

2



US Army Corps
of Engineers
Waterways Experiment
Station

AD-A243 561



DTIC
ELECTE
DEC 17 1991
S C D

Development of the US Army Corps of Engineers Wetlands Research Program, October 1990

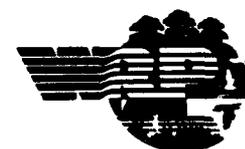
by Mary C. Landin



91-17864



October 1991 - Final Report
Approved For Public Release; Distribution Is Unlimited



91 1213 105

The following two letters used as part of the number designating technical reports of research published under the Wetlands Research Program identify the area under which the report was prepared:

	<u>Task</u>		<u>Task</u>
CP	Critical Processes	RE	Restoration & Establishment
DE	Delineation & Evaluation	SM	Stewardship & Management

Destroy this report when no longer needed. Do not return it to the originator.

The findings in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

The contents of this report are not to be used for advertising, publication, or promotional purposes. Citation of trade names does not constitute an official endorsement or approval of the use of such commercial products.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE October 1991	3. REPORT TYPE AND DATES COVERED Final report	
4. TITLE AND SUBTITLE Development of the US Army Corps of Engineers Wetlands Research Program, October 1990			5. FUNDING NUMBERS	
6. AUTHOR(S) Mary C. Landin				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) USAE Waterways Experiment Station, Environmental Laboratory, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199			8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) US Army Corps of Engineers, Washington, DC 20314-1000			10. SPONSORING / MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161				
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited			12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) <p>The US Army Corps of Engineers (USACE) Wetlands Research Program (WRP) was designed and implemented in fiscal year 1991 to address the needs expressed by the National Wetlands Policy Forum Report for protecting and managing the Nation's wetlands. The purpose of the ongoing WRP is to use scientific and engineering disciplines of the USACE, in coordination and cooperation with other agencies and offices, to provide environmentally sound, cost-effective techniques to examine and provide information on a number of research and development topics.</p> <p>To accomplish planned WRP work, eight task areas (TAs) have been developed. These include two program management task areas: TA-I, Interagency Coordination and Cooperation, and TA-II, Technology and Information Transfer. Six research and development task areas have 18 work units that address specific wetland topics. These include TA-III, Critical Processes of Wetlands; TA-IV, Delineation and Evaluation of Wetlands; TA-V, Restoration, Protection, and Establishment of Wetlands; TA-VI, Predicting and Minimizing Impacts in Wetlands; TA-VII, Wetlands Change Assessment; and TA-VIII, Stewardship and Management of USACE-Controlled Wetlands.</p> <p style="text-align: right;">(Continued)</p>				
14. SUBJECT TERMS See reverse			15. NUMBER OF PAGES 44	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED	18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT	

14. (Concluded).

Bioengineering	Wetland management
Cumulative impacts	Wetland mitigation
GIS	Wetland processes
Wetland delineation	Wetland protection
Wetland design criteria	Wetland remote sensing
Wetland engineering	Wetland restoration
Wetland evaluation	Wetland stewardship
Wetland inventory	Wetlands

13. (Concluded).

Forty-three wetland demonstration sites will be used to conduct and evaluate wetland restoration, protection, techniques, stewardship, and management. These sites are representative of various wetland types, hydrology regimes, and geographic locations.

Numerous products will result from WRP research efforts. This technology transfer includes technical notes, technical reports, guidelines manuals, instructional videotapes, information exchange bulletins, journal and proceeding publications, workshops and conferences, and dissemination of information through training courses.

Accession For	
NTIS GRA&I	<input checked="" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By _____	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	

Contents

Preface	v
1—Introduction	1
Background	1
Purpose	3
2—Program Development	5
3—Program Structure	9
4—Program Management Task Areas	11
Task Area I: Interagency Coordination and Cooperation	11
Task Area II: Technology and Information Transfer	12
5—Research and Development Task Areas	15
Task Area III: Critical Processes of Wetlands	15
Task Area IV: Delineation and Evaluation of Wetlands	20
Task Area V: Restoration, Protection, and Establishment of Wetlands	22
Task Area VI: Predicting and Minimizing Impacts in Wetlands	28
Task Area VII: Wetlands Change Assessment	31
Task Area VIII: Stewardship and Management of USACE-Controlled Wetlands	33
6—Work Unit Funding	39
References	41



Preface

The Development Report of the US Army Corps of Engineers (USACE) Wetlands Research Program (WRP) was written by Dr. Mary C. Landin, member of the WRP Planning Group, and reviewed by all members of the Group, with guidance and reviews provided by the WRP Peer Review Group and the Technical Director's Office of the US Army Engineer Waterways Experiment Station (WES). Technical information and comments were taken directly from input by USACE field offices and from Headquarters, USACE (HQUSACE).

Members of the WRP Planning Group were Mr. Russell F. Theriot, Manager, WRP, Environmental Laboratory (EL), and Dr. John W. Barko, Mr. Ellis J. Clairain, Jr., Mr. Bruce A. Ebersole, Mr. Mitch A. Granat, Mr. Mark R. Graves, Dr. Landin, Dr. Charles R. Lee, Dr. James H. May, Ms. Joan Pope, Dr. Marian P. Rollings, Dr. Lawson M. Smith, and Mr. Jack K. Stoll, all of WES.

The eight WRP Task Area Managers provided technical input on Work Units. They are, by order of Task Area number: Mr. Richard E. Coleman, Mr. Thomas R. Patin, Mr. Ebersole, Mr. Clairain, Dr. Landin, Mr. H. Wade West, Ms. Jean H. O'Neil, and Mr. James W. Teaford. Technical comments were also provided by Dr. Charles Racine of the Cold Regions Research and Engineering Laboratory; Messrs. John Anderson, Jon Burgess, Greg Desmond, Carl Lanigan, and Bruce Smith, all of the Engineer Topographic Laboratories; and Messrs. E. Carl Brown, Stephen C. Knowles, Robert J. Larson, Richard A. Price, and Michael J. Trawle, all of WES. Technical reviews were provided by Mr. R. F. Theriot; Mr. Glenn Rhett, Assistant Manager, WRP; Dr. Robert M. Engler, Manager, Environmental Effects of Dredging Programs, EL; Dr. John Harrison, Chief, EL; Dr. Conrad J. Kirby, Dr. Victor E. LaGarde III, Dr. Raymond L. Montgomery, and Mr. Donald L. Robey, Division Chiefs, EL; and Mr. E. Carl Brown, Mr. H. Roger Hamilton, Mr. Edward J. Pullen, and Dr. Edwin A. Theriot, Group Chiefs of the Environmental Resources Division (ERD), EL.

Members of the WRP Peer Review Group who provided management oversight and coordination were Dr. Dennis R. Smith, Chairman, Dr. Don C. Banks, Mr. William H. McAnally, Dr. Montgomery, Mr. Robey, and Dr. C. Linwood Vincent, all of WES.

WRP Field Review Group members were Mr. Robert N. Blama, US Army Engineer District, Baltimore; Mr. Mitchell Isoe, US Army Engineer Division, North Central; Mr. Lawrence Oliver, US Army Engineer Division, New England; Mr. Larry Vinzant, US Army Engineer District, Sacramento; Mr. Rodney Woods, US Army Engineer Division, Ohio River; Mr. Owen Dutt, US Army Engineer District, St. Louis; Mr. Don Dunwoody, US Army Engineer Division, Missouri River; Mr. Michael Lee, US Army Engineer Division, Pacific Ocean; Mr. Jacob Redlinger, US Army Engineer Division, North Pacific; Mr. Don Hill, US Army Engineer District, Charleston; Mr. Dwight Quarles, US Army Engineer District, Fort Worth; Mr. Cecil Soileau, US Army Engineer District, New Orleans; Mr. Pete Milam, US Army Engineer District, Jacksonville; Mr. Robert Hauch, US Army Engineer District, Galveston; and Mr. Michael Watkins, US Army Engineer District, Kansas City.

WRP Technical Monitors, HQUSACE, were Dr. William L. Klesch, Chairman, Chief of the Office of Environmental Policy, Mr. Joseph R. Wilson, Dredging and Navigation Branch, Mr. Samuel Collinson, Regulatory Branch, and Mr. James W. Wolcott, Natural Resources Management Branch, all of the Operations, Construction, and Readiness Division; Messrs. John Bellinger and Philip Pierce of the Office of Environmental Policy; and Mr. David Buelow, Water Control and Quality Branch, Engineering Division.

