Institute for Wetland Science and Public Policy of the
Association of State Wetland Managers

A Guide for Local Governments

Wetlands and Watershed Management

- Wetlands
- Riparian Areas
- Floodplains

By:

Dr. Jon Kusler

**Institute for Wetland Science and Public Policy of the
Association of State Wetland Managers**

Publication number 28

A Guide for Local Governments

WETLANDS AND WATERSHED MANAGEMENT

- WETLANDS
- RIPARIAN AREAS
- FLOODPLAINS

By:

Dr. Jon Kusler

Funded by:
The McKnight Foundation

In Cooperation with

The U.S. Environmental Protection Agency, Division of Wetlands

and

The National Park Service, Rivers and Trails Program

October 1, 2003

DISCLAIMER

PREFACE

This guidebook has been written to help local governments simultaneously achieve water resources management, water-related ecosystem protection and land use management goals. It has been written for engineers, biologists, planners, staff of environmental nonprofit organizations, landowners, legislators and others interested in developing integrated community resource management programs and reducing community water-related conflicts. It has been written to help local governments achieve "smart growth" and attain "sustainable" communities by protecting and restoring wetlands, riparian areas, floodplains as part of broader related water resources and land management.

Local water resources/watershed management efforts that need coordination or integration with wetland-related ecosystem protection efforts include floodplain management, stormwater management, water supply, point source pollution control, nonpoint source pollution control, and broader watershed management efforts. Wetland-related ecosystem protection efforts needing coordination or integration with water resources programs include wetland protection, riparian protection, floodplain habitat protection, fisheries management and other water-related habitat protection and restoration programs.

Both water resources management programs and ecosystem protection and management programs are important to the sustainable use and the "restoration and maintenance of the chemical, physical, and biological integrity" (Water Pollution Control Amendments, 1972) of the Nation's waters. Yet, these programs in the past have often been pursued separately and quite often in conflict.

Coordinating water resources management, ecosystem protection and restoration, and land use efforts requires rethinking programs with broader, multiobjective perspectives. It requires improved information bases and multiobjective assessment approaches consistent with decision-making needs. It requires bringing together agency staff in the various wetland/floodplain ecosystem programs, water resources/watershed management and land use programs to share information and build cooperation. It requires multiobjective visions, consensus-building and new partnerships.

Coordination of water resources/watershed, ecosystem protection and restoration, and land use efforts cuts across agency programs, geographical boundaries, areas of expertise, and "turf". But, coordination is essential if both traditional water resources management and broader land use goals are to be achieved.

This guidebook examines the concept of wetlands and watershed management, and considers the involvement of key actors, assessment, compensation for impacts, and the reconciliation of water resources management and ecosystem protection. It concludes with recommendations for looking to the future of wetlands and watershed management efforts. Appendices contain additional information pertaining to wetland, floodplain and riparian area functions and values and a selected bibliography and list of web sites.

The guidebook draws on lessons learned from a broad range of wetland, floodplain, water resources development, watershed management, river, water quality and other community efforts over the past 20 years. It also draws, in part, on a series of background reports prepared over a seven-year period for a broader Wetlands and Watershed Management Project conducted by the Institute for Wetland Science and Public Policy including a report: Assessing Wetland Functions and Values.

We hope this guidebook will be useful and will stimulate thinking. Our goal is to draw together various local groups and interests, who are logical partners, but have been separated by differing program missions and expertise. This guidebook is not a "cookbook" because coordination or integration of ecosystem management and water resources/watershed management is much too complex to follow a single path. Rather, the guide raises issues and suggests approaches that may be helpful in many community contexts.

ACKNOWLEDGEMENTS

Principal funding support for this guidebook was provided by the McKnight Foundation. The U.S. Environmental Protection Agency, Wetlands Division and the National Park Service Rivers and Trails Program also provided support. All of this support is gratefully acknowledged.

The help and guidance of Dan Ray of the McKnight Foundation, Reggie Parish and Stan Austin of the U.S. Environmental Protection Agency, and Jeanne Christie of the Natural Resources Conservation Service are much appreciated. The research and editorial assistance of Jennifer Brady Connor, Mary Binder, Bethann Stewart and Sharon Weaver are also much appreciated.

The guidebook is based, in part, upon a series of wetlands and watershed workshops and national symposia the Association of State Wetland Managers conducted or helped sponsor in 1993-1998 with a broad range of cooperating parties in West Palm Beach, Florida; Niagara Falls, New York; Atlanta, Georgia; Eugene, Oregon; Columbia, Missouri; St. Paul, Minnesota; Omaha, Nebraska; Tampa, Florida; Reno, Nevada; St. Louis, Missouri. Approximately 2500 local government staff, state government staff, federal agency personnel, representatives from non-profits, developers, and landowners attended these workshops and symposia.

The guidebook also draws upon many other publications listed below and in the bibliography.

Finally, it is based upon hundreds of discussions with both water resources and wetland ecosystem professionals at community, state and federal levels over the last four years.

A hearty thanks to all!

Jon Kusler

OTHER GUIDANCE MATERIALS

This guidebook is part of a series of documents developed and workshops conducted as part of a Wetlands and Watershed Management Project undertaken by the Association of State Wetland Managers in the 1995-2003 period. These documents are targeted to different audiences and address somewhat different issues. In addition to the present report these documents include:

Kusler, J.A. and T. Opheim. 1996. **Our National Wetland Heritage, Second Edition, A Protection Guide,** The Environmental Law Institute, Washington, D.C., (149 pp.) is intended for the general public, local government officials and local land use planners interested in land planning approaches to wetland protection and restoration. It provides a great deal of “how to" information concerning wetland protection from a local land planning and management perspective. The document contains many color photos, tables and boxes. It is available from Island Press, the Environmental Law Institute, Washington, D.C., and the Association of State Wetland Managers.

Kusler, J.A., D.E. Willard and H.C. Hull Jr. (eds.). 1997. **Wetlands and Watershed Management: A Collection of Papers.** ASWM, Berne, NY, (466 pp.) is a more technical document intended for local government water planners and managers as well as land use planners and not-for-profits. It consists of 81 papers from a series of wetland and watershed workshops and symposia conducted by ASWM in the l996-1997 period. It considers wetland and watershed management scientific issues in greater depth and provides case-study examples of local wetlands and watershed management efforts in a broad range of contexts. It is available from the Association of State Wetland Managers in Berne.

Kusler, J.A., 2003. **Wetland Assessment for Regulatory Purposes,** ASWM, Berne, NY is a three-part series designed to help community, state and federal planners, engineers and biologists assess wetlands, and related land and water resources. The first report in this series addresses the assessment of wetland functions and values for regulatory purposes; the second focuses on legal considerations in wetland assessment; and the final report discusses the integration of wetland assessment into regulations and proposes a Collaborative Wetland Assessment Process. These products were developed as part of the Wetlands and Watershed Project because assessment of wetlands and related ecosystems for regulatory purposes is a critical component of wetlands and watershed management efforts. These documents are also available from the Association of State Wetland Managers.

Please contact the Association if you are interested in one or more of the other documents.

Other Priority Reading

We suggest another group of priority readings. See the bibliography of this report for a broader list.

- *Association of State Floodplain Managers. 1997. Using Multi-Objective Management to Reduce Flood Losses In Your Watershed.. Association of State Floodplain Managers, Madison, WI.*
- *Crane, S. (ed.) 1995. Wetland Conservation: Tools for State and Local Action. World Wildlife Fund, Washington, D.C.*
- *Carter, J.G. (l989). A Citizen’s Guide to Protecting Wetlands. National Wildlife Federation, Washington, D.C.*

- *Environmental Protection Agency, 1997. Top Ten Watershed Lessons Learned. Environmental Protection Agency, Washington, D.C.*
- *Environmental Protection Agency, 1994, Section 319 Success Stories. Environmental Protection Agency, Washington, D.C.*
- *International City/County Management Association. 1999. Protecting Wetlands and Managing Watersheds: Local Government Case Studies. International City/County Management Association, Washington, D.C.*
- *Kusler, J.A. 1982. Innovation in Local Floodplain Management: A Summary of Community Experience. University of Colorado, Natural Hazards Research and Applications Information Center, Special Publication 4. Boulder, Colorado.*
- *Labaree, J.M. 1992. How Greenways Work: A Handbook on Ecology. National Park Service and Atlantic Center for the Environment, Ipswich, Massachusetts*
- *Little, C.E. 1990. Greenways for America. Johns Hopkins University Press. Baltimore, Maryland*
- *National Park Service. 1996. Floods, Floodplains, and Folks. National Park Service, Rivers, Trails and Conservation Assistance Program. Washington, D.C.*
- *National Park Service. 1991. A Casebook In Managing Rivers for Multiple Uses. National Park Service, Rivers and Trails Program. Washington, D.C.*
- *International City/County Management Association. 1999. Protecting Wetlands and Managing Watersheds: Local Government Case Studies. Washington, D.C.*
- *National Wildlife Federation. 1999. Higher Ground. Washington, D.C.*
- *Schueler, T. 1995. Site Planning for Urban Stream Protection, Metropolitan Washington Council of Governments*
- *U.S. Environmental Protection Agency. 1993. Proceedings, Watershed '93, A National Conference on Watershed Management. March 21-24, 1993, Alexandria, Virginia.*
- *U.S. Environmental Protection Agency. 1996. Proceedings, Watershed '96: Moving Ahead Together, Technical Conference and Exposition, June 8-12, 1996, Baltimore, Maryland. 1165 pp.*
- *U.S. Environmental Protection Agency. 1996. Protecting Natural Wetlands: A Guide to Stormwater Best Management Practices, Washington, D.C.*
- *World Wildlife Fund. 1992. Statewide Wetlands Strategies: A Guide to Protecting and Managing the Resource. Published by Island Press, Covelo, California.*

TABLE OF CONTENTS

TABLE OF BOXES

LIST OF FIGURES

CHAPTER 1: WETLANDS AND WATERSHED MANAGEMENT: THE CONCEPT

"To be effective, the nation's wetlands protection and management programs must anticipate rather than react. They should focus on the future, not the present or the past; on effectively protecting the remaining resources and actively restoring or creating additional wetlands. They should anticipate needs and problems on the basis of rigorous analyses of regional resources, trends, stresses, and values. They should consider the whole, not just the individual parts."

— The Conservation Foundation, Protecting America's Wetlands: An Action Agenda. The Final Report of the National Wetlands Policy Forum (1988).

"...(W)etlands management should be integrated with other resource management programs such as flood control, allocation of water supply, protection of fish and wildlife, and stormwater and nonpoint source pollution control."

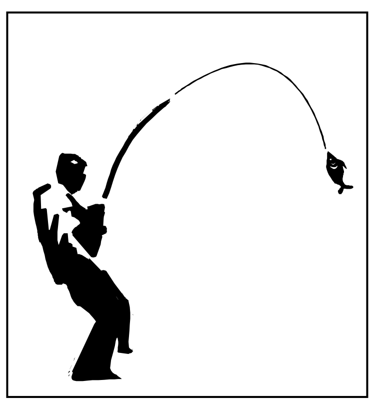
— National Governors Association, Water Resources Policy Statement, February 1992.

"The Federal government should expand partnerships with State, Tribal, and local governments, the private sector and individual citizens and approach wetlands protection and restoration in an ecosystem/watershed context..."

— White House Office on Environmental Policy, Protecting America's Wetlands: A Fair, Flexible, and Effective Approach, August 24th, 1993.

"*Much of the focus of the clean water program over the past 25 years has been to reduce chemical contamination of waters. Chemical contamination, however, addresses just one element of the Clean Water Act's charge to "restore and maintain the chemical, physical, and biological integrity of the nation's waters (italics added). As the clean water program moves to address problems on a watershed basis, other impairments to aquatic systems (e.g., damage to fish habitat, loss of wetlands that are nurseries of aquatic life, stream corridor degradation) have become more obvious and of greater concern."*

— Clean Water Action Plan: Restoring and Protecting America's Waters, 1998.



This page left blank.

CHAPTER 1: WETLANDS AND WATERSHED MANAGEMENT: THE CONCEPT

THE NEED FOR INTEGRATED APPROACHES

"Historically, this nation has approached water resources as isolated and categorical, with programs designed specifically for certain waters depending upon where they are found. Now we know that our water resources are part of an interrelated, hydrologic and environmental system that demands systematic management."

National Governor's Association Water Resources Policy Statement, February, 1993.

The following guidebook focuses upon a critical aspect of broad planning and management — integration of water resources planning and management with protection and restoration of wetland, riparian area, floodplain and related aquatic ecosystems. Traditionally water resources planning and management efforts have been partially or totally separated at the community level from ecosystem protection and land use management efforts.

As the 21st century begins, communities in the United States are faced with unparalleled challenges in water resources management, land use management, and the protection and restoration of wetlands and related riparian, floodplain and aquatic ecosystems. As populations grow, there is increased demand for water supply, flood control, stormwater management, water pollution control and other intensive management of water resources. Simultaneously, there is an increased demand for education, fishing, research, bird watching, boating, hiking, jogging, and other cultural uses of waters. All depend on healthy wetland, riparian, floodplain, and aquatic ecosystems.

As populations increase, development occurs and erosion and pollution increase. This threatens both people and ecosystems. Wetland and related floodplain and riparian ecosystems are degraded by fills, drainage, water pollution, altered hydrologic regimes, and other activities. Peak flood flows increase. The National Academy of Sciences has estimated that urbanization typically increases flood peaks for stormwater runoff 6-8 times over those naturally occurring. In the Denver area, peak flows may be increased 50 times. Increased flooding damages property and, in some instances, also destroys or damages natural habitats.

Separate programs have been developed to meet water resource management goals, protect natural ecosystems, and plan and manage our lands. But, the three must be linked or integrated.

The problems with uncoordinated water, ecosystem and land management programs do not stop with increased natural hazard and ecosystem losses. The cost of roads, sewers, water supply, stormwater management, schools and other public services skyrockets due to urban sprawl. New development, believed to be key to local real estate tax relief, may cost more than added tax revenues. Once attractive communities with historic structures, trees, open spaces, birds, and other wildlife become mosaics of strip development.

The need to integrate watershed management, ecosystem protection and restoration, and land use planning is particularly great where much of the landscape is wet—Louisiana, Florida, South Carolina, North Carolina Alaska, Minnesota, Wisconsin, Michigan and Maine. Efforts to separately analyze, plan and manage wetlands, riparian areas, floodplains, waters and lands in these contexts ignore fundamental hydrologic and ecological interrelationships (Figure 7, pg 17).

