and Infrastructure
John Anderson, House Committee on Transportation and Infrastructure

Meeting 2 (February 7-8, 2002, Washington, D.C.)

Richard Mertens, Water and Power Branch, Office of Management and Budget
General Vald Heiberg (Army Retired), former Chief of Engineers
Hon. Wayne Gilchrest (D-Maryland)

Meeting 3 (Closed, July 12-13, 2002, Woods Hole, Massachusetts)

Meeting 4 (Closed, November 7-8, 2002, Irvine, California)

Meeting 5 (January 27-28, 2003, Washington, D.C.)

William Werick, Institute for Water Resources, Corps of Engineers
General Robert Griffin, Director of Civil Works, Army Corps of Engineers
Eldon James, Rappahannock River Basin Commission

Meeting 6 (Closed, April 3-4, 2003, Palo Alto, California)

PEER REVIEW

Meeting 1 (October 29-30, 2001, Washington, D.C.)

General Robert Flowers, Chief of Engineers, U.S. Army Corps of Engineers
Ronald N. Kostoff, Office of Naval Research

Richard Worthington, USACE
Meeting 2 (January 10-11, 2002, Washington, D.C.)
Timothy Searchinger, Environmental Defense
Jack Fritz, National Research Council
Meeting 3 (Closed, March 7-8, 2002, Irvine, California)

PROJECT PLANNING PANEL
Meeting 1 (April 16-17, 2002, Washington, D.C.)
James Johnson, Chief of Planning Corps of Engineers
David Moser and Eugene Stakhiv, Institute for Water Resources, Corps of Engineers Robert Lindler, Chief of Planning, Corps of Engineers, Baltimore District
John Williams, Citizen member of the C&D Canal Working Group
Steve Fitzgerald, Chief Engineer, Harris County (TX) Flood Control District
David Conrad, National Wildlife Federation
Nellie Tsipoura, Natural Resources Defense Council

Meeting 2 (August 16-17, 2002, St. Paul, Minnesota)
Col. Robert Ball, USACE
Dominic Izzo, Acting Deputy Assistant Secretary of the Army for Civil Works
Edward McNally, Lead Planner, USACE
Buddy Arnold, Team Leader, Planning and Policy Team, Mississippi Valley Division
Susan Smith, Senior Planner, Planning and Policy Team, Mississippi Valley Division
Meeting 3 (Closed, November 5, 2002, Irvine, California)
Meeting 4 (Closed, February 26-27, 2003, Washington, D.C.)

ADAPTIVE MANAGEMENT
Meeting 1 (May 2-3, 2002, Washington, D.C.)
James Johnson, Chief of Planning, USACE
Lynn Martin, Institute for Water Resources
Meeting 2 (July 29-30, 2002, St. Paul, Minnesota)
Kenneth Lubinski, Senior Scientist, Upper Midwest Environmental Sciences Center
Gretchen Benjamin, Wisconsin Department of Natural Resources
Steve Light, Institute for Agriculture and Trade Policy

Donald Powell, USACE, St. Paul District
Lisa Heddin, USACE, St. Paul District
Gary Palesh, USACE, St. Paul District
Jeff Gulan, USACE, St. Paul District
Leon Mucha, USACE, St. Paul District
Dick Otto, USACE, St. Paul District
Dan Krumholz, USACE, St. Paul District
Steven Tapp, U.S. Fish and Wildlife Service
Keith Basseke, U.S. Fish and Wildlife Service

Meeting 3 (November 21-22, 2002, West Palm Beach, Florida)

John Ogden, South Florida Water Management District
Nick Aumen, National Park Service
Stu Appelbaum, USACE
Mark Kraus, National Audubon Society

RIVER BASINS AND COASTAL SYSTEMS

Meeting 1 (June 4-5, 2002, Washington, D.C.)