The report was prepared under the administrative supervision of Mr. E. Carl Brown, Chief, Wetlands and Terrestrial Habitat Group, ERD, EL; Dr. Conrad J. Kirby, Chief, ERD; and Dr. John Harrison, Chief, EL.

COL Larry B. Fulton, EN, was Commander and Director of WES. Dr. Robert W. Whalin was Technical Director, and Dr. Dennis R. Smith was Assistant Technical Director.

This Development Report is current through October 1990. Subsequent changes will be documented in future WRP publications.

This report should be cited as follows:

Landin, M. C. 1991. Development of the US Army Corps of Engineers Wetlands Research Program, October 1990. Vicksburg, MS: US Army Engineer Waterways Experiment Station.



PRINTED ON RECYCLED PAPER

1 Introduction

Background

The US Army Corps of Engineers (USACE) has responsibility in its water resources projects for flood control, hydropower production, navigation, water supply storage, recreation, and fish and wildlife resources. Pursuant to the Federal Water Pollution Control Act Amendments of 1972 (Clean Water Act of 1977), as amended, the USACE also has responsibility for conducting a regulatory program that considers all functions and values of wetlands and negative impacts and cumulative or regional effects of individual or multiple projects in wetlands. Through its project planning, construction, operations and maintenance (primarily dredging), regulation, and accompanying activities in wetlands, the USACE is directly involved in wetlands protection and management.

Many existing public laws (PL), Executive Orders, and Engineer Regulations provide authority for or require that the USACE consider environmental impacts and consequences of its wetlands activities. Some of the most significant of these are as follows:

- a.* Rivers and Harbors Act of 1899 (33 U.S.C. et seq.).
- b.* The National Historic Preservation Act of 1966 (16 U.S.C. 470a et seq.), as amended.
- c.* The National Environmental Policy Act of 1969 (NEPA) (42 U.S.C. 4321 et seq.), as amended.
- d.* The Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.), as amended.
- e.* The Watershed Protection and Flood Prevention Act (16 U.S.C. 1001 et seq.).
- f.* The Federal Water Pollution Control Act Amendments of 1972, as amended.

- g.* The Marine Protection, Research, and Sanctuaries Act of 1972 (33 U.S.C. 1401 et seq.).
- h.* The Coastal Zone Management Act of 1976 (16 U.S.C. 1456[c]), as amended.
- i.* The Endangered Species Act (16 U.S.C. 1531 et seq.), as amended.
- j.* The Water Resources Development Act of 1976 (PL 94-587).
- k.* The Clean Water Act of 1977 (33 U.S.C. 1251 et seq.), as amended.
- l.* The Water Resources Development Act of 1986 (PL 99-662).
- m.* Executive Order 11593 (Protection and Enhancement of the Cultural Environment), 13 May 1971.
- n.* Executive Order 11988 (Floodplain Management), 24 May 1977.
- o.* Executive Order 11990 (Protection of Wetlands), 24 May 1977.
- p.* Environmental Regulation 1165-2-27 (Establishment of Wetland Areas in Connection with Dredging), 18 August 1989.
- q.* The Water Resources Development Act of 1990 (PL 101-640).
- r.* The Coastal Wetlands Planning, Protection, and Restoration Act of 1990 (PL 101-646).

Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899 are wetlands regulatory protocols. Section 150 of PL 94-587 gives the USACE the authority to use existing project funds on a limited basis for wetlands restoration and creation. PL 99-662 has been used by the USACE for accomplishing beneficial uses of dredged material, such as wetlands enhancement, restoration, and creation, and for shoreline protection in conjunction with construction activities. PL 101-640 provides the USACE with authority to protect existing threatened wetlands; funding mechanisms are still being evaluated. PL 101-646 provides Federal revenue sources to the State of Louisiana for coastal wetlands protection and restoration, administered by the USACE, and for general coastal wetlands conservation.

The National Wetlands Policy Forum report "Protecting America's Wetlands: An Action Agenda," published in 1988, outlines national wetlands problems and provides recommendations to achieve better wetlands protection and management. One of the primary recommendations in the Forum report is that "...the federal government initiate a National Wetlands Research Program to promote better understanding and better dissemination of information about the function of wetlands ecosystems in order to improve the effectiveness of the nation's wetlands programs. Key areas of research should include functions and values of wetlands, the assessment of cumulative

impacts, the effectiveness of protection programs, and restoration and creation techniques" (The National Wetlands Policy Forum 1988, p 59).

To continue as a leader in managing the Nation's environmental problems, the USACE must affirm and enhance its traditional leadership role in water resources management. As one of the stewards of the Nation's wetlands resources, the USACE must be sensitive to the Nation's natural resource base, the status of that base, and the ecological and economic benefits provided by wetlands.

The Administration has stated a strong interest in better protection and management of the Nation's wetlands. The USACE's ongoing Wetlands Research Program (WRP) has been designed and is being implemented to support that interest. This report outlines that program, which is responsive to these broad agency responsibilities, environmental mandates, and recommendations presented in the Forum report.

Purpose

The purpose of the WRP is to use scientific and engineering disciplines of the USACE, in coordination and cooperation with other agencies and offices, to provide environmentally sound, cost-effective techniques to manage the Nation's wetlands. To accomplish this purpose, the WRP encompasses a number of activities:

- a. Conducting an active interagency coordination and cooperation effort relative to the accomplishment of the WRP broad purpose, including cooperative projects.
- b. Providing a mechanism for technology and information transfer from the WRP to USACE offices, other agencies, and the general public, through a variety of traditional and innovative channels.
- c. Examining the basic processes that result in wetlands functions, and relating these processes and functions to USACE activities.
- d. Refining existing technology for delineating and evaluating wetlands in order to provide methods sensitive to regional differences in wetland soils, vegetation, and hydrology.
- e. Examining existing wetlands restoration, protection, and establishment sites and evaluating success of techniques used.
- f. Demonstrating and/or evaluating wetlands restoration, protection, and establishment techniques and further refining those techniques for other wetlands projects within USACE activities.

- g.* Developing engineering and scientific guidelines and technologies for designing, constructing, and managing wetlands.
- h.* Developing methods to address man-caused impacts on specific wetlands functions and critical wetlands types.
- i.* Developing standards for data management systems (DMS) for use in wetlands accounting, and developing standards for collecting and interrelating remotely sensed and "on-the-ground" data.
- j.* Refining existing mapping techniques to better serve USACE wetlands needs, and improving existing DMS technology to address large-scale projects.
- k.* Demonstrating and/or evaluating reduction of non-point source pollution using wetlands in USACE projects.
- l.* Demonstrating and/or evaluating wetlands habitat development and management on USACE reservoirs and USACE project lands in cooperation with Federal and state agencies and their wetlands and conservation programs.
- m.* Developing wetlands protection measures for preservation of existing wetlands.
- n.* Developing guidelines and field manuals for regional delineation and evaluation, wetlands restoration and creation, and stewardship and management.

2 Program Development

Developing and implementing a major multidisciplinary research and development (R&D) program to fully address wetlands management issues is a complex process involving Federal, state, local, and private interests. It requires the consideration of different technical and philosophical viewpoints and the application of numerous technical disciplines. The USACE has been a recognized leader in wetlands research for nearly two decades.

The Dredged Material Research Program (DMRP), conducted during the period 1973 to 1978, demonstrated that dredged material could be used to build and restore wetlands. The DMRP provided much of the engineering and scientific knowledge base that the USACE has relied upon to carry out wetlands restoration, protection, and establishment activities (US Army Corps of Engineers 1986). During the DMRP, engineering studies included design and evaluation of dredging structures and equipment; dredged material soil consolidation, movement, and transport; and determination of critical elevation, tidal, and water conditions for successful wetlands establishment on dredged material. Chemical evaluations of dredged material examined contaminant uptake in wetlands plants in both the laboratory and field.

Biological studies included demonstrations of wetlands establishment (not restoration) on dredged material that compared these new man-made sites to older natural wetlands of similar type and location. Among the parameters evaluated were soils, vegetation, fish, wildlife, benthic and aquatic invertebrates, water quality, and general environmental and physical successional changes over time, as well as biotechnical methods useful in wetlands establishment and development and socioeconomic considerations and impacts.

From 1978 to the present, the Dredging Operations Technical Support (DOTS) Program has provided a continuing base for expanding the engineering and scientific technology of beneficial uses of dredged material and wetlands restoration, protection, and establishment. The DOTS Program has also provided the opportunity for long-term monitoring and evaluation of a number of wetlands built or restored by the USACE using dredged material, for examination of the successional changes over time, and for the accomplishment of wetland project objectives.