A combination of water resources problems, rising losses from flooding and other natural hazards, destruction of wildlife and open space, and destruction of community beauty and has prompted many communities to initiate multiobjective land and water management efforts. These have been variously described as "smart growth," "sustainable city," "ecological planning," or "watershed planning" and management programs. Programs for specific areas have also been described as "greenway," "environmental corridor," "wetlands and watershed management" and "floodplain management."

The goal of these efforts is much the same — to plan and guide future growth and development consistent with environmental, historic, and other functions and values. Wetlands, riparian areas, floodplains, and related aquatic ecosystems (lakes, streams, coastal waters) provide a wide range of natural functions and values.

Box 1

Wetland, Riparian Area, Floodplain Functions and Values

- **Flood storage**
- **Flood conveyance**
- **Wave retardation**
- **Erosion control**
- **Natural crops and timber**
- **Pollution control**
- **Fish and shellfish habitat**
- **Waterfowl and other bird habitat**
- **Endangered species habitat**
- **Ground water recharge**
- **Micro-climate modification**
- **Recreation and ecotourism**
- **Historical, archaelogical**
- **Aesthetic**
- **Education and research**

See Appendices F and G for more detail.

Most wetlands, riparian areas, and floodplains are located adjacent to rivers, streams, lakes and coastal waters. Other wetlands are located in more isolated depressions and on slopes where ground water discharges onto the surface.

Wetlands, riparian areas and floodplains are transition areas between aquatic systems and uplands. They are subject to periodic saturation by ground water or flooding by surface water, creating flood and erosion hazards for development located in these areas. Wetlands are the major transition areas in the parts of the nation with substantial rainfall. Riparian areas, consisting of narrow bands of vegetation, are equally important and serve similar functions in arid and semi-arid regions. Both wetlands and riparian areas comprise part of broader floodplains along rivers, lakes, and coastal areas.

How can communities simultaneously meet water resources management, ecosystem protection goals and land use goals?

In theory, integration is simple. Communities need to bring together water resources management and ecosystem managers with other key players (stakeholders) in water and land management. Communities need to help such groups form common visions. They need to implement those visions utilizing a broad range of techniques.

Successful efforts need to overcome a variety of problems and restraints. They need to be truly multi-objective. They need to address the existing fragmented nature of water resource and ecosystem management and the lack of common information bases and consensus building mechanisms. They need to manage resources from a landscape or watershed perspective, rather than focus on a small portion of the total water system.

Real integration has been rare, except in areas such as community waterfront projects.

Traditional water resources management efforts have been further separated into individual programs such as flood control, floodplain management, water supply, stormwater management, erosion control, and navigation. These distinct efforts have been authorized by different statutes and often staffed by individuals with unrelated expertise and interests. Programs have typically been implemented based on political, not hydrologic, boundaries. Ostensibly multi-objective, most of the programs have focused upon a single, primary goal.

Similarly, efforts to protect and restore wetlands and related ecosystems have been separated into wetland, public waters, lake protection, coastal zone management, river management, floodplain management, "critical area" and other types of programs. These efforts have also focused on a specific type of area or issue (e.g., fisheries) and have been staffed by individuals with a disparate expertise and interest. These programs have tended to concentrate on a single goal, or limited goals, for a particular component of the broader ecosystem.

For each of these types of programs, separate bureaucracies have partnered with different political "clients," such as agricultural interests, developers, fishermen and duck hunters.

Fragmentation, conflicts, and lack of coordination among programs was less a problem as long as communities had an abundance of open land and water resources, ample tax revenues and federal or state grants-in-aid for separate treatment of flood control, waster disposal, stormwater management, acquisition of recreation and open spaces and other purposes. Single purpose programs could be independently pursued, despite the lack of cost effectiveness and conflicts in programs.

Still, problems caused by lack of coordination have emerged. Despite expenditure of many billions of dollars to clean up rivers and lakes, high levels of pollution continue in many waters due to nonpoint source runoff (more than $85 billion was spent throughout 1973-1985 period alone). And, the desired fish have not returned to many waters because fish need wetland, which is disappearing, and other habitat, not simply cleaner water.

In addition, despite expenditure of more than $15 billion for federal flood control reservoirs, dikes and other flood control measures in the last sixty years, flood losses continue to rise due in part to the accelerated runoff in a watershed caused by the removal of vegetation, addition of impervious surfaces, destruction of wetlands, and construction of ditches and channels that accelerate runoff.

Today, there are not only decreasing budgets but also political pressure for rethinking water resources management, land use planning and wetland/floodplain ecosystem programs to make them more certain and predictable and more responsive to landowner needs. There are strong pressures for "regulatory reform" in many states as well as at the national level to reduce duplication in efforts and provide more certainty and predictability to landowners.

Box 2: *People are Key*

Many types of experts and multidisciplinary approaches are needed to integrate water resources and wetland, riparian area, floodplain and related ecosystem management.

- **Engineers**
- **Biologists, botanists**
- **Land and water use planners**
- **Hydrologists and geologists**

Box 3: *Some Water Facts*

- **In 1985 it was estimated that water withdrawals for residences, offices, farms, power plants, and factories were at an average of nearly 400 billion gallons per day or about 650 gallons per person.**
- **Estimates of domestic water use include:**
  - **Taking a bath — 30 to 40 gallons**
  - **Taking a shower — 20 to 30 gallons**
  - **Running a washing machine — 20 to 30 gallons**
  - **Washing dishes — 8 to 10 gallons**
  - **Flushing a toilet — 4 to 6 gallons**
- **In 1996, 2,193 fish consumption advisories due to pollution were issued in 48 states.**
- **Of the nation's 382 million acres of cropland, more than 70 million acres suffer erosion rates that threaten long term productivity.**

Box 4
Some Wetland Facts

- **Of the 215 million acres of original wetland, only 100 million remain. Fifty-three percent have been destroyed.**
- **Coastal wetlands make up about 5% of the wetlands in the US; inland wetlands make up the remaining 95%.**
- **70% of the coastal fisheries are dependent on wetlands.**
- **Well over l/3 of the 564 plant and animal species listed as threatened or endangered in the U.S. utilize wetland habitats during some portion of their life cycles.**
- **A one-acre wetland storing 1 foot of water (an acre-foot) equals 326,000 gallons or 43,560 cubic feet of water. This water weighs 2.7 million pounds.**
- **Nationally, 80% of the breeding bird population requires bottomland hardwood systems for survival.**
- **More than one half of U.S. adults hunt, fish, birdwatch or photograph wildlife.**

As efforts have been made to address individual elements of watershed management and ecosystem protection pursuant to individual "wetland," "floodplain," "public water," and other programs on a case-by-case basis, the truth of what has been long been taught in text books is increasingly clear--hydrologic systems are really connected and site-specific efforts to manage water and water-related lands often fail to achieve objectives because of the failure to consider their hydrologic and ecological context.

Case-by-case, site-by-site, and program-by-program approaches that only look at individual sites and issues are inherently flawed, despite attempts to make them appear quantitative and efficient.

To achieve both traditional water resources management and ecosystem management goals, water must be protected and managed not only as it flows in major rivers and streams and lakes, but also as it descends from headwater areas through the watersheds in surface and ground water flow, drainage channels, wetlands, floodplains, and related systems. Water must be protected and managed not only in times of normal flow, but also during high flows (floods) and low flows (droughts). Water must be protected and managed not only in lakes and stream channels, but also in adjacent wetlands, floodplains and riparian areas. Water and its adjacent corridors must be managed as a unit.

Box 5
Water Resource Problems Resulting From Ecosystem Losses

- **Increased Nonpoint Pollution**
- **Increased Flooding**
- **Increased Erosion**
- **Increase Sedimentation of Reservoirs**
- **Loss of Groundwater Recharge**
- **Loss of Canoeing/Water Recreation**
- **Loss of Waterfowl**
- **Loss of Biodiversity**
- **Loss of Fisheries**
- **Loss of Mammals**
- **Loss of Amphibians**
- **Loss of Reptiles**
- **Loss of Educational, Research Opportunities**

The need for integrated management has been broadly recognized at federal and state levels in the last decade. (See A Clean Water Action Plan: Restoring and Protecting America's Waters; 1994). This recognition has resulted in the adoption of a variety of coastal zone management, floodplain management, rivers, public land management, shoreland zoning, watershed management and other programs described in Appendix D. It has also resulted, at the local level, in adoption of land use planning, watershed management, coastal zone management, greenway and a host of other programs.

But, community integration of water resources and ecosystem programs is still quite rare. Most of the nation's waters and wetlands continue to be managed on a fragmented, program-by-program basis. There is limited coordination between water quality, flood loss reduction, source water and ecosystem protection and management programs.

In recent years wetland, riparian area, stream and floodplain restoration has emerged as a key component in local wetlands and watershed management programs. Wetland restoration, creation and enhancement provides opportunities for solving existing water quality, erosion, habitat, fisheries and other water resources problems. The Federal Clean Water Action Plan (1994) states that a "critical goal for pollution control and natural resource protection is to continue to slow the rate of wetlands loss nationwide and accomplish a net gain of at least 100,000 acres of wetlands each year by the year 2005."

WHAT IS "WETLANDS AND WATERSHED MANAGEMENT"?

We use the term "wetlands and watershed management" to mean multi-objective, integrated water resources and wetland-related (wetland, riparian area, floodplain) ecosystem protection and restoration. Wetland and watershed management programs involve collaborative and multiobjective data gathering, consensus-building, planning and implementation. The geographical scope of such programs varies from single river corridors to entire watersheds.

In some instances, wetlands and watershed management may involve "stand-alone" planning and management processes. Decision-makers may use such a "beginning-to-end" processes to plan and make management decisions for waters, wetlands, floodplains, riparian areas and other lands.

Wetlands and watershed assessment and planning may also be part of comprehensive land planning or water resources management programs designed for more specific purposes such as flood control, source water protection, stormwater management, pollution control, or more comprehensive land use management. It can be part of comprehensive land use management.

The idea behind a wetlands and watershed management approach is not to create new bureaucracies, but rather to bring existing water resources management and ecosystem management together.

It does not matter what a wetlands and watershed management effort is called or the set of issues that sparks the effort. What matters is the multi-objective approach that considers the hydrologic regime and endeavors to achieve both water resources management and ecosystem protection and restoration objectives.

Box 6
Wetlands and Watershed Management

Wetlands and watershed management efforts:

- **Bring together "key" biological, botanical, engineering, and other decision-makers (stakeholders);**
- **Generate the sorts of landscape level and watershed level information needed for both traditional water resources management and the protection and restoration of wetlands and related ecosystems;**
- **Help key actors (stakeholders) form collaborative and multi-objective visions for use of land and waters; and**
- **Facilitate collaborative implementation of plans and strategies.**

And, the principal planning and management strategy in wetlands and watershed management is often simple—

protect and restore lakes, rivers, streams, drainageways and their associated wetland, riparian, and floodplains while, simultaneously, achieving broader water resource management and land management goals. The protection and restoration of water and water-related land corridors simultaneously serves a broad range of water resources and ecosystem management goals.

Wetlands and watershed management requires going back to basics: What are community water and ecosystem management goals? What are the water-related problems? Where is the water in the community coming from and going? What paths does it take? What role does the wetland related ecosystem play in achieving water management goals? What is the community's vision for the future and how can it achieve this vision?

Efforts to integrate water resources management and ecosystem management are not new. Partial integration of watershed and ecosystem management has already been applied in hundreds of local watershed planning, ecosystem planning and land use planning and management efforts from cities as widespread as Boston, Milwaukee, Baltimore, Washington, D.C., Atlanta, Denver, San Francisco, Portland, and Seattle. There is considerable experience to draw upon to guide future efforts.

CHALLENGES

However, bringing together people and groups with different needs and perspectives is not easy. Gathering the information needed to meet a broad range of water and ecosystem management objectives can be complicated and costly.

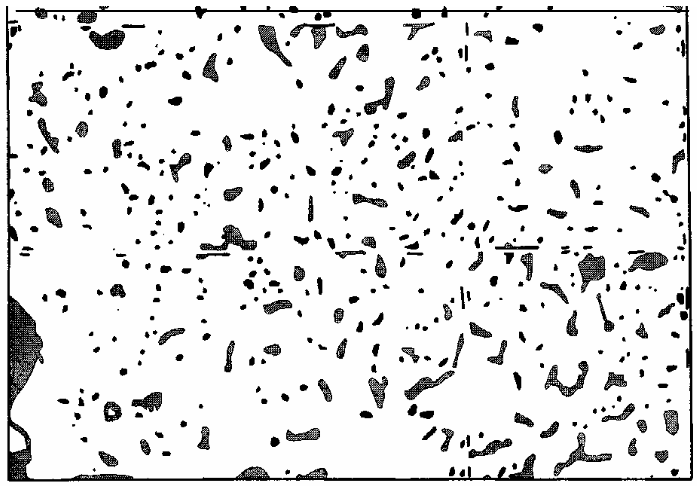
At all levels of government improved databases, technological and scientific advances in water resources, and aquatic ecosystem assessment and analysis such as watershed hydrologic models and wetland assessment models can help. But, technological advances are a double-edged sword. On the one hand, advances allow more accurate information gathering and analysis for integrated management of water resources and aquatic ecosystems. Computerized mathematical models, such as geoinformation systems, can be used to determine runoff, flood levels, sediment regimes and many other features of hydrologic systems needed for flood loss reduction, water supply, and other management needs. Biological surveys utilizing "biocriteria" can help characterize the condition of wetlands and other ecosystems.

On the other hand, computerized models often address only a particular goal, issue or problem. All of the money available to a local government can often be spent on information gathering and analysis for a particular issue (e.g., flooding, wetland analysis) providing little of the total information needed for multi-objective management.

Consequently, communities must undertake balanced and multiobjective information gathering. They need to combine community-wide general studies with more specific information gathering for specific areas and sites such as a wetland, riparian area, or floodplain with rare and endangered species habitat. See discussion in Chapter 4.

Funding is another issue. Communities have often found that multi-objective approaches (e.g., greenways) cost less overall than site and issue-by-issue approaches to individual parcels of land. But, funding in government programs is typically compartmentalized for particular purposes, such as water supply, pollution control and stormwater management. Communities must use creativity to simultaneously tap flood loss reduction, stormwater management, recreation, pollution control, transportation and other budgets. They must also find new ways of funding, such as the issuance of bonds.