Harry Kitch, Guidance Development Branch, Planning and Policy Division, Corps of Engineers
Scott Faber, Water Resources Specialist, Environmental Defense
Robert Brumbaugh, Institute for Water Resources
Charles Chesnutt, Coastal Engineer, Engineering & Construction Division, USACE

Meeting 2 (September 5-6, 2002, New Orleans, Louisiana)

Russ Reed, Jacksonville District, USACE
William Good, Coastal Resources Division, Louisiana
Kenneth Orth, Institute for Water Resources, Corps of Engineers
Joeseph Dixon, Los Angeles District, USACE
David Schmidt, Savannah District, USACE
John Saia, New Orleans District, USACE
John Keifer, Kentucky Geological Survey
Craig Fischenich, Waterways Experiment Station, USACE

Meeting 3 (Closed, November 8, 2002, Irvine, California)

Appendix C

Rosters

Coordinating Committee

LEONARD SHABMAN, Chair, Resources for the Future, Washington, D.C.
GREGORY B. BAECHER, University of Maryland, College Park
DONALD F. BOESCH, University of Maryland, Cambridge
ROBERT W. HOWARTH, Cornell University, Ithaca, New York (*through November 2002*)
GERALDINE KNATZ, Port of Long Beach, Long Beach, California
JAMES K. MITCHELL, Virginia Polytechnic Institute and State University, Blacksburg
LARRY A. ROESNER, Colorado State University, Fort Collins (*through August 2003*)
A. DAN TARLOCK, Chicago-Kent College of Law, Chicago, Illinois
VICTORIA J. TSCHINKEL, The Nature Conservancy, Altamonte Springs, Florida
JAMES G. WENZEL, Marine Development Associates, Inc., Saratoga, California
M. GORDON WOLMAN, Johns Hopkins University, Baltimore, Maryland

Peer Review Procedures

JAMES K. MITCHELL, Chair, Virginia Polytechnic Institute and State University, Blacksburg
MELBOURNE BRISCOE, Office of Naval Research, Arlington, Virginia
STEPHEN J. BURGES, University of Washington, Seattle
LINDA CAPUANO, Honeywell, Inc., San Jose, California
DENISE FORT, University of New Mexico, Albuquerque
PORTER HOAGLAND, Woods Hole Oceanographic Institution, Massachusetts
DAVID H. MOREAU, University of North Carolina, Chapel Hill
CRAIG PHILIP, Ingram Barge Company, Nashville, Tennessee
JOHN T. RHETT, Consultant, Arlington, Virginia

RICHARD E. SPARKS, Illinois Water Resources Center, Urbana
BORY STEINBERG, Steinberg and Associates, McLean, Virginia

Panel on Methods and Techniques of Project Analysis
GREGORY B. BAECHER, Chair, University of Maryland, College Park
JOHN B. BRADEN, University of Illinois, Urbana-Champaign
DAVID L. GALAT, University of Missouri, Columbia
GERALD E. GALLOWAY, Titan Corporation, Fairfax, Virginia
ROBERT G. HEALY, Duke University, Durham, North Carolina
EDWIN E. HERRICKS, University of Illinois, Urbana-Champaign
CATHERINE L. KLING, Iowa State University, Ames
LINDA A. MALONE, College of William and Mary, Williamsburg, Virginia
RAM MOHAN, Blasland, Bouck & Lee, Inc., Annapolis, Maryland
MAX J. PFEFFER, Cornell University, Ithaca, New York
DOUG PLASENCIA, AMEC, Phoenix, Arizona
DENISE J. REED, University of New Orleans, Louisiana
JAN A. VELTROP, Consultant, Skokie, Illinois

Adaptive Management for Resource Stewardship
DONALD F. BOESCH, Chair, University of Maryland-Center for Environmental Science, Cambridge
HENRY J. BOKUNIEWICZ, University of New York, Stony Brook
RICHARD DE NEUFVILLE, Massachusetts Institute of Technology, Cambridge
G. EDWARD DICKEY, Consultant, Baltimore, Maryland
HOLLY D. DOREMUS, University of California, Davis
FREDRICK J. HITZHUSEN, Ohio State University, Columbus
CARL HERSHNER, Virginia Institute of Marine Science, Gloucester Point, Virginia
CHARLES D. D. HOWARD, Charles Howard Associates, British Columbia, Canada
WILLIAM R. LOWRY, Washington University, St. Louis, Missouri
BARRY NOON, Colorado State University, Fort Collins
THAYER SCUDDER, California Technology Institute, Pasadena
ROBERT W. STERNER, University of Minnesota, Minneapolis

River Basin and Coastal Systems Planning
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GAIL M. ASHLEY, Rutgers University, Piscataway, New Jersey