In the same time frame, early wetlands research from 1976 to 1982 provided information to USACE offices on wetlands delineation, evaluation, and assessment of critical wetlands functions and values. This included wetlands identification, development of hydric soil and hydrology criteria as wetlands delineators, and study of transition zones of various wetlands cover types.

From 1982 to 1989, the regulatory-based Wetlands Research Program has conducted considerable wetlands research studies and developed numerous essential products. The two most important products are the Wetlands Delineation Manual (Environmental Laboratory 1987), which was incorporated into the Federal Manual for Identifying and Delineating Jurisdictional Wetlands, currently being revised (Federal Interagency Committee for Wetland Delineation 1989), and the Wetlands Evaluation Technique (Adamus et al. 1987) and software for assessing functions and values.

Much has been accomplished during implementation of these programs. However, the USACE's role in wetlands has expanded, and public concern for declining wetlands quantity and quality has increased significantly. Therefore, though much has already been accomplished, additional study needs have been identified and are being addressed. For example, engineering and scientific technology is generally available for building and restoring wetlands using dredged material. However, very limited information is available on restoration, protection, and construction for other types of wetlands, including those built for mitigation, flood control, massive threatened wetlands such as coastal Louisiana, and management of impoundments, rivers, and lake systems.

Given this solid foundation of past R&D efforts and an expanding role in wetlands, the Headquarters, US Army Corps of Engineers (HQUSACE), recognized that more could be done to make USACE activities more efficient, cost-effective, and environmentally sensitive, compatible, and acceptable. Moreover, the role of the USACE in stewardship and management of the Nation's wetlands resources has been clearly identified. HQUSACE also recognized that a comprehensive USACE wetlands effort must be responsive to the full range of USACE field office needs.

Prior to the establishment of the WRP, to determine USACE field office wetlands information needs and concerns, the HQUSACE and the US Army Engineer Waterways Experiment Station (WES) initiated steps to obtain input from the field. These steps, based on the report of the National Wetlands Policy Forum (1988), identified major areas of concern to USACE regulatory, operations, navigation, construction, and planning elements.

In June 1989, a survey questionnaire was sent to all USACE field offices. The purpose of the survey was to identify and characterize USACE information needs and concerns related to wetlands activities associated with all field offices. The information obtained from over 200 responses by field

offices was analyzed and synthesized, and provided to HQUSACE for use in directing the proposed WRP.

In September 1989, a USACE workshop was conducted as a follow-up to the survey (Landin et al. 1991). Its primary purpose was to identify specific wetlands information and technology needs related to field office activities. Workshop attendees included 74 USACE representatives from 29 Districts, 6 Divisions, 6 Laboratories, and HQUSACE. In October 1989, a draft Memorandum for Record containing a summary proceedings of the workshop was sent from HQUSACE to the USACE field elements for comments; the resulting information was incorporated into WRP planning and development.

This Development Report is based on the National Wetlands Policy Forum report (1988), input provided from the survey and workshop findings, subsequent field review of the survey results report and workshop proceedings, as well as meetings and discussions with representatives from universities, the private sector, Federal and state agencies, and conservation groups. It also includes continued input from early Field Review Group (FRG) meetings of the WRP, and from the WRP Technical Monitors from HQUSACE. The report identifies and carries out USACE major R&D needs and requests in eight major Task Areas and 20 Work Units, several of which have up to eight technical research areas. The Development Report is current through October 1990; subsequent changes will be reported in future WRP publications.

3 Program Structure

Day-to-day direction of the WRP is the responsibility of a full-time Program Manager (PM) at WES. The PM will function as the principal point of contact for Technical Monitors and the Field Review Group. A part-time assistant PM and eight part-time Task Area Managers are responsible for day-to-day WRP work.

Two administrative and six technical wetlands research Task Areas have been identified:

- **Program Management Task Areas**

- Task Area I: Interagency Coordination and Cooperation

- Task Area II: Technology and Information Transfer

- **Research and Development Task Areas**

- Task Area III: Critical Processes of Wetlands

- Task Area IV: Delineation and Evaluation of Wetlands

- Task Area V: Restoration, Protection, and Establishment of Wetlands

- Task Area VI: Predicting and Minimizing Impacts in Wetlands

- Task Area VII: Wetlands Change Assessment

- Task Area VIII: Stewardship and Management of USACE-Controlled Wetlands

Wetlands research plans and directions are presented for the eight Task Areas in Chapters 4 and 5 of this report. The WRP was established as a 3-year program. As such, the primary emphasis has been on using existing information and technology and on cooperative work agreements with ongoing USACE and interagency wetlands efforts. Laboratory and field research to fill identified wetlands data gaps is being conducted in those cases where the research can be designed to provide a product within the 3-year duration of the WRP. R&D products are being made available as quickly as practical so that they can be used in other ongoing research or stewardship activities. The PM office is coordinating this interaction.

Considerable interaction is occurring among USACE field offices, the WRP, HQUSACE, and cooperating resource agencies and groups. A strong USACE field office input, with cooperative WRP projects, is necessary for the program to succeed. In addition, several Federal agencies have ongoing Wetlands Research Programs; coordination of the work taking place in these programs is occurring at both HQUSACE and WES.

4 Program Management Task Areas

The USACE recognizes the need for a high level of interagency work effort, and the responsibility for imparting technical wetlands information gained through research and demonstration efforts, to a wide range of governmental and private offices. The WRP is coordinating with Federal and state agencies, as well as with private environmental groups such as the Wildlife Management Institute, the National Wildlife Federation, the National Audubon Society, and Ducks Unlimited. Given the current status of wetlands knowledge and the emphasis within the USACE, the HQUSACE views such interagency efforts and technology/information transfer at least as important as the six technical research tasks outlined in Chapter 5 of this report.

Task Area I: Interagency Coordination and Cooperation

Work Unit 12W01: Interagency Coordination and Program Management

Overall management of the WRP on a daily basis is necessary to achieve WRP goals within the existing time frames and budgets. The WRP requires major involvement of and interaction with Federal and state resource and regulatory agencies, conservation groups, and USACE field offices and laboratories. Interagency coordination activities will include cooperative efforts with these groups to develop and continuously assess the progress and results of research and demonstration projects. This includes actual collaborative work in collecting field data and in developing interagency documents on wetlands. It also involves interagency workshops and participation in national, regional, and local formal and informal committees and ad hoc working groups and forums to facilitate professional exchange of ideas and information. The goal is to involve as many players as feasible, and to partner/interact where appropriate to expand the program scope and acquire available funds.

Early products of this work unit include the published proceedings of the USACE Wetlands Workshop held in September 1989 (Landin et al. 1991) and this Development Report. Other products will include technical reports from interagency working groups, such as the technical group on wetlands restoration, protection, and establishment formalized under Work Unit 12W13, and general coordination of wetlands research among Federal agencies and others involved in ongoing wetlands research.

Task Area II: Technology and Information Transfer

Work Unit 12W02: Technology and Information Transfer

Technology and information transfer is an integral component of the WRP, and is critical to WRP success. An important function of technology transfer is to provide mechanisms for disseminating information from the six WRP R&D Task Areas to USACE offices, other Federal, state, and regional agencies, academia, interested private organizations, and the public at large. Research results must be effectively, rapidly, and simultaneously made available to all USACE elements, other agencies and organizations, and the public. Technology transfer is being carried out using a variety of methods, including the following:

- a.* An introductory pamphlet already being distributed.
- b.* A newsletter, issued on at least a quarterly basis.
- c.* A series of Technical Notes from the 18 Work Units under the six R&D Task Areas.
- d.* Technical Reports and Guidelines Manuals.
- e.* Direct technical assistance, using expertise and technology developed during the WRP, the Wetlands Regulatory Assistance Program, and other USACE technical assistance programs.
- f.* Instructional videotapes.
- g.* Training courses, transmitting developed technologies about wetlands to a variety of audiences.
- i.* Field- and national-level workshops from the six R&D Task Areas.
- h.* Technical software products.

- j.* Input to USACE Engineer Manuals, Engineer Technical Letters, Engineer Pamphlets, or Guide Specifications.
- k.* Input to other agencies' technical guidelines and manuals upon request.
- l.* Other technology transfer opportunities as they arise during the life of the WRP.

5 Research and Development Task Areas

The basis, purpose, approach, products, and general accomplishments of each of the six R&D Task Areas, as well as the research directions of the 18 Work Units included, are discussed in this chapter.