Figure 1
Wetlands Within Central Sheridan County, North Dakota



In some areas like Sheridan County, the density of waters, wetlands, floodplains, and riparian areas is so great that any effort to separate management of these areas from land use management is impossible. Source: U.S. Fish and Wildlife Service, Habitat and Population Evaluation Team, Bismarck, North Dakota.

Many communities such as Tulsa, Oklahoma, Baltimore County, Maryland, King County, Washington, Boulder, Colorado, and Eugene, Oregon have found that multi-objective approaches facilitate funding—if a broad range of community interests are involved. For example, Tulsa spent years unsuccessfully trying to implement a floodplain management program with narrow flood loss reduction goals. This changed in 1984 when a Memorial Day Flood killed 14, injured 288, damaged or destroyed 7,000 buildings, and left $180 million in damages.

As a result of the flood, the community decided to broaden the goals for the program to include recreation, and protection of wetlands and other ecosystems. Voters, representing a range of interests, approved a significant bond issue for floodplain greenways and floodplain acquisition and relocation.

THE NEED FOR TAILORING

Successful wetlands and watershed management, therefore, requires innovation and sensitivity to local conditions. The content of a program must depend upon specific goals, the interests and capabilities of various stakeholders and partners, implementation tools and other factors. The content of efforts must also depend upon whether a wetlands and watershed management effort is to be a stand-alone management process or part of a broader water or ecosystem management program (e.g., stormwater, floodplain management, zoning).

The more detailed, suggested steps for a "stand alone" effort are described in Chapter 2.

WHERE WETLANDS AND WATERSHED MANAGEMENT IS PARTICULARLY NEEDED

Integrated water resources and wetland assessment, planning and management is particularly needed where there are many wetlands in the landscape, where there are serious water resources problems or where extensive development is taking place with resulting changes in watershed hydrology.

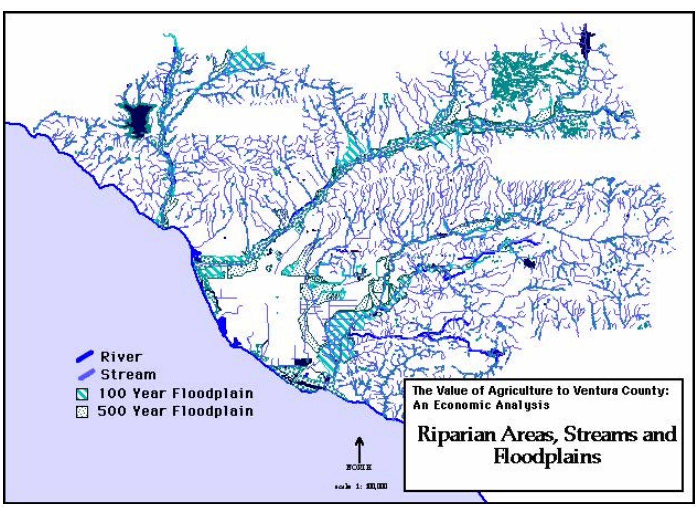
Wetlands occupy much of the landscape in the northern band of glaciated states and in some coastal states (e.g. Louisiana, South Carolina, Florida). Here are numerous wetlands and their collective impact on land use and water use decision-making is even greater. Because they are scattered throughout the landscape and along minor rivers and streams, wetlands form key components of many parcels intended for subdivision, road building, agriculture and other purposes.

These wetlands include much of the estimated 50 million plus acres of partially drained agricultural wetlands. They include many stormwater detention facilities, which have inadvertently become wetlands, and wetlands created when roads, railroads, bridges, dikes and levees, and other fill and grading operations blocked natural drainage.

It is not only difficult to carry out development without affecting wetlands in these areas, but wetlands are also affected by activities throughout watersheds. An overall hydrologic analysis and management plan is needed. Activities throughout watersheds affect the amount, timing and velocity of flow into wetlands which determine the short- and long-term characteristics of wetlands, floodplains, and riparian areas.

Multi-objective wetlands and watershed assessment and management programs can be used to identify and map wetlands in such contexts and develop impact reduction and compensation strategies such as greenways, stream buffers and mitigation banks. Wetlands and watershed management efforts can provide the hydrologic and ecological management framework for determining the importance of individual wetlands and designing impact reduction and compensation measures. It is in such contexts that it is particularly important to relate wetland, floodplain, riparian zone, and watershed-based land and water management programs.

Figure 2



Source: http://cdr.ucdavis.edu/mbrown/steve/rip.html. Graphic courtesy of E. Steve McNiel, 1997 9-10

ILLUSTRATION OF WETLANDS/WATERSHED MANAGEMENT: DU PAGE COUNTY, ILLINOIS

Du Page County, Illinois provides an example of integrated wetlands/watershed management.

In the 1980s, Du Page County, the most rapidly growing County in Illinois, was faced with competing and highly fragmented water and natural resource programs much like their counterparts throughout the nation. The county was concerned about water and related wetland resources from several major perspectives:

- Stormwater management
- Flooding and floodplain management
- Water supply (domestic wells, local government, commercial, industrial)
- Water quality including sediment, toxics, nutrients (point and nonpoint source)
- Wetland and riparian area protection
- Recreation and aesthetic uses of water (fishing, swimming, canoeing, bird watching, education, research, etc.)

To address water from these perspectives, the county concluded that it needed to address:

- Normal flows (water supply, water quality, recreation)
- High flows (flooding, stormwater, erosion)
- Low flows (fish, recreation, water supply, water quality)

In 1989, the Illinois legislature authorized Du Page County and several other counties in the metropolitan Chicago area to establish multi-objective, county-wide water management districts.

Du Page County established a Department of Environmental Concern to implement such a district. The Department decided to go back to basics in addressing multiple water management issues. Instead of focusing on individual water management programs in existence, the county decided to ask the questions: Where was every drop of water which fell in Du Page Country coming from over a period of years (normal flows, high flows, low flows)? Where was every drop going? What happened to the water as it flowed off the land and through the county? What did this mean to the citizens of Du Page County? What should happen to the water?

Du Page County began to plan its use of water in a more integrated way by gathering all of the existing information about the water resources of the county, including the wetlands, rivers, lakes, streams, reservoirs and drainage ditches. The county also examined the land resources in terms of soils, topography, existing land uses and drainage, and conducted an inventory of all of the rivers and lakes.

Du Page identified areas with flooding, erosion and other problems, and areas in public ownership. It looked at existing land use plans and maps to determine growth areas.

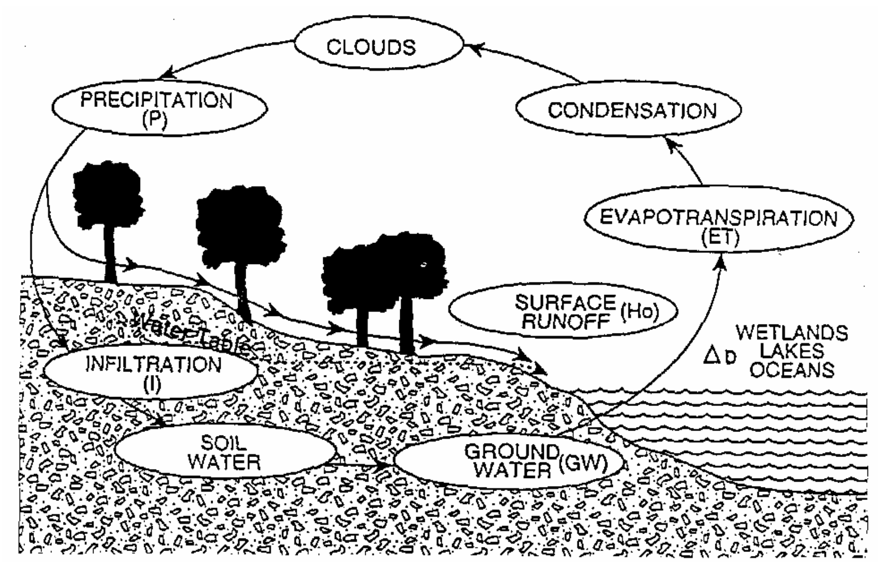
The ultimate goal was to prepare not only a plan for the county, but also an integrated wetland protection, stormwater, floodplain and pollution control ordinance. In 1991, the county adopted an integrated, stormwater ordinance, which addressed floodplain and wetland protection and management, with a goal of no net loss of wetlands. Du Page established a GIS system to help them plan and manage data.

Stormwater provisions divide the county into watershed planning units. Wetlands have been mapped and assessed. Wetland regulations place wetlands in several categories with differing mitigation criteria applying to two of these categories. “Critical” wetlands have been designated through an "advanced identification" effort and other criteria including a wildlife index test, a water quality test, the presence of endangered species and other factors. Wetlands in the critical category require a 3:1 mitigation ratio. Wetlands in the "regulatory" category require a 1.5:1 mitigation ratio. Determination of a wetlands category is made when a permit application is submitted. Mitigation is encouraged on-site. However, the county has also established several wetland mitigation banks for use where on-site mitigation is not possible or practical.

In March 1997, the Corps of Engineers granted the county a Programmatic General Permit to allow the county to review wetland permits that had limited environmental effects and provide the Corps with continued oversight. The Corps has also authorized the county to use a mitigation bank.

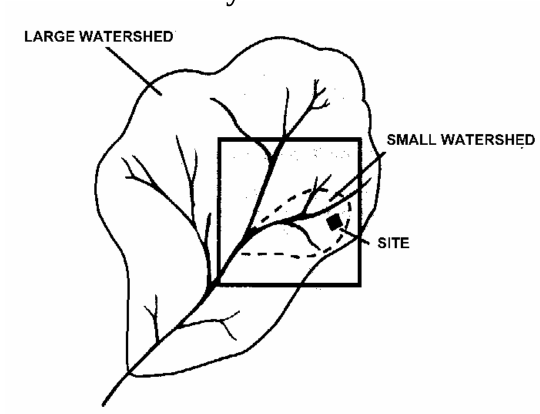
Du Page County is not alone in integrating wetlands and watershed management to create the necessary information for informed decision-making, and to coordinate key programs. Other examples include: many towns in the Southeastern Wisconsin Regional Planning Area; West Eugene, Oregon; Boulder, Colorado; Baltimore County, Maryland; Juneau and Anchorage, Alaska; and Dade County, Florida.

Figure 3
The Hydrologic Cycle



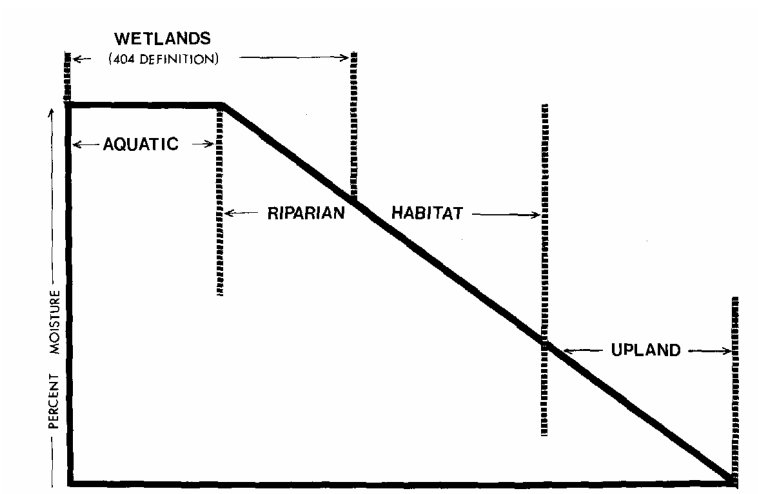
Wetland, floodplain, and riparian areas along with rivers, lakes and streams form key drainage and wildlife corridors Precipitation falls as rain, snow or hail upon watershed areas. Some is evaporated but most (typically) moves from headwaters through and out of the watershed through subsurface groundwater flows, diffused surface flows, and networks of creeks, streams, lakes, ponds, rivers and associated wetlands, floodplains, and riparian areas. From: Scientific Assessment and Strategy Team, Science for Floodplain Management Into the 21st Century, Washington, D.C. (1984).

Figure 4
A Hierarchy of Watersheds



Community lands constitute a "hierarchy" of watersheds (i.e.. lands and waters contributing runoff to a single point or points). Usually planning and management areas (see area contained in square) constitute a small portion of the watershed of a major river of stream. But, these same areas may constitute the entire watersheds for smaller streams, lakes, or ponds. Source: E.P.A. Office of Water, Protecting Natural Wetlands: A Guide to Stormwater Best Management Practices, EPA 843-B-96-001 (October, 1996)

Figure 5
Wetland-Related Ecosystems



References are made in the present guidebook to wetland and related ecosystems. These terms refer to not only wetland but related riparian, floodplain, and aquatic ecosystems that are characterized by periodic flooding, high ground water, or standing shallow water. The depth of water and frequency of inundation differ but the essential morphological and ecological characteristics of these systems (in contrast with upland system) are determined by **water**. Soils, vegetation, and animal life are all determined, in large measure, by the water regime. Functions and values also depend, in large measure, upon maintenance or restoration of the water regime.