DENISE L. BREITBURG, Smithsonian Environmental Research Center, Edgewater, Maryland
VIRGINIA R. BURKETT, U.S. Geological Survey, Lafayette, Louisiana
JOSEPH J. CORDES, George Washington University, Washington, D.C.
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JOHN A. DRACUP, University of California, Berkeley
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Appendix D

Biographical Information of Coordinating Committee and Staff

Leonard Shabman, *Chair*, is Resident Scholar at Resources for the Future in Washington DC. Previously he was a faculty member at Virginia Tech and served as the Director of the Virginia Water Resources Research Center. He has been a staff economist at the United States Water Resources Council, Scientific Advisor to the Assistant Secretary of Army, Civil Works August and a Visiting Scholar at the National Academy of Sciences National Research Council. He has provided consultation and advice to numerous governmental and non-governmental organizations. Dr. Shabman's research has ranged over diverse topics including natural hazard management, wetlands management, benefit cost analysis for public investment decision making, the role of economic analysts in public policy formulation and incentive-based environmental regulation. He is a member of the Water Science and Technology Board and has served on NRC committees, including Restoration of Aquatic Ecosystems, Flood Control for the American River, California, Watershed Management, U.S. Geological Survey Water Resources Research, and as vice chair for "Compensating for Wetlands Losses Under the Clean Water Act." He earned his Ph.D. degree from Cornell University.

Gregory B. Baecher is professor in and chair of the civil engineering program at the University of Maryland. Prior to joining the faculty at Maryland in 1995, Dr. Baecher served on the faculty of civil engineering at the Massachusetts Institute of Technology from 1976 to 1988, and he served as the chief executive officer and founder of ConSolve Incorporated, Lexington, Massachusetts, from 1988 to 1995. His fields of expertise include risk analysis, water resources engineering, and statistical methods. Dr. Baecher is currently a member of the Water Science and Technology Board (WSTB). Dr. Baecher received his B.S. degree in civil engineering from the University of California-Berkeley and his M.S. and his Ph.D. degrees in civil engineering from the Massachusetts Institute of Technology.

Donald F. Boesch is a professor of marine science and president of the University of Maryland Center for Environmental Science (UMCES). Dr. Boesch is a biological oceanographer who has studied coastal and continental shelf environments along the Atlantic Coast and in the Gulf of Mexico, eastern Australia, and the East China Sea. He has published two books and more than 60 papers on marine benthos, estuaries, wetlands, continental shelves, oil pollution, nutrient overenrichment, environmental assessment and monitoring and science policy. In 1980 he returned to his native state as the first executive director of the Louisiana Universities Marine Consortium (LUMCON), where he was also a professor of marine science at Louisiana State University. He was a Fulbright postdoctoral fellow at the University of Queensland and subsequently served on the faculty of the Virginia Institute of Marine Science. Dr. Boesch received his B.S. degree from Tulane University and his Ph.D. degree from the College of William Mary.

Geraldine Knatz is the managing director of development for the Port of Long Beach. Appointed to her current position in March 1999 after 11 years as planning director, she oversees the port's engineering, properties, and planning divisions. She directed the port's reuse planning for the former Long Beach naval complex and has been involved in the Alameda Corridor rail improvement project since its inception in the early 1980s. She is active in the American Association of Port Authorities (AAPA) and chairs its Harbor and Navigation Committee, which deals with dredging and environmental issues. In 1997, she was named to represent the International Association of Ports and Harbors (IAPH) on an international treaty body known as the London Convention, which regulates international ocean dumping practices. In 1994, she was appointed to the National Sea Grant Panel, which oversees certification and funding of Sea Grant Colleges. Dr. Knatz received her M.S. degree in environmental engineering and her Ph.D. degree in biological sciences from the University of Southern California.

James K. Mitchell (NAS/NAE) is the University Distinguished Professor Emeritus at Virginia Polytechnic Institute and State University in Blacksburg, Virginia. Dr. Mitchell's expertise is in civil engineering and geotechnical engineering, with emphasis on problems and projects involving construction on, in, and with the earth; mitigation of ground failure risk; waste containment and site remediation soil improvement; soil behavior; geotechnical earthquake engineering; environmental geotechnics; and compositional and physicochemical properties of soils. He has

served on several NRC committees. Dr. Mitchell received his B.S. degree in civil engineering from Rensselaer Polytechnic Institute and his M.S. and Ph.D. degrees from Massachusetts Institute of Technology.