Task Area III: Critical Processes of Wetlands

An understanding of critical wetland processes is vital to effective management of existing and proposed wetlands. In addition, such information is needed to properly evaluate wetland functions, to explain past, present, and future wetlands changes, and to provide correct criteria for wetlands restoration, protection, establishment, stewardship, and management. Work is being undertaken to modify and adapt existing technology for use in quantifying critical processes within the wetland environment.

To provide sites for critical processes research, three reference sites are being considered as representative of USACE wetlands activities. These will be used in all Work Units in this Task Area and by some Work Units in other R&D Task Areas.

A comprehensive review of existing methods for quantifying and interpreting changes in hydraulics and hydrology, sedimentation and erosion, water quality, and soils and vegetation is being conducted and will be reported. Work done in Task Area III will provide input into the other Task Areas and will identify data and technology gaps that need to be addressed in R&D efforts. Task Area III will develop the strategy for building a framework relating critical processes to wetlands functions. Additionally, Task Area III will produce methods for quantifying critical processes within a wetland environment, as well as complement the work at WRP demonstration sites.

Over time, all recognized wetlands functions involve numerous interactions. The following four Work Units were identified and are being pursued based on wetland functions and the role of critical processes in these functions.

Work Unit 12W03: Hydraulics and Hydrology

Water availability within a wetland and the manner in which water moves through a wetland are critical to the wetland's success. Success is measured in terms of the quantity and quality of the functions the wetland provides. An understanding of the hydraulic and hydrologic processes in wetlands is vital to establishing and maintaining a functioning wetland. Many of these processes are poorly understood for the wetland environment.

This Work Unit has three primary objectives:

- a.* To determine the critical hydraulic and hydrologic processes and parameters for certain wetland types and functions.
- b.* To develop guidance on analytical procedures to evaluate and predict the critical hydraulic and hydrologic processes in different wetland regimes under low, normal, and extreme event conditions.
- c.* To provide expertise, techniques, and research results to other Task Areas.

This Work Unit has been structured into three Research Areas: (a) surface water processes, (b) groundwater processes, and (c) wave processes. In each Research Area, field investigations will be conducted to

- a.* Identify critical processes and parameters that control these processes.
- b.* Identify techniques to quantify water attributes in wetlands.
- c.* Evaluate existing analytical methods for quantifying or predicting key processes such as groundwater movement, surface water movement, and surface wave generation and propagation.
- d.* Adapt these methods for use in evaluation techniques.

In addition, this Work Unit and others in this Task Area will assist in demonstrating the technology for use in wetlands restoration, protection, and establishment; wetlands evaluation; identification and avoidance of impacts; and wetlands management. The applicability of existing hydraulic and hydrologic analytical methods for use in wetland ecosystems simulation will also be evaluated.

Work Unit 12W03 products over the time frame of the WRP include:

- a.* Technical Notes on the various processes studied.
- b.* An overall Task Area critical processes workshop.

- c. Personal computer modules for evaluation of ground, surface, and wind wave processes.
- d. A Technical Report on hydrologic and hydraulic processes in wetlands.

Work Unit 12W04: Sedimentation and Erosion

Sedimentation and erosion processes are directly linked to several wetland functions, and are directly related to wetland vitality. Wetlands can be both created and destroyed by sediment deposition or erosion, and habitat can be enhanced or adversely affected. Understanding the sedimentation and erosion processes in wetlands is vital to establishing, protecting, and maintaining a functioning wetland. Unfortunately, knowledge of sedimentation processes is lacking. Methods for quantifying sediment transport processes in a wetland environment are few in number and technically deficient in key areas. There is also little engineering guidance for predicting sedimentation and erosion in natural or man-made wetlands.

Three primary objectives have been established for this Work Unit:

- a. To determine the critical sedimentation and erosion processes for certain wetland types and functions.
- b. To develop guidance on procedures to evaluate and/or predict the sedimentation and erosion rates and depositional patterns based on the hydrologic process.
- c. To provide expertise, techniques, and research results to other Task Areas.

Work Unit 12W04 has been structured into two Research Areas: (a) surface water sedimentation processes and (b) erosion by wave action. Field investigations are being conducted to identify critical processes and parameters that control these processes, techniques to quantify wetland sedimentation processes, and gaps in information and technology. Existing analytical methods are being evaluated to quantify or predict key sedimentation processes such as sediment suspension and transport and sediment depositional patterns. These will be adapted and used to assist in demonstrating technology for other Task Areas. This Work Unit will also identify the applicability of existing analytical sedimentation techniques for use in wetland ecosystems modeling.

Work Unit 12W04 products over the time frame of the WRP include:

- a. Technical Notes on the various processes.

- b.* A personal computer module on surface water sedimentation processes for wetland evaluation.
- c.* An overall Task Area critical processes workshop.
- d.* A Technical Report on sedimentation and erosion processes in wetlands.

**Work Unit 12W05:
Water Quality**

Wetlands play a major role in regulating the quality of water flowing through the wetland system. This role needs to be more clearly understood. While wetlands can function to improve the quality of the water passing through them, the processes and factors involved need to be identified and functional relationships defined. Understanding the processes that impact water quality is essential to evaluating and successfully managing wetlands. Techniques are needed to assess water quality characteristics of wetlands and to assess the functional ability of wetlands to change water quality.

This Work Unit has four primary objectives:

- a.* To determine the critical water quality processes for high-priority wetland types.
- b.* To develop techniques to assess and interpret the functional ability of wetlands for water quality enhancement and treatment of non-point source pollution.
- c.* To develop guidance on water quality models for use in wetlands.
- d.* To provide expertise, techniques, and research results to other Task Areas.

As part of Work Unit 12W05, information from field investigations and published literature is being used to identify critical water quality processes and parameters and to determine data gaps. Existing techniques to assess the functional ability of wetlands in treatment and assimilation of non-point source pollutants are being evaluated, and recommendations for pursuing this wetlands use will be made. In addition, existing numerical simulation water quality models that assess water quality characteristics or functional ability to improve water quality are being evaluated for inclusion in a wetlands ecosystem simulation strategy.

Products from this Work Unit will be Technical Notes on water quality processes and assessment of functional ability and Technical Reports on water quality processes and prediction and assessment of the functional ability of wetlands to enhance water quality.

**Work Unit 12W06:
Soils and Vegetation**

Any wetland function that depends upon vegetation is directly linked to and modified by soil processes. Information is lacking on soils processes as they affect vegetation. Before these relationships can be developed, the chemical, physical, and biological processes of wetland soils and vegetation must be determined. Understanding the formation, evolution, and geochemical cycling of wetland soils and vegetation is essential to determining and improving wetland survival and success.

For this Work Unit, the primary objectives are as follows:

- a. To determine the processes responsible for hydric soil formation and critical soil/vegetation interactions.
- b. To identify the principal mechanical processes and physical characteristics of wetland soil strata.
- c. To determine the critical biological and chemical processes that affect hydric soil formation, water and sediment quality, and response of vegetation.
- d. To identify potential techniques to quantify wetland soil processes and functions related to processes.
- e. To develop guidance on techniques to quantify growth and evolution of vegetation.
- f. To provide expertise, techniques, and research results to other Task Areas.

Under Work Unit 12W06, field investigations of soil and vegetation processes are being conducted to identify the critical parameters that control these processes, to evaluate techniques and instrumentation for quantifying soil processes in wetlands, and to identify gaps in information technology. For physical soil processes, emphasis is on such parameters as sediment-water exchange, consolidation, compaction subsidence, desiccation, dispersion, liquefaction, and hydration. Points of emphasis for chemical soil processes include chemical transformations, absorption/desorption, oxidation/reduction, sediment-water exchange, microbial processes, and the response of vegetation to these processes. Development of hydric soils is being documented, focusing on soil stratigraphy, and the critical mechanical processes for soil strata are being determined. The results will be applied in wetlands evaluation and will be provided and recommended to other Task Areas.

Products of this Work Unit include Technical Notes on hydric soil and vegetation processes, personal computer modules on hydric soil and vegetation processes, and a Technical Report on wetland soils and vegetation processes in wetlands.

Task Area IV: Delineation and Evaluation of Wetlands

All USACE projects associated with wetland areas require decisions regarding delineation of wetlands boundaries and assessment of functions and values of wetlands. Evaluations leading to these decisions must be made in a timely manner during early stages of regulatory and project planning activities. Procedures must be technically sound yet sufficiently flexible to allow rapid assessment with limited data. At the same time, the procedures must provide for refining the results as additional data and time become available or future requirements dictate.