Box 7: ***Examples of Programs that Need Coordination and/or Integration through Wetlands/Watershed Management Efforts***

Water Resources and Watershed Management Programs

Types of water resources management or watershed management programs in need of coordination with one another and with ecosystem management efforts include:

- **Pollution control**
- **Stormwater management**
- **Flood control and floodplain management**
- **Water supply**
- **Water recreation**
- **Soil and water conservation**
- **Navigation**
- **Fisheries and wildlife**
- **River basin planning**

Wetland and Related Ecosystem Management Programs

Individual types of ecosystem protection, restoration and management efforts in need of coordination with one another as well as water resources/watershed management programs include:

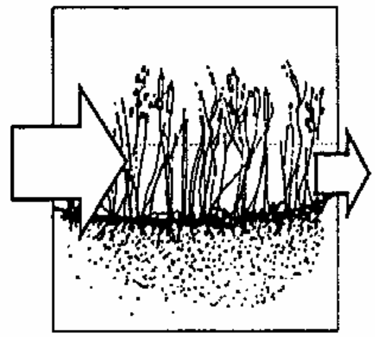
- **Wetland protection and restoration**
- **Floodplain protection and restoration**
- **Riparian habitat protection**
- **River protection and management (urban river, scenic and wild river)**
- **Wildlife (fish, waterfowl, mammal, endangered species, other)**
- **Lake protection and management**
- **Estuarine protection, estuarine sanctuaries**
- **Coastal zone management**
- **Shoreland and shoreline management**
- **Water-based critical area programs (e.g., the Florida Keys, Lake Tahoe, Hackensack Meadowlands)**

Box 8: ***Benefits of Wetlands and Related Ecosystems to Traditional Water Resources Management Programs***

- **Stormwater.** Protection and restoration of wetlands, riparian areas, and floodplains can store runoff, reducing the need for stormwater detention areas. Wetlands and floodplains can reduce the nutrients, debris, organic matter, toxics and other pollution in stormwater. Stormwater detention areas can be designed as wetlands, reducing water quality problems.
- **Floodplain Management.** Protection and restoration of wetlands, riparian areas, and floodplains can provide flood storage and conveyance, wave retardation, and erosion control. This reduces the need for dikes, levees, channel straightening and other protective works.
- **Point Source Pollution Control.** Constructed and restored wetlands can be used to help provide tertiary treatment of wastes. They can cost effectively help achieve the goals of restoring and maintaining the chemical, physical, and biological integrity of the nation's waters and protecting and restoring aquatic systems.
- **Nonpoint Source Pollution Control.** Protection and restoration of wetlands, riparian areas, and floodplains along rivers and streams, at the margins of lakes and ponds, and at headwaters can help reduce nutrients, sediment, and other pollutants by intercepting them before they reach water bodies or by treating pollutants in water bodies.
- **Water Supply.** Protection and restoration of wetlands, riparian areas, and floodplain areas along rivers and streams and at the margins of water supply reservoirs, lakes, and ponds can help protect water quality and reduce pollutants. They can reduce sedimentation in reservoirs by intercepting pollutants, reduce shoreline erosion, enhance fishery and recreation values. Restored or created wetlands, riparian areas, and floodplains can enhance groundwater recharge.

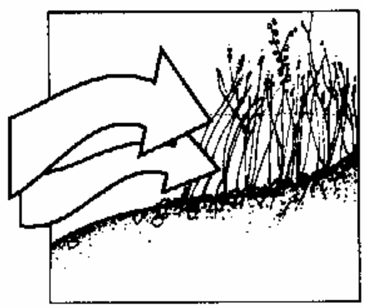
Figure 6
Some Principal Functions of
Wetlands, Riparian Areas, and Floodplains
Needed for Water Resources/Watershed Management
(See Appendix D for a More Detailed Description of Functions/Values)

Flood Protection



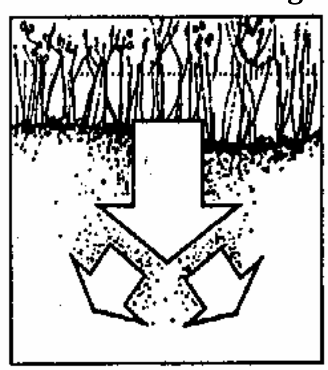
Wetlands store and convey runoff during severe storms, reducing downstream flood damages.

Shoreline Stabilization



Vegetated wetlands can help prevent shoreline erosion and reduce the impact of storm waves. Wetland vegetation absorbs energy from surface waters and binds the soils.

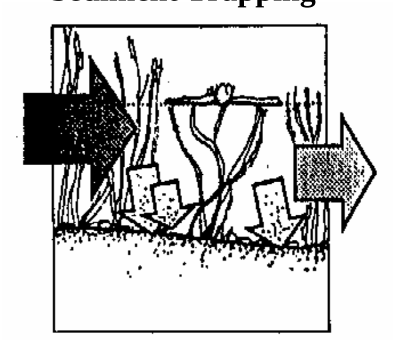
Groundwater Recharge



In some instances, wetlands can help recharge ground waters which provide drinking water and maintain stream flows. This is particularly true for seasonally flooded wetlands and riparian zones.

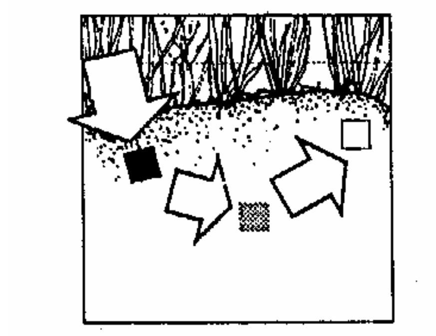
Continued pg. 16

Sediment Trapping



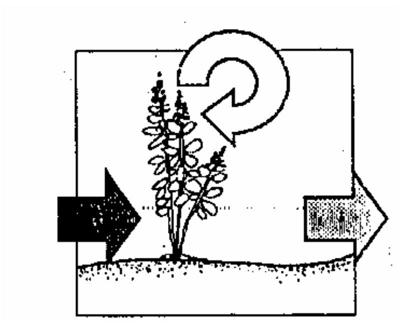
Runoff flowing through a wetland is slowed by wetland topography and vegetation, causing the deposition of soil particles (sediment).

Chemical Detoxification



Some of the pollutants carried into wetlands are trapped as soil particles settle in the wetlands; other pollutants are converted to less harmful forms by biochemical processes.

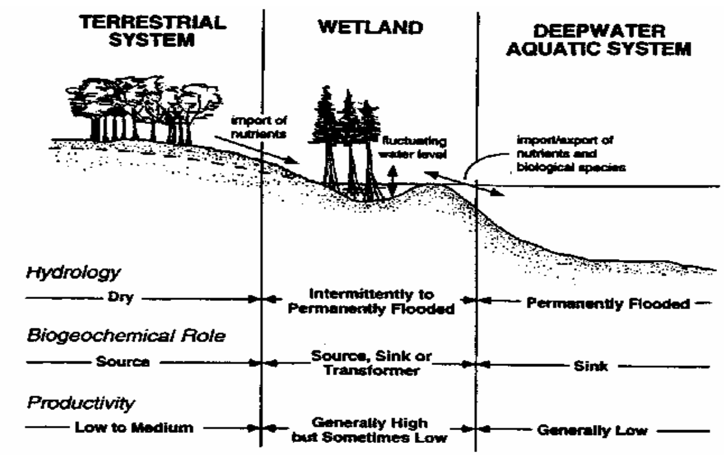
Nutrient Removal



Much of the nitrogen and some of the phosphorous entering wetlands is taken up by wetland plant materials, deposited in wetland sediments, or converted into gases which escape to the atmosphere by microorganisms.

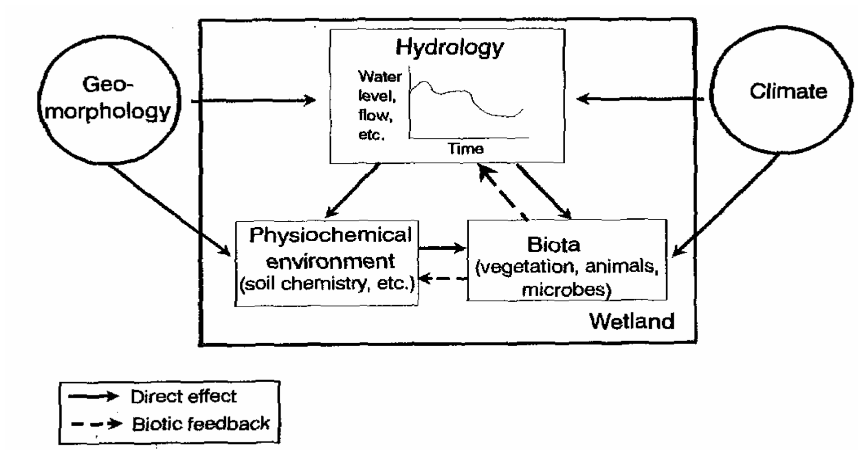
From: New York Department of Environmental Conservation, Wetlands Regulation Guidebook, Albany, New York (1994).

Figure 7
Wetlands: Transition Areas



Wetlands are the "common denominator" in the planning and management of lands and water-related ecosystems. They are, in many communities, the most extensive water-dominated ecosystems in the community (both by numbers and acreage). In addition, they form the beds and banks of many lakes, rivers, creeks, streams and estuaries and high water (flood conveyance) areas and link these areas. Forming the transitional areas between upland and aquatic ecosystems, wetlands and related floodplain and riparian systems protect and restoring water quality from land-based pollution sources. From, Natural Research Council, National Academy of Sciences, Wetlands: Characteristics and Boundaries, Washington, D.C. (1995)

Figure 8
The Relationships Among Hydrology, Physiochemical Environment and Biota in Wetlands

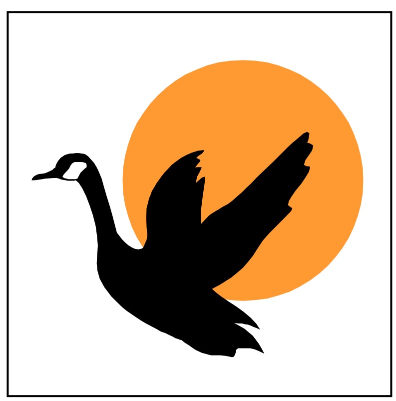


Geomorphology and climate are the overall factors determining wetland characteristics. More specific parameters determining wetland characteristics include water depth and velocity, water quality, hydroperiod, vegetation types, soils, and other factors. From, Natural Research Council, National Academy of Sciences, Wetlands: Characteristics and Boundaries, Washington, D.C. (1995).

CHAPTER 2: STEPS IN WETLANDS AND WATERSHED MANAGEMENT

Key components of a wetlands and watershed management stand-alone effort include:

- ***Identify problems and issues***
- ***Identify and bring together key actors ("stakeholders")***
- ***Formulate overall goals***
- ***Define the geographical planning/management areas (watersheds and sub-watersheds).***
- ***Map wetlands and water resources; assess existing and possible future conditions***
- ***Examine impacts of alternative land use and water use options***
- ***Carry out more detailed analyzes as needed***
- ***Involve the public***
- ***Develop specific plans for particular areas***
- ***Implement plans for particular areas***
- ***Monitor, enforce, and make adjustments***



CHAPTER 2: STEPS IN WETLANDS AND WATERSHED MANAGMENT

1. IDENTIFY PROBLEMS AND ISSUES

Most wetlands and watershed management efforts have begun with identification of a specific set of problems or issues (see box on p.23) such as serious floods, pollution or other problems.

Systematic identification of water-related problems can help develop support for wetlands and watershed management, and identify key actors or stakeholder groups. One motivated individual, a local or organization, or an agency can begin the process. Problem "prevention" and long term resource management must eventually become program goals as well.

2. IDENTIFY AND BRING TOGETHER KEY ACTORS ("STAKEHOLDERS")

A second step in wetlands and watershed management is identifying and bringing together in a work group key actors, or stakeholders. Initially, this work group may include only a few individuals. It may be informal.

Key actors are the individuals and organizations with a major stake in what happens to waters and wetland/aquatic ecosystems and who also have the ability to influence what happens. They are the individuals and organizations who can organize, adopt and implement land and water planning and management strategies (refer to the box on p.25 for ideas about whom to contact for a particular issue).

The individuals initiating wetlands and watershed management need to realize that key actors will participate only if they feel they have a stake in the outcome of such processes and can benefit from the process. This is discussed in greater depth in the next chapter.

Figure 9

Steve Gordon, Planner, Lane Council of Governments planner, played a leadership role in bringing together key actors and developing the West Eugene comprehensive Wetland Management Plan.

Photo credit: Alan Reid, http://www.oregonbirds.org/awards/meeting2002/OFOmeeting2002.html

Box 9
Recommendations from Symposia and Workshops

What are keys to success for wetlands and watershed management efforts? Selected suggestions by speakers and participants in the ASWM wetlands and watershed workshops during the 1995-2002 period include the following:

- **"Recognize from the onset that implementing multiobjective management is more than a technical issue. Bringing key actors with regard to a set of issues or problems to the table is essential."**
- **"Look multi-objectively at water resources (pollution prevention and control, flood hazards, wildlife, fisheries, etc.) rather than in terms of achievement of single objective or goal."**
- **"Look at the water resources (lakes, streams, estuaries, wetlands, floodplains, riparian areas) as an interrelated hydrologic/ecological system and not simply as individual waters."**
- **"Focus on common sense, on the ground issues, problems, and opportunities."**
- **"Facilitate the sharing of hydrologic and ecological information and get the 'right information for decision-making' before all of the key actors."**
- **"Be conscious of costs and limitations of data and expertise and look for cost-effective 'win-win' opportunities."**
- **"Reduce and 'compensate' (restoration, creation, enhancement) for ecological impacts."**
- **"Make any planning or data gathering specific enough to be meaningful; utilize a hierarchy of data gathering, assessment, analysis and implementation scales because highly detailed resource assessments and plans cannot be prepared for all areas."**
- **"Make the ultimate results usable at the parcel level as well as the community and regional levels. The ultimate test of any effort is what happens on the ground."**
- **"Don't create new bureaucracies, but find mechanisms for coordinating, assisting, and simplify existing ones."**
- **"Provide consensus-building and conflict resolution mechanisms."**
- **"Emphasize that restoration as well as protection of wetlands and other aquatic ecosystems are a way to solve problems (pollution, flooding) and to offset future losses."**
- **"Do not create 'black boxes.' Translate scientific concepts into understandable guidance."**
- **"Give landowners a 'voice.' Listen to what they have to say."**
- **"Use technology (e.g., remote sensing, GIS systems), but do not overestimate its capabilities."**
- **"Aim for common 'visions.'"**
- **"Look for implementation approaches such as greenways and environmental corridors which will simultaneously achieve multiple objectives."**
- **"Improve regulations; supplement regulations with nonregulatory programs."**
- **"Employ a variety of implementation techniques; no single technique is enough."**
- **"Monitor progress and stay flexible. This will take time."**

Box 10

Examples of Problems or Issues Prompting Wetlands and Watershed Management Efforts

Inadequate Water Supply

- Falling ground water levels
- Inadequate quantity of surface water for domestic, industrial and other uses
- Water disputes among landowners, governmental entities
- Fish kills, other loss of wildlife or habitat due to inadequate flows, low water levels in rivers, ponds, lakes, streams

Repeated and Serious Flood Damages

- Disaster or flood insurance payments
- Residences, commercial activities, other activities subject to frequent flooding
- Loss of life
- Loss of jobs or serious “down time” for economic activities
- Repeated damage to public works (roads, sewer and water)
- Threats to levees, dams, etc. due to increased flood heights cause by watershed activities
- Liability law suits

Erosion and Sedimentation

- Reservoirs, lakes quickly filling with sediment
- Erosion threatening bridges, infrastructure
- Streambed and bank erosion threatening residential, commercial, industrial, agricultural, other activities
- Breach of barrier islands, destruction of beaches
- Coastal land loss (e.g., Louisiana) due to sediment deprivation

Pollution

- Algae blooms in lakes, streams, and estuaries due to excessive nutrients in water
- Fish kills
- No fish or shellfish, or fish with high levels of contaminate
- High coliform levels, limiting swimming, water skiing, or other water sports, and domestic water supplies
- High level of toxics in waters threatening fish, wildlife, domestic water supplies, and other uses
- Loss of waterfowl, other birds, amphibians, etc.
- Abandoned lands (e.g., Superfund sites, dumps)

Loss of Wildlife and Wildlife Habitat

- Loss of endangered and threatened species of all types
- Loss of biodiversity

(continued, pg. 24)

(Examples of Problems or Issues, cont.)