A. Dan Tarlock holds an A.B. and LL. B. from Stanford University and is currently the Distinguished Professor of Law and associate dean for Faculty at the Chicago-Kent College of Law. He previously practiced law in San Francisco and Denver, and taught at the University of Chicago, Indiana University, the University of Kansas, the University of Michigan, the University of Texas, and the University of Utah. Mr. Tarlock has written and consulted widely in the fields of water law, environmental protection and natural resources management. Mr. Tarlock served a member of the WSTB and chaired the Committee on Western Water Management Change, which published the report *Water Transfers in the West*. In 1997-1998, he served as the principal writer for the Western Policy Advisory Review Commission's report *Water in the West*. Mr. Tarlock is currently serving as one of the three U. S. legal advisers to the Secretariat of the Commission on Environmental Cooperation, established by the North American Free Trade Agreement Environmental Side Agreement.

Victoria J. Tschinkel is state director of the Nature Conservancy in Altamonte, Florida. Her expertise is in assisting corporate clients on strategic environmental issues and in representing clients before agencies and the state legislature. Ms. Tschinkel is a director of Phillips Petroleum Company, Resources for the Future, and the Center for Clean Air Quality. She is a member of the National Academy of Public Administration. She also served as secretary of the Florida Department of Environmental Regulation (1981-1987) and has held positions on a number of national advisory councils such as the National Environmental Enforcement Council and the Energy Research Advisory Board. She currently serves as a member of the NRC Board on Radioactive Waste Management and is a former member of the Commission on Geosciences, Environment, and Resources. She has served on numerous NRC study committees. Ms. Tschinkel earned her B.S. degree in zoology from the University of California, Berkeley.

James Wenzel (NAE) is president and chair of Marine Development Associates, Inc., a company he formed in 1994. Mr. Wenzel has 40 years of experience in the fields of ocean science, and engineering. Formerly with Lockheed Corporation, he was responsible for many ocean

system and technology developments, including the *Deep Quest* research submarine, the U.S. Navy's deep submergence rescue vehicles, and the design and construction of deep ocean-large object recovery systems. His environmental cleanup activities include the application of technologies to the remediation of contaminated shelf sediments, corporate strategic planning, and ocean technology development. Mr. Wenzel is a member of several professional organizations, including the Society of Naval Architects and Marine Engineers and the Marine Technology Society and is a director of the Year of the Ocean Foundation. Mr. Wenzel was presented with an honorary doctorate from California Lutheran University for his contributions to ocean engineering. He received B.S. and M.S. degrees in aeronautical engineering from the University of Minnesota.

M. Gordon Wolman (NAS) is a professor in the Department of Geography and Environmental Engineering Geomorphology and Department of Environmental Health Sciences at Johns Hopkins University. His fields of research include hydrology, geomorphology, and geography. In relating catastrophic to moderate natural events, his "magnitude-frequency" theory is widely accepted among scientists and engineers dealing with rivers, floods, and erosion. He also chaired the Isaiah Bowman Department of Geography and became professor of geography, and chaired the Department of Geography and Environmental Engineering at Johns Hopkins University. He was the B. Howell Griswold, Jr., Professor of Geography and International Affairs and also served as interim provost, and interim provost and vice president for academic affairs. Dr. Wolman is a member of the National Academy of Science and has served in numerous NRC committees. Dr. Wolman received his B. A. (with honors) from The Johns Hopkins University), and his M.S. and Ph. D. degrees in geology from Harvard University.

Staff

Jeffrey W. Jacobs is a senior program officer with the National Research Council's Water Science and Technology Board. His research interests include policy and organizational arrangements for water resources management and the use of scientific information in water resources decision making. He has studied these issues extensively in both the United States and mainland Southeast Asia. Since joining the NRC in 1997, he has served as study director for 13 study committees. He received his B.S. degree from Texas A&M University, his M.A. degree

from the University of California, Riverside, and his Ph.D. degree from the University of Colorado.

Ellen A. De Guzman is a research associate with the National Research Council's Water Science and Technology Board. She has worked on a number of studies including Privatization of Water Services in the United States, Review of the USGS National Water Quality Assessment Program, and Drinking Water Contaminants (Phase II). She co-edits the WSTB newsletter and annual report and manages the WSTB homepage. She received her B.A. degree from the University of the Philippines.