The overall goal of Task Area IV has been to develop regionally structured, technically sound, systematic procedures to determine wetland boundaries and to assess wetland functions and values.

Work Unit 12W07: Wetland Delineation

The Federal Manual for Identifying and Delineating Jurisdictional Wetlands (Federal Interagency Committee for Wetland Delineation 1989) has provided a single national delineation manual for all Federal agencies since February 1989. The Manual is currently under Administration review and will be modified. The WRP recognizes that the Manual needs regional refinement in particular technical areas associated with hydric soil characteristics, interpretation of hydrophytic vegetation, and analysis of hydrology. Several important assumptions associated with the mandatory criteria and with field indicators necessary to identify and delineate wetlands boundaries will be examined in Work Unit 12W07 to assess their validity and technical basis. This Work Unit is designed to improve regional sensitivity, accuracy, and consistency of determinations of hydric soils, hydrophytic vegetation, and hydrology used in the Manual to identify wetlands and determine wetlands boundaries.

The primary objectives of this Work Unit are as follows:

- a. To investigate relationships between measured hydrologic regimes and field indicators of wetland hydrology, hydric soils, and hydrophytic vegetation.
- b. To develop specific delineation guidance for selected regions or priority wetland types.

Initial work efforts are focusing on New England and Florida, where projects to examine the relationships between hydrology, soil characteristics, and plant communities are under way. Opportunities for cooperative research with other agencies and organizations are being sought. In

addition, WES is joining in a cooperative study with the Soil Conservation Service (SCS) to refine hydric soil morphological indicators in Oregon, North Dakota, Indiana, and Alaska. Work is being coordinated with other Task Areas.

A number of Technical Reports will be produced as Work Unit products. Topics to be addressed include

- a. Hydrology, soil morphology, and plant communities in Florida sandy soils.
- b. Soil morphology and vegetation in relation to high water tables in New England.
- c. A nationwide study of hydric soil criteria and field indicators.
- d. Effects of water table rise on soil characteristics near Alton, IL.
- e. Refining the wetland boundary determinations in Alaska.

Work Unit 12W08: Evaluation of Wetland Functions and Values

Wetland evaluation techniques were designed to rapidly assess a wide range of functions in wetlands of the United States. The rapid assessment format, wide range of functions assessed, and diversity of wetlands in its broad geographic scope placed restrictions on the level of detail that could reasonably be incorporated into the evaluation assessment models. These models tend to be simple, and are capable of assessing wetland functions only at a relatively broad level. Therefore, results from application of the technique often do not reflect significant functional differences among wetlands. The insensitivity of the technique has limited its usefulness to USACE Regulatory Offices.

This Work Unit has one primary objective, to develop a more robust and sensitive procedure for assessing wetland functions. Secondary objectives include construction of assessment models for appropriate functions in different wetland classes, and the incorporation of methods for assessing the value and regional importance of wetlands.

The changes resulting from accomplishment of the above objectives will provide evaluation procedures for the USACE. Emphasis in FY 91 has been on the establishment of a framework for regional evaluation procedures, development of a hydrogeomorphic classification of wetlands, development of assessment protocols, and a review of existing valuation procedures and regional importance of wetlands. Expert working groups will be organized to begin development of assessment models for two priority wetland classes, with outyears being used to develop and field test assessment models.

Draft versions of a framework for an evaluation procedure to assess wetland functions and a hydrogeomorphic classification of wetlands have already been completed, and a workshop was held to introduce and critique the draft framework. Comments are currently being evaluated and assimilated. A coastal wetlands expert group has been established and is developing a draft assessment model.

Products of this Work Unit include several Technical Notes on priority wetland types, valuation, and regional importance; several Technical Reports on the evaluation framework, hydrogeomorphic wetland classification, valuation procedures, and regional importance procedures; and a functional assessment workshop.

Task Area V: Restoration, Protection, and Establishment of Wetlands

The USACE has constructed and/or restored numerous wetlands in recent years as part of ongoing navigation and flood control projects. During this time, a variety of engineering, bioengineering, and environmental techniques were developed and tested. However, the knowledge base of the four important success factors in restoration and establishment—hydrology and hydraulics, wet soils, vegetation, and energy sources—needs improvement. In addition, information on wetland functions predominant in current projects (such as fish and wildlife habitats, sediment and erosion control, and water quality improvements) is limited for certain wetland types. The incorporation of wetlands restoration, protection, and establishment into local flood control and navigation projects needs sharper definition so that it can be routinely applied to USACE projects.

USACE field offices and their permit applicants are in immediate need of written scientific and engineering guidelines and procedures for wetlands restoration and construction. A major goal of Task Area V is to develop guidelines that can be used in all phases of USACE projects, and which will also find use by USACE permit applicants. To accomplish this goal, existing wetlands built or restored from dredged material, for mitigation or other nonregulatory purposes (shoreline stabilization, erosion control, R&D), will be revisited. Selected sites will be used to evaluate and (where time permits) demonstrate wetlands restoration and development techniques.

To address the broad needs of wetlands restoration, protection, and establishment, four Work Units have been established and implemented. This Task Area has dual goals of demonstrating wetlands engineering and techniques for restoration, protection, and establishment, while conducting topical research on priority wetland types.

Work Unit 12W12: Improved Wetlands Design Criteria

While numerous wetland sites have been constructed or restored, precise design criteria are not readily available. Decision-making frameworks or protocols, especially for mitigation, for wetland restoration and establishment are also not currently available.

This Work Unit has two primary objectives:

- a.* To investigate and develop engineering, geotechnical, and environmental design criteria for the major wetland types with which the USACE works.
- b.* To complete preliminary USACE technical guidelines and decision-making frameworks, both now in draft, for wetlands restoration and establishment for mitigation.

Work Unit 12W12 is structured into four major Research Areas:

- a.* Siting, circulation, and design using geohydrology criteria.
- b.* Soils and geotechnical design criteria.
- c.* Baseline plant and animal criteria.
- d.* Engineering procedures, decision-making frameworks, and engineering design.

Field tests within these four Research Areas are being conducted at some of the demonstration site studies under way in Work Unit 12W15, and are being coordinated across Task Areas. The decision-making framework currently in draft review will be field tested in FY 92 and FY 93.

A number of products are scheduled for this Work Unit, including the following:

- a.* Technical Notes from the four Research Areas on various components of wetland design and procedures.
- b.* A Technical Guidelines Manual on wetlands restoration and establishment for mitigation, a continued work effort from FY 90.
- c.* A Technical Report on a decision-making framework for mitigation, a continued work effort from FY 90.
- d.* A Guidelines Manual on wetland design criteria.
- e.* Input into other Task Area V workshops, working groups, coordinated fieldwork at demonstration sites, and product reviews.

**Work Area Unit 12W13:
Technical Standards for Monitoring
and Success Criteria for Wetlands**

The USACE has developed monitoring techniques and success criteria that apply to dredged material wetlands and are recommended to the USACE Districts. However, restoration and construction standards have not been developed for other man-induced wetlands. Because many organizations, agencies, and groups are involved in wetlands restoration and creation, a broad-based multi-agency approach is needed.

Work Unit 12W13 has one primary objective: to develop practical technical standards for monitoring and measuring the success of wetlands restoration and establishment sites suitable for field and laboratory application. These must be coordinated with and agreed upon by Federal and state resource and regulatory agencies and responsible conservation organizations.

To accomplish the above objective, a broadly representative technical interagency Working Group has been selected to meet at selected intervals and provide input to the Work Unit. Standards currently used by the USACE and other agencies will be identified, evaluated, and synthesized into a draft working document that will serve as a basis for the Working Group. Over several meetings, this working document will be refined, and will be reviewed by field personnel of all represented agencies. The Principal Investigator will serve as liaison between the technical Working Group and Work Units 12W12, 12W14, and 12W15, and will use input from other Task Areas as appropriate.

Interagency Working Group meetings and draft group papers will be considered products of the Work Unit. The principal product will be a practical manual on field/laboratory technical monitoring and success criteria, which will be provided for interagency review, approval, and use.

**Work Unit 12W14:
Techniques, Structures, and Equipment
for Wetlands Restoration and Establishment**

To fill existing information gaps regarding wetlands site preparation, vegetation establishment, and maintenance of wetland vitality and sustainability, a comprehensive survey of existing information is needed, in addition to a synthesis of that information and new research data. Field testing of techniques, structures, and methodologies for wetlands restoration, protection, and establishment is required before recommending them for general USACE wetlands work.