Loss of Community Heritage, Cultural and Aesthetic Values

- Archaeological values
- Biodiversity
- Ecotourism
- Education, interpretation
- Recreational use
- Natural views, open spaces

Conflicting Agency Policies, Inadequate Mechanisms for Resolving Conflicts Regarding Floodplain Resources

- Stormwater
- Water supply
- Flood control
- Pollution control
- Land use, land use regulation

Inadequate Information for Planning/Management

- Water resources management, watershed management planning
- Wetland/aquatic ecosystem planning/ management
- Zoning and land use planning
- Regulatory permitting

Landowner, Developer Complaints

- Inadequate maps and other information concerning wetland and other aquatic ecosystem boundaries
- Inadequate information concerning wetland functions/values
- Confusion and uncertainty concerning various program requirements
- Lack of predictability and certainty
- High costs of permitting, information gathering

Box 11: Tips for Involving Key Actors

- **Identify people and groups that will benefit or suffer costs from improved resource management or loss of resources.**
- **Use simple and understandable language.**
- **Include all key actors from the beginning.**
- **Recognize that each actor has something important to contribute.**
- **Focus on specific geographical areas and problems/issues. People often tend to be area-specific in their interests. However, simultaneously keep the big picture in view.**
- **Look for common issues and win-win solutions.**
- **Challenge each participant to have a vision.**

Box 12: Key Actors

Key actors in wetlands and watershed management vary, depending on local context. Key actors may include:

1. Local, state, federal water and watershed management program staff

- Multi-objective watershed planning
- Flood loss reduction
- Stormwater management
- Water supply
- Point source pollution control
- Nonpoint source pollution control
- Navigation
- Recreation planning

2. Water-related habitat and wildlife management program staff

- Fisheries
- Waterfowl
- Rare and endangered species
- Other habitat

3. Staff from other planning/management efforts

- Land use planning
- Transportation
- Private land management activities
- Forestry
- Agriculture
- Mining

4. Staff and/or members from “grass roots” groups and organizations

- Soil and water conservation district staff
- Local nonprofits

5. Landowners and developers

3. FORMULATE OVERALL GOALS

General goals for wetlands and watershed management will differ somewhat, depending upon the context. One overall (general) goal of federal, state, and local wetland and watershed management efforts is the overall goal stated in Section 101 of the 1972 Water Pollution Control Amendments: "(R)estore and maintain the chemical, physical, and biological integrity of the Nation's waters." Other more specific land and water management goals may include:

- Promoting the most suitable use of land and waters throughout the community,
- Protecting community cultural and historic resources including property values,
- Reducing or preventing community flood and stormwater losses,
- Providing recreation opportunities,
- Protecting and improving water quality,
- Protecting and enhancing fish, bird, animal, and other habitat,
- Providing safe drinking water,
- Controlling point and nonpoint water pollution, and
- Promoting community economic development and well-being.

A work group may also adopt more specific goals or standards like those suggested below. Such standards can help guide information gathering, planning, and more specific goal formation for particular areas.

Box 13

No Net Loss Goal

The National Wetland Policy Forum in 1990 recommended the following interim and long term goals (See Protecting America's Wetlands: An Action Agenda, The Conservation Foundation, Washington, D.C.):

Interim Goal: To achieve no overall net loss of the nation's remaining wetlands base.

Long Term Goal: To increase the quantity and quality of the nation's wetlands resource base.

Box 14

Ecological Planning Goals — Wetlands and Related Ecosystems

- Maintain the biodiversity of habitats and plant and animal species,
- Maintain the connectivity of systems,
- Protect rare and endangered species,
- Maintain the natural hydrologic regimes,
- Maintain natural perturbations in systems such as flooding.

In general, wetland regulations at federal and state levels now require that regulated activities be located at alternative (non wetland) sites if such sites are practical. They require mitigation (reduction) of impacts through project design. And, they require "compensation" for wetland impacts through wetland restoration or creation if wetlands are damaged or destroyed.

Box 15

Standards for Activities in Wetlands (Section 404 Program)

A variety of specific regulatory and guidance standards have been developed at federal, state, and local levels to achieve the overall no net loss goals. For example, at the federal level, sequencing steps and requirements for reviewing Section 404 wetlands and waters permits are set forth in EPA's 404(b)(l) Guidelines (40 CFR Part 230):

Step 1: Determine whether the proposed project is water dependent.

Step 2: Determine whether practical alternatives exist for the proposed project.

Step 3: Identify the potential impacts of the proposed project on wetland functions in terms of project specific and cumulative effects.

Step 4: Identify how potential project impacts can be avoided or minimized in terms of project specific and cumulative effects.

Step 5: Determine appropriate compensatory mitigation for unavoidable project impacts.

Step 6: Grant or deny a permit to discharge dredged or fill material based on a comparison of the values of the benefits gained from the proposed project versus the benefits lost from the proposed project.

Step 7: If a permit is granted, monitor compensatory mitigation to determine compliance.

4. DEFINE THE GEOGRAPHICAL PLANNING/MANAGEMENT AREA

Defining the geographical planning area (often a watershed and its subwatersheds) is an important step in creating more specific visions, plans and goals. It can also help in identifying key actors and in data gathering, planning and ultimate management. Defining the relevant watershed and its subwatersheds is a challenging aspect of wetlands and watershed management because community, political and property ownership boundaries (e.g., parcel, community, state) often do not coincide with watershed boundaries.

Water in a typical community comes from two principal sources: precipitation falling onto community lands and various inflows (surface and ground water) from outside the community. Most water in small creeks, drainage ditches, streams, lakes and wetlands comes from precipitation falling on community lands. Water in larger streams, lakes, rivers, the oceans and regional aquifers often comes from larger watershed areas.

The sources and paths water takes in running off of the land is important from several perspectives. Water quantity and quality depend, in large measure, on land-uses associated with water's flow, the detention times for the water, and the physical and chemical processes at work along the lengths of those paths.

Work groups need to determine the overall watershed boundaries as well as specific subwatershed boundaries relevant to particular problems and issues. Much of the information gathering will then focus on these smaller watershed areas.

Determining the subwatershed boundaries that need more detailed analysis can often be done by first relating problems, issues and goals to the sources and paths of water.

A hierarchy of scales, resulting in several "watersheds" and levels of analysis, may be relevant to assessment and management. For example, the immediate, surrounding land that contributes runoff may be most important to water quality and wildlife in a floodplain oxbow lake. The larger river watershed is relevant to larger flood flows and sediment regimes.

Determining the sources and paths of water in a community (or the portion of a community subject to a wetlands and watershed management plan) can be done on a broad scale based on examination of topographic maps, air photos, soil maps and other sources of information. More detailed hydrologic and hydraulic studies can then be undertaken for more specific areas (as needed).

Box 16
Watershed Analysis

The scales and foci of watershed analysis are typically determined, in part, by scientific considerations and, in part, by institutional considerations, such as land ownership and community boundaries. Some foci and scales include:

- **Parcel focus.** The land parcel is the typical assessment and planning unit for a private or public landowner. Detailed analysis of the quantity and quality of water falling upon the parcel and entering and running off a parcel is needed for parcel-level stormwater planning and management, soil and water conservation planning, wetland assessment, wetland restoration and parcel-level planning. However, parcel level analysis also needs to take place within an overall hydrologic and ecological framework because the parcel typically does not coincide with the entire runoff area.
- **Specific water body/wetland focus.** A second common focus for analysis is a specific water body (wetland, river, stream, lake, pond.) The watershed for a specific water body or wetland includes all of the lands providing runoff or groundwater flow. It may include hundreds of acres to hundreds of square miles. Determination of the quantity and quality of water entering and running off a watershed is undertaken in community stormwater management, floodplain management, lake protection and restoration, estuarine protection and restoration, specific wetland protection and restoration, source water planning, and nonpoint and point pollution control efforts.
- **Community-wide studies.** Community-wide watershed analysis is also quite common. Assessing the quantity and quality of water entering and running off of community lands typically requires analysis of a number of subwatersheds. The scale of watershed and subwatershed analysis depends upon the application and situation but rather generalized analysis are usually undertaken because of limitations on funds and staff. More detailed analysis may take place for specific areas within a community that have special problems or special resources (e.g., a pristine lake).
- **Regional, state, basin wide focus.** Large-scale analyses have also been undertaken on a regional or state basis. For example, all states have inventoried their waters from pollution and source water perspectives. The quantity and quality of water entering and running off of a state or region also requires analysis of subwatersheds. The scale of analysis also depends upon the application. Typically only general analysis is possible on a region, state, or basin focus. However, more detailed analysis may take place for particular problems or special resource areas.

5. MAP WETLANDS AND WATER RESOURCES; ASSESS EXISTING AND POSSIBLE FUTURE CONDITIONS

Mapping of wetlands and other water resources (lakes, streams, rivers, etc.) is the next a key step in wetlands and watershed management. Joint initial information gathering among various agencies and groups can provide a factual basis for more specific plans and help build understanding and working relationships between various key actors (See Chapter 4). Additional assessments will probably be necessary, although the information required, the scale and the degree of accuracy may vary.

When substantial changes in the water resources are proposed, watershed assessment must often develop scenarios for (1) wetlands and water resources under existing conditions, and (2) wetlands and water resources pursuant to various future management scenarios.

To carry out such an assessment, a community must ask: What "baseline" conditions exist? What changes will occur? How will these changes affect flooding, water quality, water supply and wetland and related ecosystems? What will be the affect of impact reduction and compensation measures?

6. CARRY OUT MORE DETAILED ANALYSES AS NEEDED

The more detailed analyses needed by wetlands and watershed efforts depend on the specific goals of the planning and management effort, the physical condition, changes underway in the watershed, and other factors. In general, the desired scales and degrees of accuracy increase as development pressures and the number and magnitude of changes in water and related ecosystem changes increase. For example, simple mapping of waters and wetlands may suffice for wetlands and watershed conservation planning for an area under no development pressure. Scenarios projecting major hydrological changes can be used to aid planning efforts, evaluate impacts and design impact reduction and compensation measures.

Wetlands and watershed assessment and management efforts have increasingly applied geoinformation systems to store and analyze data and provide various informational outputs.

7. FORM VISIONS

Having established overall goals and inventoried resources, a wetlands and watershed work group is then in a position to form a vision or several visions for the future of specific lands and waters. At first, this vision may be general (e.g., we want greenways for our stream corridors) but will become more specific as detailed mapping and studies are undertaken and cost, landowner attitudes and other factors are taken into account. In successful efforts, this vision has often been subjected to broad public review so that it becomes a "community" vision and not simply the vision of a small group or committee.

8. INVOLVE THE PUBLIC

In most instances, successful wetlands and watershed management efforts enjoy strong public involvement.

Approaches for involving the public include:

- Advisory committees
- One-on-one contacts
- Workshops
- Public “comment” procedures
- Public hearings

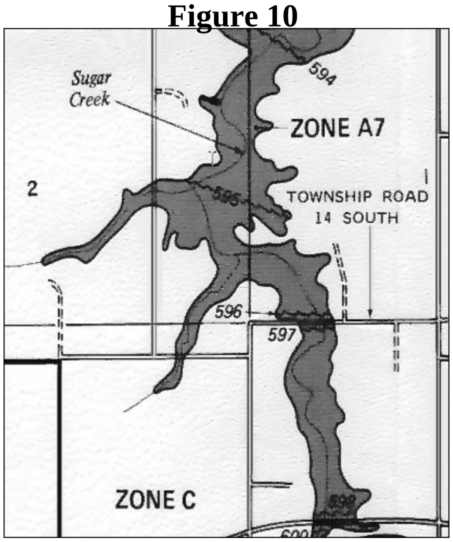
9. DEVELOP MORE SPECIFIC PLANS FOR PARTICULAR AREAS

Wetlands and watershed efforts begin with broad brush surveys but, in most instances, must ultimately require more detailed assessment, goal setting, visioning and planning for particular portions of river, stream and drainage corridors. These assessments may address problem areas (e.g., floodplains, degraded wetlands, sources of pollution, segments of stream with erosion problems), areas with special resource values (e.g., endangered species habitat, greenways, etc.), areas under intensive development pressures (e.g., a major subdivision), and, in some instances, proposed economic development areas (e.g., an industrial park).

More detailed inventories and planning are needed because a generalized wetlands and watershed assessment plans invariably lack the requisite scale for site-specific management.

Communities have found it impractical or impossible to gather detailed information and carry out detailed and accurate analyses sufficient for an entire community or region as a whole. Successful wetlands and watershed management efforts must bridge the gap between regional, broad brush hydrologic and ecosystem analysis, goal setting, and planning and site-specific planning and management for specific areas.

Figure 10



Sangamon, Illinois Floodplain.
Used with permission: http://www.co.sangamon.il.us/Floodplain/FloodInsurance.htm

Box 17
Benefits of Protecting Drainage Corridors

Protection of rivers, stream and drainage corridors including adjacent wetlands, floodplains, and riparian areas can often:

- **Protect flood conveyance along rivers and streams**
- **Reduce damage from stream bank and coastal erosion**
- **Store and slowly release flood and stormwaters**
- **Reduce development in flood-prone areas**
- **Reduce the amount of nonpoint source pollution (sediment, nutrients, chemicals, debris) reaching rivers, lakes and streams from upland sources**
- **Provide wildlife habitat and corridors**
- **Provide shade to reduce the temperature of water in rivers and streams**
- **Provide outdoor recreation opportunities**
- **Link neighborhoods and protect the beauty and quality of life of communities**

10. IMPLEMENT PLANS FOR PARTICULAR AREAS

Implementation of wetlands and watershed management efforts for both a planning area as a whole and for more specific management areas usually depends on a combination of regulatory and non-regulatory approaches. Typically, land- and water-use planning and regulations have played major roles. (See Our National Wetland Heritage, A Protection Guidebook, and Wetland Assessment for Regulatory Purposes for more discussion and examples of regulations). However, restoration of wetlands, construction of wetlands, bioengineering of streams and other techniques may also be needed. (See discussion in the chapters that follow).

11. MONITOR, ENFORCE, MAKE ADJUSTMENTS

Assessment and management efforts require monitoring, enforcement and adjustments over time as new and more detailed information is gathered, implementation plans are developed, and site-specific plans are implemented for specific areas.

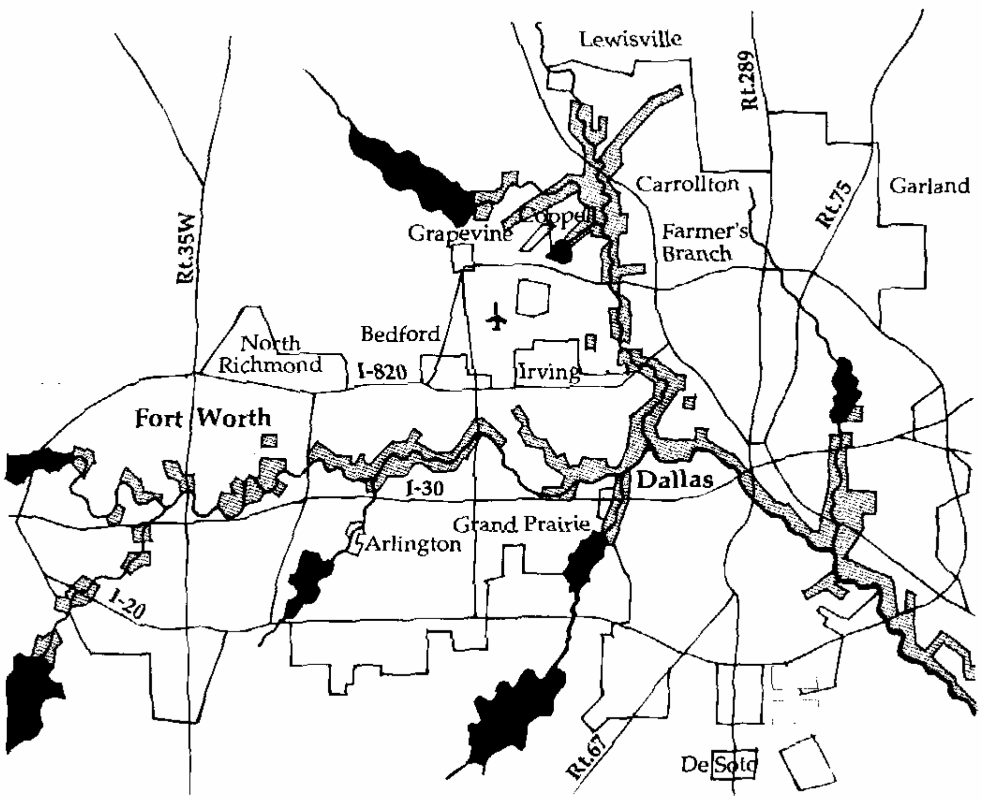
A flexible, dynamic approach to wetlands and watershed management is needed because all of the required information cannot be gathered at once and water is a highly dynamic resource, causing changes to occur over time. The quantity, quality and timing of flows vary naturally over time due to climatic cycles. Flows also change with human activities. Plans and policies which indicated future watershed and hydrologic changes such as anticipated“ build out” can reduce the number and magnitude of future adjustments.

Box 18

Examples of Implementation Techniques

- **Comprehensive land use planning**
- **Water planning**
- **Land use regulations**
- **Water use regulations**
- **Wetland regulations**
- **Shoreland, Coastal Zone, Public Water Regulations**
- **Pollution control regulations**
- **Pollution control facilities**
- **Stormwater and floodplain regulations**
- **Real estate tax policies favoring open space**
- **Landowner incentive programs: (e.g., Wetland Reserve, CRP)**
- **Public land use planning and management at all levels of government**
- **Road, sewer and water, utility infrastructure planning and construction**
- **Construction of structures (detention basins, dams, etc.)**
- **Dredging, channelization efforts**
- **Acquisition for greenways, parks**
- **Wetland mitigation banks**
- **Stream, wetland, lake, estuary restoration**

Figure 11
Trinity River
Dallas-Fort Worth, Texas



Example of river corridor planning and protection. From: Floods, Floodplains and Folks, National Park Service Rivers, Trails and Conservation Assistance Program (1996).

CHAPTER 3: INVOLVING KEY ACTORS

Key actors often include:

- *Engineers*
- *Botanists, biologists and ecologists*
- *Water planners*
- *Land use planners*
- *Federal, state, local agency staff*
- *Not-for-profit staff*
- *Landowners and developers*

CHAPTER 3: INVOLVING KEY ACTORS

Without the involvement and support of key actors (stakeholders), wetlands and watershed management efforts will fail, no matter how accurate the scientific information and how creative the project designs. Involving key people and groups, such as engineers and biologists, into wetlands and watershed management processes is the subject of this chapter.

Some overall recommendations for involving key actors or stakeholders are first provided. Then, recommendations are included for involving specific key groups.

PEOPLE ARE KEY

To make wetlands and watershed management work, people must want integration and coordination. This is not so easy when groups view their programs as their "territory". Multi-objective management begins when an individual or group reaches out to others. This individual or group must understand that achievement of a vision will require the help of many.

The individuals and groups crucial to the success of watershed management efforts include: the engineers and planners from water resources management programs; the biologists, botanists and planners from ecosystem management programs; land use planners; staff of not-for-profit organizations (e.g., local land trusts); transportation agency staff; landowners, developers and others.

A VISION

A work group can be drawn together and motivated by a vision or combination of visions for the future. This vision may involve cleaning up a stream, creating greenways, restoring wetlands, creating parks, or reducing flood hazards and losses. A work group may begin to develop a common vision by asking, "What sorts of land and waters do I want for my community and my children?"

BUILDING CONFIDENCE

Often the first meeting of a work group will allow the members to meet each other and identify common problems and issues. A work group may then best focus on a single, doable task or issue and actually carry out the activity (e.g., removing tires and debris for a stretch of stream, putting up interpretation signs at a wetland). Successful completion of even a small task can help bring together a newly formed wetlands and watershed work group.

Site visits to problem areas or areas with special values (e.g., a pristine wetland) can also help build confidence and consensus. Going into the field reduces polarization and gets people thinking about practical solutions.

JOINT NATURAL RESOURCE ASSESSMENTS

As discussed in Chapter 4, joint natural resource assessments that simultaneously address water resources management and wetland/floodplain ecosystem management issues can be an important common denominator step in integrating wetlands and watershed management planning. Water resource engineers, biologists, botanists and ecologists, and broader land use and infrastructure planners all typically need improved water resources and ecological information. All groups need wetlands, riparian area, floodplain and water resources maps and hydrological assessments. Working together, groups can define issues and carry out joint resource assessments from which all participants can benefit. Joint assessments can focus thinking and build cooperation.

Joint resource assessments at a landscape level (e.g., mapping of wetlands and waters) can lead to more detailed assessments for particular areas, such as eroding sections of streams. A major problem with both water resources/watershed management and wetland/aquatic ecosystem management efforts has been the inability of these efforts to move from a broad scale down to the ground level.

Joint natural resource assessments can produce common maps for a wide range of purposes and facilitate the development of joint analytical models, including hydraulic, hydrologic and ecological models. These models can both describe existing conditions and project future runoff and hydrologic and hydraulic characteristics under various development scenarios. The models can be used to help evaluate project impact and design impact reduction measures.

LOOKING FOR "WIN-WIN"

Another key to involving shareholders is the identification of win-win strategies that offer something to everyone in the work group. For example, protection of a river corridor and acquisition of a greenway may reduce flood and erosion losses and water pollution, while simultaneously protecting wetlands, providing recreational opportunities and protecting the aesthetic and cultural values of neighborhoods. There may be many win-win opportunities.

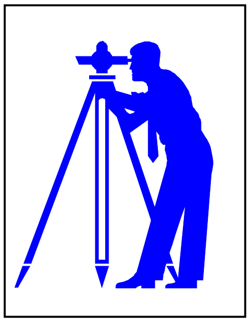
KEEPING IT SIMPLE: PROTECTING THE CORRIDORS

Key actors can often be best brought together through simple planning and implementation strategies that have ecological benefits, such as protecting river, stream and drainage corridors. Corridor protection efforts can help reduce flood loss, control erosion and pollution, improve recreation and meet other more traditional water resources management goals.

INVOLVING THE ENGINEERS

Involving local engineers is essential to wetlands and water resources management. Local governments employ engineers in water management, pollution control, highway design and maintenance, and other capacities. Engineers play major roles in designing and implementing local water projects or the infrastructure that may impact waters (e.g., bridges).

Gaining the cooperation of engineers is not always easy and may be hindered by a variety of factors. Many engineers have limited training in biology and botany and are unfamiliar with ecosystem management principles. They may view protection and restoration of wetlands as an impediment to their water projects.



Gaining the cooperation of engineers in wetlands and watershed management requires involving them early on. Some arguments that may persuade them to participate include:

• **Multi-objective management can help meet traditional water resources management goals.** Wetlands and watershed inventory and modeling efforts can provide a hydrologic context for floodplain and stormwater management efforts. Such efforts can also help meet specific water resources management objectives, such as conveying flood flows, storing flood waters, stabilizing erodible stream banks, protecting source water supply and preventing water quality problems.

• **Multi-objective management can reduce conflicts and improve funding.** Many engineering projects are now being blocked legally, politically or financially due to conflicts with ecosystem management. Reduction in conflicts and opposition to projects can be achieved through improved, common information bases, by bringing all of the key actors to the table, and by identifying common denominator, win-win strategies of the sort discussed in Chapter 5.

• **Multi-objective management can help meet regulatory requirements.** Wetlands and watershed management plans can help engineers comply with federal, state and local permitting regulations. Such plans can be used to help design impact reduction and compensation measures, such as wetland mitigation banks for protection and restoration of ecosystems because this is what is required by local, state or federal regulations, or because this is what the local community wants.

INVOLVING BIOLOGISTS AND BOTANISTS

Involving biologists and botanists in wetlands and watershed management is also essential. Biologists and botanists are located in local planning agencies, pollution control agencies, park and recreation agencies, and in other local departments. Biologists and botanists may also work for schools as teachers or for local land trusts, not-for-profits and consulting firms.

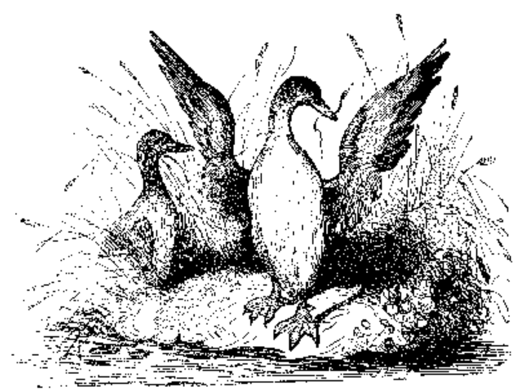
Biologists and botanists may be encouraged to participate in wetlands and watershed management efforts with the following views:

• **Multi-objective management can better protect wetland, riparian, floodplain, and aquatic area plants, fish, waterfowl, other birds, amphibians, and mammals.** Plants and wildlife are dependent upon overall hydrologic regimens, including adequate water supply.

• **Multi-objective information gathering can improve assessment.** Efforts to assess wetland, riparian, and floodplain functions and values must take into account watershed factors that are not easily considered in case-by-case analyses. For example, it is difficult to determine the functions of altered, artificial and managed wetland systems without knowing short-term and long-term water regimes, which depend on watershed runoff. Sophisticated wetland evaluation methodologies are futile if they fail to consider changes in hydrology.

• **Multi-objective management can better reduce cumulative environmental impacts.** Wetlands/floodplain ecosystems are gradually (and sometimes not so gradually) destroyed by groundwater draw-down, diversions, drainage ditches, changes in land uses and other activities that disturb runoff, natural water levels, and sediment regimes.

• **Multi-objective management can improve performance of wetland, stream, riparian zone, lake and estuarine restoration projects.** Many aquatic ecosystem projects fail to achieve goals, despite careful planning and expenditures of large amounts of money, because they are hydrologically unsound. Wetlands and watershed management approaches can help assess and protect water regimes.



Box 19
What Does Wetlands and Watershed Management Have to Offer Water Resources/Watershed Managers?

- **Less costly and more effective achievement of traditional water resources management goals through the combination of natural system approaches and more traditional approaches for pollution control, flood loss reduction, stormwater management, erosion control and recreation.**
- **Improved landscape level mapping and assessment of wetland/aquatic ecosystem functions/values to aid planning efforts, environmental impact analysis, impact reduction, and impact compensation efforts.**
- **Improved sources of information and the ability to draw on expertise in many agencies not available in fragmented wetland/watershed programs (e.g., wetland maps, biological expertise).**
- **A broader range of problem solving techniques (e.g., reduction in flood losses by restoration of wetlands).**
- **Facilitated regulatory permitting by considering wetlands and related ecosystems upfront and improved design of impact reduction and compensation measures.**
- **Improved cost-sharing capabilities and political acceptability of approaches and projects.**

Box 20
What Does Wetlands and Watershed Management Have to Offer Wetland/Riparian/Floodplain Ecosystem Managers?