The primary objective of this Work Unit is to identify, evaluate, compile, and field test practical, cost-effective wetlands restoration, protection, and

establishment engineering and bioengineering techniques, structures, and equipment that are applicable to USACE wetlands activities and projects.

This Work Unit is structured into four Research Areas, all dealing with wetlands engineering or bioengineering and plant materials for wetland restoration, protection, and establishment. These include:

- a. Techniques to restore or establish hydrology and correct elevations.
- b. Soils transport, handling, stockpiling, and site preparation.
- c. Propagation techniques, selecting and handling plant material, and bioengineering methods.
- d. Engineering structures and techniques.

The most relevant applications identified and evaluated are being field tested on demonstration sites under Work Unit 12W15. Input from other Work Units in Task Area V and other Task Areas of the WRP will be incorporated with information found in this Work Unit, and compiled into a practical handbook of wetlands engineering that addresses techniques, structures, and equipment, including bioengineering. In addition, plant materials are being evaluated by SCS, and a joint plant materials handbook on propagation and other methodologies will be written in cooperation with the SCS.

Products of Work Unit 12W14 include Technical Notes from the four Research Areas, a National Wetlands Engineering Workshop (with published proceedings), cooperative interagency field tests within Task Area V, and a comprehensive Wetlands Engineering Handbook.

Work Unit 12W15: Wetlands Field Demonstrations

The USACE has restored or constructed tens of thousands of wetlands acres during its various project activities over nearly two decades and, in a number of cases, has collected and evaluated data in these wetlands and adjacent habitats. However, unresolved questions remain with regard to the extent to which wetlands can be restored or developed. Experts working in this field generally agree that most of the technology needed for restoration and establishment exists, but is either poorly known or poorly applied, especially in the case of mitigated wetlands. The great majority of "failed" wetlands are in the category of mitigation, not the large wetlands typically restored or built by state or Federal resource agencies, which tend to be very successful. The two challenges for the WRP are to complete the technical information on restoration, protection, and establishment for wetland types normally dealt with by the USACE and to provide demonstrations of working wetlands and the technology transfer necessary to inform both technicians and the lay public on existing and new techniques.

Work Unit 12W15 has two primary and very broad objectives:

- a. To demonstrate and evaluate wetlands restoration, protection, and establishment in a cooperative interagency spirit on numerous and representative locations throughout the United States.
- b. To determine and test wetland techniques, methodologies, design criteria, protocols, and engineering, as well as the need for ecosystems modeling.

This Work Unit also has a number of secondary objectives identified within its Research Areas. The foremost of these, however, is to work with Task Area II to disseminate existing and new information in this field as widely as possible through a variety of media.

From a list of 243 potential demonstration sites submitted to the WRP from USACE field offices, 27 were selected in this Work Unit to represent a wide range of wetland types, geographic regions, climatic conditions, water regimes, and different stages of development or wetland age. One military site was also selected, bringing the total number of demonstration sites to 28. Because of the short time frame of the WRP, sites with existing baseline databases and strong interagency participation are receiving greatest emphasis. Sites were selected according to priorities set by USACE field offices in the questionnaire response and wetland workshop discussed in Chapter 2. They are, in no particular order: wooded wetlands, riverine and depressional freshwater marsh/shrub habitats, and coastal intertidal wetlands of all types.

The selected wetlands are being used to test and evaluate wetland procedures and methodologies. Work on all sites is tied directly to Work Units 12W12 and 12W14, and is being coordinated with Work Unit 12W13 and all other Task Areas of the WRP. The wetland demonstration sites were selected to address, and have been grouped by, eight technical Research Areas:

- a. Comparison of man-made versus naturally occurring wetlands.
Demonstration sites are located in
 - (1) Miller Sands Island and the lower Columbia River, Oregon.
 - (2) Gaillard Island and Mississippi Sound, Alabama/Mississippi.
 - (3) Pointe Mouillee, Western Lake Erie, Michigan.
 - (4) Aberdeen Proving Grounds, Chesapeake Bay, Maryland.
 - (5) Hamilton Antenna Field and other man-made salt marshes in San Francisco Bay, California.
 - (6) Buttermilk Sound, Altamaha River, Georgia.

- b. Wetland engineering for protection and restoration of coastal Louisiana. Four demonstration sites, located in Plaquemines and Terrebonne Parishes, include a variety of wetland engineering technique and structures being applied to address coastal erosion, subsidence, and degradation.**
- c. Use of wetlands in coastal erosion and shoreline stabilization. Demonstration sites are located in**

 - (1) Aransas National Wildlife Refuge/West Bay in the Gulf Intracoastal Waterway, Texas.**
 - (2) Bodkin Island, Chesapeake Bay, Maryland.**
 - (3) Galilee Sanctuary, Narragansett, Rhode Island.**
- d. Evaluation of bottomland hardwoods restoration techniques and methodologies. Demonstration sites are located at**

 - (1) Lake George, Yazoo Basin, Mississippi.**
 - (2) Kentucky Lake, Tennessee.**
- e. Freshwater riparian marsh and shrub restoration and establishment. Demonstration sites are located at**

 - (1) Green Bottom Wildlife Management Area, West Virginia.**
 - (2) Upper Snake River, Jackson Hole, Wyoming.**
 - (3) Two sites at Yolo Bypass, Sacramento, California.**
- f. Freshwater wetland restoration and establishment in lakes, swamps, pools, and wet prairies. Demonstration sites are located at**

 - (1) Weaver Bottoms marsh restoration, Upper Mississippi River, Minnesota/Wisconsin.**
 - (2) Amazon Channel wet prairie, central Oregon.**
 - (3) Charlotte County mitigated wetlands, Florida.**
 - (4) L-Lake mitigated wetlands, Savannah River Plant, Aiken, SC.**
- g. Evaluation of coastal intertidal restoration and creation at interagency cooperative sites. Demonstration sites are located at**

 - (1) Bolivar Peninsula salt marsh creation, Galveston Bay, Texas.**
 - (2) Lincoln Avenue mitigation site, Puget Sound, Tacoma, WA.**
 - (3) Winyah Bay intertidal marsh creation, South Carolina.**
 - (4) USACE/National Marine Fisheries Service MOA (Memorandum of Agreement) sites, near Harkers Island, North Carolina.**

- h.* Wetland restoration where special hydrology or soils problems occur. Demonstration sites are located at
 - (1) Des Plaines River wetland restoration, Chicago, IL.
 - (2) Beaver Creek fen restoration, Dayton, OH.

Several wetland demonstration sites that have been selected are suitable for research that crosses over Research Area definitions and over other Work Units and Task Areas. These are being used for multiple work efforts.

Each demonstration wetland site selected has been or is being cost- and/or work-shared with local sponsors and other agencies and organizations.

In addition to field studies, major products of this Work Unit include

- a.* At least one Technical Note and/or other written or video tape products from each demonstration wetland. In most cases, multiple products are planned.
- b.* Technical Reports from the eight Research Areas.
- c.* A National Wetlands Restoration, Protection, and Establishment Multi-agency Workshop, with published proceedings.
- d.* Extensive interagency coordination and work efforts across all Work Unit and Research Area topics.
- e.* Information sharing and work coordination across other WRP Task Areas.
- f.* Numerous WRP newsletter articles.
- g.* Numerous refereed journal articles and technical presentations and proceedings papers as feasible and appropriate. This has been an ongoing technology transfer effort since the Work Unit's inception.

Task Area VI: Predicting and Minimizing Impacts in Wetlands

Adequate information, predictive tools, and standardized procedures are not currently available to assess wetlands' short-term and cumulative impacts from such causes as filling, pollutants, subsidence, and erosion, and to develop alternatives to minimize such impacts. Three WRP Work Units were proposed to address these problems, as described below.

**Work Unit 12W09:
Avoid and Minimize Impacts**

There has been no systematic review of human activities that impact wetlands, or the specific effects those activities produce. Procedures and techniques to avoid and minimize these effects have not been thoroughly investigated. Numerous activities impact wetlands; to avoid and minimize these activities in wetlands will require the identification and assessment of a range of options that are useful to wetland managers, permit applicants and regulators, and wetland restorers and mitigators.

Work under this Work Unit, which is scheduled to begin in FY 92, has four objectives:

- a. To comprehensively identify the types of activities that impact wetlands.
- b. To characterize each activity by its effect(s) on wetland functions and geographic region or wetland type.
- c. To provide an indication of the significance of that effect.
- d. To provide a hierarchy of techniques to avoid and minimize impacts to wetlands.