- **Improved sources of hydrologic and hydraulic information and expertise often not available in wetland and floodplain programs (e.g., floodplain maps, existing use information, hydrologic data and expertise).**
- **Better protection, restoration and management of wetland/floodplain ecosystem functions/values since all wetland/aquatic ecosystem functions and values are dependent upon hydrologic regimes. Without water, wetlands are uplands.**
- **Reduced impacts of water projects (dams, dikes, levees, channelization) on wetland/floodplain ecosystems.**
- **Improved assessment of wetland and floodplain functions/values which depend, in large measure, on a knowledge of existing and anticipated hydrology and sediment regimes.**
- **Improved success of wetland, riparian, and floodplain ecosystem restoration and creation efforts, which depend on maintenance of hydrology.**
- **Additional funding for wetland, riparian, and floodplain mapping, assessment, and restoration as part of broader water resources management/watershed management efforts.**

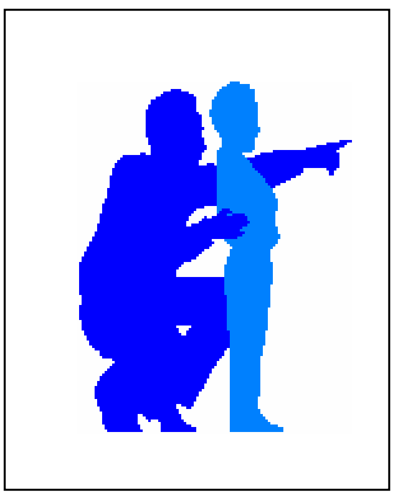
INVOLVING STATE AND FEDERAL AGENCY STAFF

Local governments also need federal and state technical and financial assistance. (See Appendix A.) Virtually all local efforts have been undertaken with such assistance.

Views that could be expressed to state and federal agencies to gain their support may include:

- **Multi-objective management will more effectively meet state and federal water resources and ecosystem program goals.** Many state and federal water and land use programs have multi-objective goals—watershed management, water resources management, public land management, and coastal zone management.

- **Multi-objective management will facilitate compliance by agencies with environmental impact review and regulatory requirements.** Multiobjective management information gathering and assessment efforts can result in improved environmental impact review and impact reduction.



INVOLVING LANDOWNERS AND DEVELOPERS

Landowners and developers may be convinced to participate in wetlands and watershed management efforts with the following statements:

- **Wetlands and watershed management efforts can provide more certainty to agencies and landowners.** Watershed assessment and management efforts can provide more certainty by defining wetland and floodplain boundaries and formulating specific plans for particular areas.

- **Wetlands and watershed management efforts can provide more predictability.** Coordinated wetland, floodplain, stormwater, pollution control, and other policies and adoption of plans also provide more predictability.

- **Wetlands and watershed management efforts can provide less duplication.** Multiobjective approaches can help cut down on the duplication in federal, state, and local, state, and federal wetland, water, floodplain and riparian regulatory permitting.

- **Wetlands and watershed management efforts can provide improved overall rationality.** Integrated approaches can help make sure plans, regulations and standards "make sense."

- **Wetlands and watershed management efforts can reduce costs and facilitate federal and state funding.** An integrated approach can reduce the costs to agencies and landowners for data gathering, planning, and plan implementation. Integrated plans can also increase federal and state funding for wetland protection (e.g. Wetland Reserve), disaster mitigation, water supply protection, and other programs.

Box 21

Private, Parcel-Level Plans

Private landowners and developers are increasingly undertaking multi-objective, parcel-level wetland, floodplain and water resources planning efforts for their lands to help comply with floodplain and stormwater regulations, erosion and pollution controls, broader zoning, subdivsion controls and building code regulations. Such efforts are particularly common for mid-sized to large projects and often involve the following steps:

1. **Site survey.** The natural resource and cultural characteristics of a parcel (soils, vegetation, topography, ownership boundaries) are surveyed to determine site potential for various economic uses and to identify potential problems (flooding, subsidence) including regulatory issues.

2. **Preparation of a concept plan for the entire property.** Such a strategy typically involves plans for various economic activities and measures to address flood, stormwater, water supply, wetland and other ecosystems considerations. It will often contain impact reduction and compensation measures (e.g., wetland restoration, revegetation of upland buffers, etc.) if the plan calls for substantial modification of wetlands and related ecosystems.

3. **Review of the plan, supplementation for particular areas.** The plan is submitted to regulatory agencies if implementation will require regulatory approval.

4. **Preparation of a final plan.** The final plan often has engineering approval and complies with other regulatory specifications.

5. **Implementation of the plan with necessary approvals.** These approvals typically require impact reduction and compensation measures.

Figure 12
Wetland Values and Natural Hazards

Values

Isolated wetlands

1. Habitat for both upland and wetland species of wildlife
2. Flood water retention
3. Sediment and nutrient retention
4. Scenic beauty

Lake margin wetlands

1. See values for isolated wetlands, above
2. Removal of sediment and nutrients from inflowing waters
3. Fish spawning area

Riverine wetlands

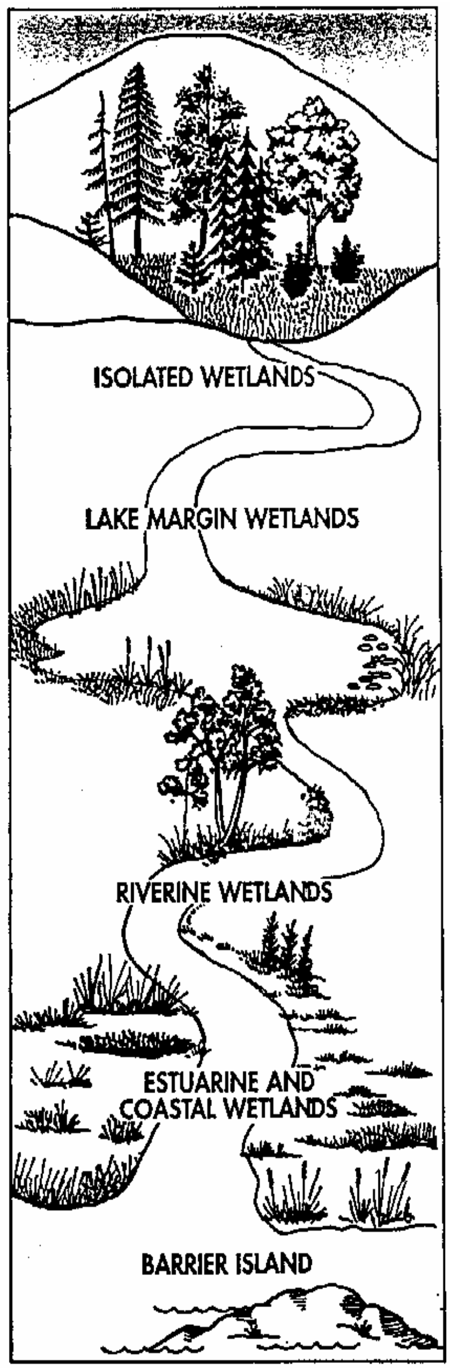
1. See values for isolated wetlands above
2. Sediment control, stabilization of river banks
3. Flood conveyance

Estuarine and coastal wetlands

1. See values for isolated wetlands, above
2. Fish and shellfish habitat and spawning areas
3. Nutrient source for marine fisheries
4. Protection from erosion and storm surges

Barrier island

1. Habitat for dune-associated plant and animal species
2. Scenic beauty



Hazards

Isolated wetlands

1. Flooding and drainage problems for roads and buildings due, in some instances, to widely fluctuating surface water and groundwater levels.
2. Serious limitations for on-site waste disposal
3. Limited structural-bearing capacity of soils for roads and buildings due to high content of organic materials

Lake margin wetlands

1. See hazards for isolated wetlands, above

Riverine wetlands

1. See hazards for isolated wetlands, above
2. Flood conveyance areas subject to deep inundation and high velocity flows
3. Sometimes erosion areas

Estuarine and coastal wetlands

1. See hazards for riverine wetlands, above
2. Often severe flood hazard due to tidal action, riverine flooding, storm surges, and wave action
3. Sometimes severe erosion area in major flood due to wave action

Barrier island

1. Often high energy wind and wave zone
2. Often severe erosion problems

From: Our National Wetland Heritage, A Protection Guide. 2nd Edition (1996).

INVOLVING LAND USE PLANNERS

Wetlands and watershed management efforts can help community planners allocate lands throughout the community to their most suitable and appropriate uses. Most states have adopted all or part of The Standard State Zoning Enabling Act promulgated by the U.S. Department of Commerce in 1926, which states in the purpose section that:

"Such regulations shall be made with reasonable consideration, among other things, to the character of the district and its peculiar **suitability** for particular uses, and with a view of …encouraging the most **appropriate** use of land throughout such municipality." (Emphasis added).

"Suitable" and "appropriate" use must take into account a broad range of factors suggested by Box 22.

Box 22

Factors Relevant to Suitability and Appropriateness

Examples of factors relevant to evaluation of the most "suitable" or "appropriate" use of community lands for particular purposes include:

- **Topographic, soils, hydrologic features**
- **Natural functions/values**
- **Natural hazards (flood, erosion, wave action, earthquake, etc.)**
- **Existing uses**
- **Land ownership (public/private)**
- **Existing infrastructure and infra-structure plans**
- **Federal, state and local regulations**
- **Economic use potential for lands and waters**
- **Community needs for housing, roads, etc.**

INVOLVING REGULATORS

Wetlands and watershed management offer the following benefits to regulators at all levels of government:

- **Provide up front information needed for regulatory permitting.** Wetland maps, floodplain maps, hydrologic models, land use cover information and other types of information developed as part of wetlands and watershed planning can provide up front information needed for regulatory permitting, reducing the burden on regulators and speeding up permit issuance.

- **Improve wetland restoration, creation and enhancement.** Wetlands and watershed planning can identify potential wetland restoration value and compensation sites throughout a community, facilitating use of restoration to compensate for residual impacts. Wetlands and watershed planning can also help protect water regimes, protecting restoration sites from changes in watershed hydrology.

- **Improve coordination between federal, state, and local regulations.** Wetlands and watershed management efforts help coordinate local, state, federal policy-making and regulations. For example, the U.S. Army Corps of Engineers (Corps) has issued local programmatic permits for a number of local wetlands and watershed management plans such as Juneau, Alaska and Du Page County, Illinois.

- **Reduce court challenges.** Wetlands and watershed management efforts can reduce landowner opposition to regulations, thereby reducing court challenges. In addition, wetlands and watershed management plans may be used to defend wetland regulations in court against charges that regulations are irrational, discriminatory or a taking of private property.

- **Help regulators address isolated and headwater wetlands.** Over the last decade, wetland protection, regulation, and management efforts at all levels of government have been expanded to more fully address headwater wetlands and semi-isolated wetlands throughout the landscape including many wetlands and floodplains along small creeks, streams, and lakes and ponds. However, case-by-case permitting approaches, which work moderately well for coastal and estuarine wetlands and wetlands along larger lakes and streams, have been less effective for isolated and headwater wetlands. Wetlands and watershed planning can help identify, plan, and regulate such wetlands.

THE WEST EUGENE WETLANDS AND WATERSHED MANAGEMENT EFFORT

The West Eugene, Oregon, wetlands planning effort began in 1987 when the city realized that significant wetlands existed in the city's primary industrial growth area. In 1989 the city contracted with the Lane County Council of Governments to undertake an intensive assessment and planning effort for this 16 square mile parcel. This effort has become, in many ways, a model for wetlands and watershed management for other areas in Oregon and the Nation. The effort has involved all of the steps suggested for wetlands and watershed management suggested above.

The planning effort began by focusing on "problem" wetlands but has broadened into a wetlands and watershed management effort addressing stormwater management and a host of other water and ecological issues. The U.S. Environmental Protection Agency (EPA) provided the county $50,000 for an advanced identification project and $250,000 for more general planning. Other funding for the project was provided by Congress, B.L.M., and other agencies. The Corps also carried out a $300,000 reconnaissance study for the "Amazon channel" to determine how environmental values could be enhanced.

The project has been characterized by broad public involvement and outreach. During the project's inception, the Lane County Council involved a broad range of local, state, and federal agencies, interest groups, landowners, and the general public. The Lane County planning staff made a concerted effort to include all interested parties through one-on-one consultations, seminars, workshops and public hearings.

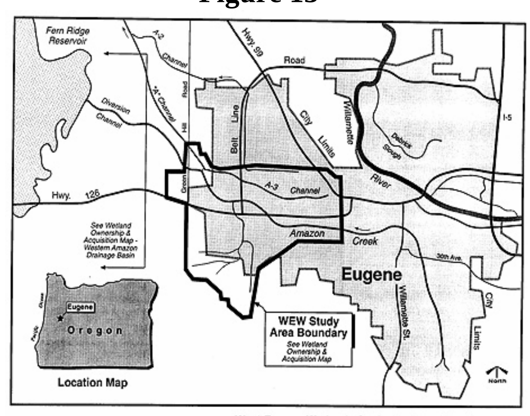
This effort also involved careful, parcel-by-parcel mapping and analysis of wetlands using field observations and the WET assessment method.

As part of this assessment and planning process, about 1000 acres of wetland were recommended for protection and 288 for development. Restoration of other wetlands and a mitigation bank were recommended to achieve a net gain of wetland functions.

The Corps, EPA, and the Oregon Division of Lands have approved the West Eugene wetland plan. The Corps has also issued a Programmatic General Permit for the city.

West Eugene is somewhat unique in the terms of funding but provides an excellent model for wetlands and watershed management.

Figure 13

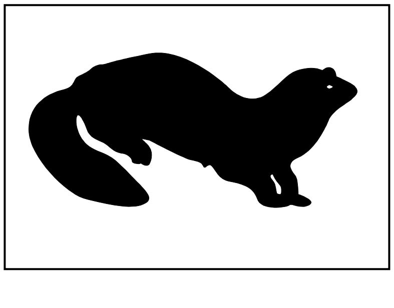


West Eugene Study Area.
Source: *http://www.rice.edu/wetlands/Maps/m35.html*

CHAPTER 4: MAPPING AND ASSESSMENT

"Geographic-based planning offers the potential to develop a cohesive framework that addresses both clean water and aquatic habitat, reflecting the independent relationships between water chemistry and ecological processes in the natural environment. To realize this potential, planning processes should include an inventory of wetlands and other aquatic sites that remove pollutants, reduce flood damages and/or supply food and shelter for fish and wildlife. Environmental, economic, and quality-of-life values of these areas should be assessed, their location and area extent determined, historic losses estimated, adverse consequences of past losses evaluated, and priorities for conservation and restoration ranked."

— Clean Water Action Plan: Restoring and Protecting America's Waters (1994)



CHAPTER 4: MAPPING AND ASSESSMENT

INPORTANCE OF MAPS AND OTHER INFORMATION

A community cannot protect or manage wetlands, floodplains and riparian areas and other water resources without knowing where they located. They also need to know the general characteristics of the water bodies and their condition. Many types of additional information with differing scales and degrees of accuracy are needed to develop visions and plans. Other information is needed to determine project impacts and to design compensation measures.