A comprehensive listing of activities that impact wetlands is being developed, with each activity characterized according to its specific effects. Matrices will be developed of the activity and its effect; the effect and the wetland function and type to which it relates; and the relative significance of the effect. Existing avoidance and minimization techniques will be identified, and additional practices will be provided. This work is being accomplished by (a) a survey of relevant disciplines to identify Best Management Practices, (b) a review of environmental engineering practices, and (c) an evaluation of advance planning techniques. Selected techniques and procedures will be field tested at demonstration sites, and a protocol will be developed for this evaluation.

The products of Work Unit 12W09 are three matrices that will serve users as checklists for screening and evaluating impacts. The primary Work Unit product is a loose-leaf manual giving techniques and practices identified and evaluated which are linked to the effect to be avoided or minimized, and to the geographic regions or wetland type to which they relate. This information will be quantified where possible.

Work Area 12W10: Methods to Predict Impacts

Prediction of known impacts is typically performed through environmental assessments and environmental impact statements for projects. However, the detail in these studies varies, and the treatment of indirect and physical process impacts may often be inadequate. This Work Unit proposes to review existing information and methods for predicting impacts, modify procedures, and develop applicable methods for wetland impact prediction. Existing methods such as surface/groundwater models, vegetation community succession models, water quality models, and soil erosion prediction models should be evaluated. A standardized decision framework should be formulated to promote consistency in wetlands impact analysis for permit applications and USACE projects. This Work Unit currently has no WRP funding, and may be dropped from consideration based on FRG recommendations.

Work Unit 12W11: Cumulative Impact Analysis

The accumulated effect of many human activities, none particularly large or damaging in themselves, may collectively produce a major change in wetland functions and loss of environmental quality. NEPA requires that cumulative impacts be considered in environmental assessments, including those for wetlands projects. Frequently, however, agencies and organizations have not dealt with cumulative impacts, in part because they lacked the necessary evaluation tools.

This Work Unit's primary objective is to develop a framework that will help the USACE perform cumulative impact assessments in wetlands.

Procedures for cumulative impact assessment are being developed by formulating candidate indices to summarize major patterns in hydrology, landscape ecology, and wildlife habitat in wetlands. These indices will be evaluated using existing data sets to derive the best approach for linking changes in hydrology to changes in vegetation to changes in availability of habitat. If possible, the approach will be extended to other wetland functions. The approach will be field tested using a different data set for practicability at the field level. A joint field effort with the US Environmental Protection Agency (EPA) will evaluate selected aspects of that agency's FY 1991 guidelines for cumulative impacts.

Major Work Unit products include Technical Notes on status, links, indices, thresholds, and the joint EPA field effort. A Technical Report and Guidance Manual on the framework for cumulative impact assessment will be written by FY 93.

Task Area VII: Wetlands Change Assessment

Although significant work has been accomplished in developing techniques for delineating wetland systems, new criteria and methodologies are needed which focus specifically on economically monitoring the physical and biological status of large areas already identified as wetlands. The emphasis will be on developing procedures that draw upon existing field techniques, as well as exploring the use of new technologies such as remote sensing and data management systems for wetlands change (loss or gain) analysis.

A desirable result of the WRP would be to create a repository of wetlands technical information housed in a central location such as WES. To accomplish this, a standard data storage design or structure should be established for all USACE wetlands databases. Work should focus on the use of existing data and on creating criteria, including

- a. Type of data essential to a wetlands database.
- b. Data quality and accuracy standards.
- c. Data compatibility and integration concerns.
- d. Data format standards and storage considerations.
- e. Data collection considerations.
- f. Storage of attribute information and relational database management systems.

Work Unit 12W16: Techniques for Characterizing Changes to Wetland Systems

Remote imagery techniques are useful in mapping wetland extent and in discriminating between various wetland hydrophyte plant communities. Multispectral imagery gathered within the visible and infrared portions of the spectrum are useful in mapping surface hydrology, detecting saturated soil conditions, and identifying early signs of vegetation stress. Space-based sensor platforms offer additional periodic revisit capabilities and economic advantages. All of these features make remote multispectral data an attractive tool for an environmental monitoring program. The national goal of no net loss of wetlands creates an urgent need to investigate and apply both image processing and onsite data collection techniques.

The primary objectives of this Work Unit are as follows:

- a. To explore the success of previous applications of multispectral data coupled with onsite data acquisition to wetland environments and develop a compendium of these results.
- b. To demonstrate the use of these data for wetlands change assessment within several of the selected demonstration wetland sites.
- c. To develop a set of guidelines for USACE offices for the data acquisition operation, hardware and software selection, and procedures for monitoring change in wetland type, function, and acreage.

In Work Unit 12W16, the focus is on the processing of multispectral data, including satellite and aircraft imagery and video and photographic coverage of wetlands. An inventory of previous efforts has been made, which involved coordination with all Federal and state agencies and private organizations that collect such data in any way. Once the initial evaluation has been completed, demonstration sites will be selected, and data will be obtained at several sampling periods using spectral and spatial image-processing techniques and procedures. The resulting information will be integrated and coordinated with other WRP Task Areas.

Major products will include a Technical Note on identification of environmental factors for evaluation of wetland systems, a Technical Report on data acquisition and detection techniques, a multi-agency symposium of monitoring technology, WRP newsletter articles, and coordination with other Work Units and Task Areas.

Work Unit 12W17: Automated Analysis, Display, and Information Bases for Wetland Systems

The USACE is responsible for evaluating and managing the condition of thousands of wetland acres. Automated databases have been used for nearly two decades by Federal and state agencies and private organizations to record the characteristics of the earth's resources in digital format. These databases permit rapid, quantitative analysis of complex geographic data and modeling and analysis of proposed management policies. This Work Unit will focus on producing guidelines for the selection and implementation of automated database technologies for the storage/retrieval, manipulation (analysis), and display of wetland spatial and attribute information.

Work Unit 12W17 has two primary objectives:

- a. To demonstrate the usefulness of automated database technology for managing regional wetland systems.

b. To develop a set of guidelines for USACE field offices concerning

- (1) The choice of suitable competing hardware and software.
- (2) Types of data essential to a wetlands database.
- (3) Data structure considerations.
- (4) Database analysis procedures.
- (5) Production of hard-copy output products.
- (6) Integration of multispectral data and change assessment techniques with the database.

Comprehensive spatial and attribute databases are being developed for several of the WRP large-scale wetland demonstration sites. Database development efforts will be coordinated with other Task Areas and Work Units, other Federal and state agencies, and private organizations with large databases. Prototypes and demonstrations will be generated to illustrate the usefulness of this technology for wetland management, and a USACE customer-oriented research service will be established to provide for databases and technology transfer.

Major products of this Work Unit are demonstrations and prototypes to allow users to determine how best to input data and use data from an extensive wetland database. In addition, a Technical Report on applications of automated databases by wetland type will be written, and a software package on wetland resource and change detection analysis and display will be developed.

Task Area VIII: Stewardship and Management of USACE-Controlled Wetlands

The USACE manages more than 3 million acres of water and more than 4 million acres of land owned in fee by the Federal Government at Civil Works water resources projects. The USACE has always promoted good stewardship of natural resources on the projects it administers; however, the current national emphasis on the ecological importance of wetlands highlights a need for more attention to wetlands in the USACE natural resources management program. Personnel in all organizational elements of the USACE play a role in the stewardship of USACE-administered lands. These USACE field elements need more information on techniques, both existing and innovative, for wetlands stewardship and management.

The basic goals of Task Area VIII are as follows:

- a. To identify wetlands stewardship techniques that provide practical low-cost means to inventory and evaluate existing wetlands on USACE projects, manage wetlands information, increase the quantity

of wetlands, improve functions and values of existing wetlands, and accomplish effective wetlands maintenance.

- b. To establish a central technical database and repository for wetlands information.
- c. To determine techniques necessary for characterizing changes occurring in USACE wetlands.

**Work Unit 12W18:
USACE Wetland Inventory and
Management Information System**

The USACE needs an inventory of its wetlands and a management information system to provide the correct level of information for effective and efficient wetlands management. This system should account for regional differences in existing wetlands, as well as the different types of projects managed by the USACE. Pertinent information should be available to all USACE management levels in a computer-based format that is reliable, responsive, and compatible with aquatic and terrestrial nonwetland resource inventory systems. This Work Unit is designed to address the compilation of such an inventory of USACE wetlands.

This Work Unit has three primary objectives:

- a. To develop a prototype wetlands inventory system designed to address project operations and project planning at the field office and District-wide levels.
- b. To develop a management information system designed to facilitate the storage, evaluation, and communication of wetlands data and information among and within USACE offices.
- c. To evaluate the state of the art of existing Natural Resource Management Simulation models for potential wetland resource management applications.

To accomplish the above objectives, interdisciplinary workshops will be conducted to assess USACE wetlands inventory and management requirements, to provide a state-of-the-art overview of approaches and management models used by other Federal agencies and private organizations, and to test preliminary guidelines for inventory data needs and system capabilities. Demonstration sites have been selected for inventory and ground-truthing studies. A management information system prototype will be evaluated on project, District, Division, and USACE levels at these sites. Final guidelines for prototype inventory and management information systems will be developed.

In addition to field studies, major products of the Work Unit will be an interdisciplinary workshop, a Technical Note on natural resource management models for wetlands management, and a Technical Report guidance document for USACE wetland inventory and management information system implementation and use.

Work Unit 12W19: Technology for Managing Wetlands

Although much information exists on managing wetlands, the information is scattered among various data sources and, in many cases, is not readily available to USACE personnel. Existing information needs to be identified, evaluated, and compiled into easily accessible and usable forms. A means to identify and evaluate new and innovative techniques is needed to facilitate the continual application of state-of-the-art wetlands management by the USACE. This Work Unit is designed to obtain that information.

The primary objective of this Work Unit is to identify, evaluate, and document existing and newly emerging information and techniques (including technology from other WRP Work Units) applicable to wetlands stewardship and management on USACE water resource projects.

As part of this Work Unit, WES is coordinating an interagency effort to

- a. Identify and assess existing technology pertinent to wetlands stewardship.
- b. Develop a handbook of existing low-cost biological and environmental engineering wetlands management techniques.
- c. Develop a guidebook for establishing and managing wetland plants on USACE projects.

Research Areas in Work Unit 12W19 include (a) non-point source pollution management, (b) sediment management, (c) wildlife habitat management, (d) fisheries habitat management, (e) pest management, (f) vegetation management, (g) natural community/biological diversity management, and (h) wetland systems management. All field studies will be conducted on demonstration sites selected in Work Unit 12W20 or in greenhouse/nursery studies.

In addition to field investigations, major products include growth trials being conducted through an SCS/USACE MOA, Technical Notes on sources of plant materials and wetland plant materials evaluations, and Technical Reports on wetlands management and plant materials.

**Work Unit 12W20:
Wetland Stewardship and
Management Demonstration Areas**

USACE project lands, because of their location along the major waterways of the Nation, constitute critical points in the landscape on local, regional, and national scales. These projects (e.g. USACE-owned reservoirs or flood control projects) often have a man-induced aquatic-terrestrial interface where the natural wetland zone is abbreviated, stressed, or missing altogether. As a result of the location and character of these projects at the land-water interface, an excellent opportunity exists for the USACE to take a lead role in demonstrating good stewardship of wetland resources by adopting a landscape approach to the restoration, protection, and management of wetlands on USACE-controlled lands. This Work Unit is designed to demonstrate those capabilities and techniques.

Work Unit 12W20 has a primary objective of developing a guidelines manual for wetlands management, with secondary objectives of interagency coordination on field demonstration sites. The manual will include

- a. Coordinated landscape approaches and solutions.
- b. Case histories from field demonstrations and other sites.
- c. Monitoring programs of innovative and state-of-the-art biological and environmental engineering techniques for protecting, improving, increasing, and maintaining wetland resources on USACE-controlled land.

A series of interdisciplinary research and advisory teams have been assembled to design and implement a coordinated set of 16 demonstration sites. These sites will be tested and evaluated for local, regional, and national aspects of wetlands stewardship and management opportunities on USACE-controlled lands. Case studies of past successes will be documented, and new field investigations will be initiated. Emphasis is being placed on (a) providing low-cost solutions to correcting and/or avoiding existing and potential problems and (b) identifying and capturing opportunities for the protection and positive management of existing wetlands. Demonstration sites tentatively selected emphasize repeatability of results based on project type, environmental setting, wetland functions and values addressed, and geographical representation.

Demonstration sites selected for Work Unit 12W20 (by topic of study) are:

- a. Plant materials.

Grenada Lake, Mississippi.
Tuttle Creek Lake, Kansas.
Cowanesque Lake, Pennsylvania.
Fern Ridge Reservoir, Oregon.

b. Non-point source pollution management.

Bowman-Haley Reservoir, North Dakota.

c. Wildlife habitat management.

Harry S. Truman Reservoir, Missouri.
Marsh, Mud, and Orwell Lakes, Minnesota.
Black Butte Reservoir, California.
Ray Roberts Lake, Texas.

d. Fish habitat management.

Conesus Lake, New York.

e. Pest management.

Upper Mississippi River Pools, Minnesota.
Lake Okeechobee, Florida.

f. Vegetation management.

Riverlands Environmental Demonstration Area, Missouri.
Felsenthal National Wildlife Refuge, Arkansas.

g. Natural community and biological diversity management.

Maine Black Duck Impoundment Study, Maine.

In addition to field demonstrations at 16 selected sites on USACE-controlled land, major products include

a. Technical Reports on selected case histories and studies, wetlands management, and demonstration study results.

b. A national workshop on integrated management of USACE lands.

6 Work Unit Funding

Funding levels for the WRP are given in the following table by Work Unit, as described in Chapters 4 and 5.

WRP Funding Requirements (\$000)					
Work Unit Number	Work Unit Title	FY91	FY92	FY93	Total
12W01	Interagency Coordination and Program Management	350	350	350	1,050
12W02	Technology and Information Transfer	150	300	300	750
12W03	Critical Processes: Hydraulics and Hydrology	135	525	330	990
12W04	Critical Processes: Sedimentation and Erosion	90	425	270	785
12W05	Critical Processes: Water Quality	50	350	200	600
12W06	Critical Processes: Soils and Vegetation	0	300	200	500
12W07	Wetland Delineation	120	410	360	890
12W08	Evaluation of Wetland Functions and Values	570	1,240	840	2,650
12W09	Avoid and Minimize Impacts	0	180	95	275
12W10	Methods to Predict Impacts	0	0	0	0
12W11	Cumulative Impact Analysis	125	275	185	585
12W12	Improved Wetlands Design Criteria	150	750	500	1,400
12W13	Technical Standards for Monitoring and Success Criteria for Wetlands	100	200	200	500
12W14	Techniques, Structures, and Equipment for Wetlands Restoration and Establishment	150	875	475	1,500
12W15	Wetlands Field Demonstrations	450	2,175	1,925	4,550
12W16	Techniques for Characterizing Changes to Wetland Systems	160	395	220	775
12W17	Automated Analysis, Display, and Information Bases for Wetland Systems	75	150	100	325
12W18	USACE Wetland Inventory and Management Information System	75	300	50	425
12W19	Technology for Managing Wetlands	50	500	250	800
12W20	Wetland Stewardship and Management Demonstration Areas	200	1,300	1,150	2,650
Total		3,000	11,000	8,000	22,000

References

Adamus, P. R., Clairain, E. J., Jr., Smith, R. D., and Young, R. E. 1987. Wetland evaluation technique (WET); Vol II: Methodology. Operational Draft Technical Report. Vicksburg, MS: US Army Engineer Waterways Experiment Station.

Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Technical Report Y-87-1. Vicksburg, MS: US Army Engineer Waterways Experiment Station.

Federal Interagency Committee for Wetland Delineation. 1989. Federal Manual for Identifying and Delineating Jurisdictional Wetlands. Cooperative technical publication. Washington, DC: US Army Corps of Engineers, US Environmental Protection Agency, US Fish and Wildlife Service, and USDA Soil Conservation Service.

Landin, M. C., Clairain, E. J., Jr., Theriot, R. F., Klesch, W. L., and Pfeiffer, J. A., Jr. 1991. Proceedings of the US Army Corps of Engineers wetlands workshop, September 1989, Aurora, Colorado. Technical Report WRP-RE-1. Vicksburg, MS: US Army Engineer Waterways Experiment Station.

The National Wetlands Policy Forum. 1988. Protecting America's wetlands: An action agenda. Washington, DC: The Conservation Foundation.

US Army Corps of Engineers. 1986. Dredged material beneficial uses. Engineer Manual 1110-2-5026. Washington, DC: Headquarters, US Army Corps of Engineers.