Mapping and other information gathering and analysis have, therefore, become key components of wetlands and watershed management efforts. If carried out jointly by engineering, biological and other groups, mapping and other information gathering can also build cooperation and consensus with regard to management goals and protection and restoration needs.

However, mapping and other information gathering and analysis are expensive and time consuming. Unlimited amounts of money can be spent. For example, the Federal Emergency Management Agency has spent, over the years, almost one billion dollars in mapping the nation's floodplains and there is much yet to be done.

Local governments typically have limited, upfront funds for lake, stream, wetland, floodplain, riparian zone, soils, topographic and other mapping and information gathering, So communities need to prioritize information gathering and utilize various cost-saving techniques including use of federal technical assistance.

Priority information needs — including the types of information, scales and degrees of accuracy — depend, in part, on the specific goals of the wetlands and watershed management effort and the major problems or issues unique to the area. For example, detailed flood and erosion hazard information may be needed for an area with many houses subject to serious flood hazards but not for other areas in a community. Appendix E summarizes some of the common hydrologic and hydraulic information needs for both water resources and ecosystem efforts.

Despite differences in information needs for particular efforts and applications (e.g., planning, regulation, acquisition), certain common denominator types of information have proven important in efforts such as wetland, riparian area, floodplain and water mapping. See Box 23.

Information with adequate scale and accuracy must not only be generated but must also be presented in a way that is understandable to the broad range of resource agencies and the public who are key actors in management of waters and lands.

Box 23: *Common Denominator Information Needs*

- Inventories of watershed and ecosystem problem areas, such as pollution sources and polluted waters, severe erosion and flood areas, sites of destroyed habitat, etc.
- Boundary maps for wetlands, riparian areas, floodplains, lakes, streams, and estuaries.
- Natural hazard maps (floodplains, erosion, unstable soils, slopes).
- Land ownership maps (public/private).
- Maps showing existing uses of lands and water.
- Maps and inventories of existing modifications (e.g., dams, dikes, levees) to waters and wetland/aquatic ecosystems.
- Water regime studies to identify existing conditions and reasonably anticipated future conditions.
- Identification of wetland/aquatic ecosystem restoration sites (desirable to guide future planning, mitigation banks, etc.).

Box 24
Use of Wetland, Riparian and Floodplain Information in Local Land and Water Use Programs

Wetland, floodplains, riparian area and other watershed information bases are useful in local planning and regulatory programs:

Comprehensive land use planning. Water and wetlands/riparian/floodplain information is relevant to many aspects of comprehensive planning including determination of the suitability of lands and waters throughout a community for particular uses, taking into account natural hazards, special functions and values (e.g. pollution control, wildlife), the compatibility of adjacent land uses, infrastructure costs, economic development needs and other factors.

Zoning. Wetlands and watershed assessments and plans can help establish various "conservancy" districts or performance standard zones for wetlands and floodplains, buffer strips for lakes, wetlands and streams, and lot size and density controls (e.g., large lot size in resource protection areas) for various areas throughout a watershed.

Subdivision controls. Local subdivision regulations often require that lands be "suitable" for their intended uses (taking into account natural hazards, etc.) that park and open space be provided by the subdivider, and that stormwater detention or retention facilities be provided. Wetlands and watershed assessments and plans can help implement these provisions.

Sanitary codes. Sanitary codes often prohibit septic tanks in high ground water areas. Wetlands and watershed assessments and plans can help identify such areas and guide sewer construction to other areas.

Floodplain regulations. Wetland and watershed assessments and plans can help provide base maps and protect floodway and flood storage areas, erosion areas, and wave action areas and can help design and implement other flood loss reduction measures.

Sediment and erosion controls, grading ordinances. Many local governments require erosion control and sediment control measures for public and private development. Wetlands and watershed assessments and plans can help guide these efforts.

Tree-cutting and other vegetation removal ordinances. Many local governments also limit vegetation removal near wetlands, lakes, and streams. Wetlands and watershed plans can identify water bodies and special protection needs.

Acquisition: Most communities have acquisition programs for parks, recreation areas, greenways, schools, general open space and public works projects. Wetlands and watershed plans can help identify and prioritize acquisition areas and aid the design of greenways programs.

Public works projects: Wetlands and watershed assessments and plans can aid public works managers in the design and siting of public works projects such as sewer, water supply, solid waste disposal, highways, airports, dikes, levees, stormwater detention facilities, pipelines, erosion control measures, mosquito control measures and the siting and construction of marinas, municipal buildings, etc.

Public land management: Wetlands and watershed management assessments and plans can aid public land management efforts for parks, greenways, sewers, water supply reservoirs, stormwater facilities, forest lands, other open space by suggesting the most appropriate uses for particular lands, the environmental impact of proposed activities, and impact reduction and compensation measures.

MAPPING

Multi-objective mapping of wetlands, floodplains, riparian areas and waters has proven to be an essential step in developing protection and restoration policies for wetland and watershed management. For example, the Parkers Creek Watershed Task Force drafted a Parkers Creek Watershed Management Plan for a portion of Calvert County, Maryland. To begin this effort, digital maps were compiled from county, state and federal sources to inventory wetlands, waterways, hydric soils, floodplains, forest cover, habitats of special concern and water supply. Maps were compiled to not only assess existing resources, but also to estimate the impact of cumulative growth on these resources.

Communities have found the U.S. Fish and Wildlife Service National Wetland Inventory maps to be useful in mapping wetlands. National Wetland Inventory maps (see http://www.nwi.fws.gov/) and orthophotos are now available online free of charge for more than a million square miles. Even broader expansion of this service may be expected. See Appendix A.

The Federal Emergency Management Agency has also made flood maps available online for many communities. See www.esri.com/hazards/makemap.html for scalable flood maps throughout the nation.

Some communities, like King County Washington, Boulder, Colorado, have undertaken independent wetland and floodplain mapping at larger scales and with more detail. Much of this assessment is based upon air photo analysis.

Communities have discovered it is necessary to combine generalized water inventories for the community as a whole (e.g., wetland maps) or a selected planning and management area, with more detailed studies for specific areas (e.g., a portion of a stream corridor). (See Appendix G.) Determining topical and geographical information-gathering priorities is also essential.

Detailed inventory of streams, lakes, ponds, springs, estuaries, wetlands, floodplains, riparian areas and other waters in terms of water depth, velocity, quality, change in flow regimes, hydroperiod and other features is expensive and cannot practically be carried out in detail for an entire community much less a whole region. Even if such an inventory is carried out, it will often have a relatively short shelf life because certain types of information, such as maximum expected flows in small streams, change as watershed development occurs.

FUNCTIONAL ASSESSMENT OF WETLANDS AND OTHER WATERS

A number of communities, such as Juneau, Alaska, and Dade County, Florida have not only mapped wetlands but also evaluated wetlands to determine the functions and values served by individual wetlands. (See Appendix F.)

Comprehensive efforts to evaluate functions and values of all wetlands in a community have met with mixed success, although Juneau and Dade County consider the assessment efforts successful.

Other communities have discovered that efforts to assess all wetland, riparian and floodplain functions and values is difficult and costly. Costs are high for detailed, geographically comprehensive surveys because there may be thousands or tens of thousands of individual wetlands, riparian areas and floodplains in a community. Each wetland may provide a dozen or more functions, such as flood control, flood conveyance, pollution control, erosion control, wave retardation and recreation. (See Appendix F.) Assessment of each function requires consideration of wetland type, size, hydrology, soils, vegetation, existing uses and other wetland features, which are not easily observed from an air photo or single site visit. The value of each function to society is also variable and difficult to assess because value depends on potential users, the location of the wetland to other waters and the scarcity of wetlands in the area.

Multiobjective broader scale evaluation of wetlands, riparian areas, floodplains and other waters taking into account overall wetland type, natural hazards, soils, existing uses and other factors without attempting to compare, in depth, individual functions and values has proven more practical for water and land management purposes Such a multiobjective evaluation may be undertaken through the simultaneous use of lake and stream maps, wetland maps, floodplain maps, soil surveys, water resource maps, existing land use maps, maps of rare and endangered species habitat, public landowner ownership maps and other types of information. These sources of information can be used collectively to suggest development and protection potential without evaluating the functions and values of individual wetlands

Some communities like Juneau have opted to use "rapid" wetland assessment techniques to compare the functions and values of wetlands. Scientists have developed more than 40 proposed rapid wetland assessment techniques since 1990 alone to help regulators, land use planners and public land managers assess wetland functions and values. See Appendix G.

But, rapid assessment techniques have all proven to be subject to limitations and problems in assessing functions and values. See Assessment of Wetland Functions and Values. There are conceptual problems with many of the techniques. The large number of methods reflects the difficulty scientists experience in agreeing on what is and is not important in assessment.

Moreover, communities cannot use wetland functions and values information alone to allocate lands to their most suitable uses and to decide under what conditions development should be permitted in a particular area. Communities also need to know the severity of natural hazards at a site (e.g., flooding erosion), soil bearing capacity and the suitability of soils for onsite waste disposal.

All of these factors need to be considered in deciding whether development should occur at particular wetland sites and in determining necessary impact reduction and compensation measures. For example, use of a wetland rating system that only shows relative functions/values of comparative wetlands may suggest that a seriously degraded wetland in an urban floodway is favorable for development. However, if the wetland floods and has erosion hazards, this may not be true.

Most communities have adopted wetland protection regulations, open space conservancy zoning or greenway designations for wetlands and waters based on multiobjective analysis and not analysis of wetland functions and values alone. More detailed analysis of functions and values is undertaken on a site-specific (rather than community-wide) basis as projects or alternations are proposed for specific areas. See Appendix G for a description of some of these more detailed assessment methods. Often communities require developers and other proposing to alter specific wetlands to use more detailed techniques such as backwater computations to evaluate and compensate for specific impacts.

Box 25
Limitations on Data Gathering and Analysis

Common restraints on data gathering and analysis include:

- Limited funds.
- Limited numbers of staff and staff expertise.
- Limited time.
- Inadequate scales and accuracy of existing data for management purposes.
- Dynamic nature of wetland and water systems, which complicates data gathering and renders information quickly out of date.
- Location of information and expertise in a broad range of agencies, making it difficult to tap and assemble information in one place.
- Lack of adequately specific and accurate georeferencing in maps, hindering compilation and the effective use of GIS systems.

COPING WITH LIMITED BUDGETS

How can communities cope with limited expertise and funds in information gathering and analysis for wetland, floodplain, and riparian and other water areas?

♦ **Form assumptions based on overall wetland, riparian, floodplain, water type.**

Communities can gain considerable insight into functions and values and other characteristics of particular wetlands, riparian areas, and floodplains and other waters by simply knowing the hydrogeomorphic class for a wetland as suggested in Appendix H. Communities may also be able to characterize wetlands to suggest overall wetland functions using National Wetland Inventory maps. The U.S. Fish and Wildlife Service has done this for a number of areas, such as New Gloucester, Maine.

♦ **Make maximum use of existing maps, air photos and remote sensing sources.**

Given limitations upon staffing and budgets, both water resources and ecosystem program managers have typically found that they must make maximum use of existing information sources and various types of air photos and satellite imagery. For example, air photos and to a lesser extent satellite data have been used to map wetlands for regulatory purposes (states, locals) and to monitor development. However, existing sources of data are not universally useful because they are often dated and lack sufficient accuracy for impact analysis or design of impact reduction or compensation measures.

♦ **Focus detailed information gathering on problem areas, areas with special values (identified in preliminary surveys) and development areas.**

Broad inventories, such as water resource, wetland, riparian, and wetland maps, may suffice for some planning purposes without more detailed assessments of hydrology, functions and values. This is particularly true where no development or alterations are proposed for wetlands and water resources. However, geographically targeted, detailed information gathering is needed for areas with particular problems (e.g., blockage of flood flows), special values (e.g., endangered species) or proposed projects. Various red and yellow flagging procedures can be used to target such information gathering.

Box 26

Examples of Existing Sources of Information

Some useful sources of information include:

- **National Wetland Inventory Maps**
- **Federal Emergency Management Agency Flood Maps**
- **USDA Natural Resource Conservation Service Soil Maps**
- **U.S. Geological Survey Geologic Maps**
- **U.S. Geological Survey and Other Orthophotos**
- **Federal, State, and Local Air Photos (Multiple Sources)**
- **State "Heritage" Program Natural Area Inventories**
- **State and Federal Lists of Rare and Endangered Species**
- **State Lake and Stream Inventories**
- **Federal, State and Local Land Use Inventories, Maps**
- **Local Plat Maps**
- **Various Types of Federal, State and Local Water Resources/Watershed Studies**

♦ **Use techniques to tap existing scientific expertise and information.**

Communities have found they often can use a variety of techniques to access staff resources, data and expertise, including regulatory and resource agencies, not-for-profits and academic institutions, among other sources.

Box 27

Techniques to Tap Sources of Information and Expertise

Techniques to tap the scientific and other knowledge include:

- **Involve in inventory efforts, early on, a broad range of agencies and groups with data.**
- **Solicit information from managers, such as flood information from public works managers, or fish information from local not-for-profits like Trout Unlimited.**
- **Develop preliminary plans and inventories and solicit comments from a broad range of groups.**
- **Hold public workshops and hearings to gather information from the public.**
- **Form commissions and work groups.**
- **Conduct joint permit processing.**

♦ **Require landowners/developers to develop more specific information on a project-by-project basis.**

When wetland regulations were first adopted in the early 1970s, regulators hoped that boundary maps and other types of assessments could be developed with sufficient accuracy to replace onsite delineation of wetland boundaries or assessment of functions and values at the time permit applications were submitted. A great deal of money was spent preparing very detailed wetland maps in some states.

Field experience has indicated, however, that maps and other types of up-front assessments, even those with considerable detail, have not usually proven sufficient to make final determinations of wetland boundaries, functions/values and other features for a number of reasons:

- There are physical limitations in representing wetland, floodplain, and water boundaries with enough precision on maps (e.g. the width of a pencil line may be 10-25 feet) to determine precise wetland boundaries or other characteristics on the ground.

- There are practical limits to accurate mapping and other information gathering, even if considerable amounts of money are spent, due to limitations on mapping technologies (e.g., aerial photo interpretation), changes in watershed hydrology and the overall lack of time series hydrologic information.

- The number of wetlands, riparian areas, and floodplains increases exponentially with map scale and the cost of accurately delineating all boundaries, functions and values, and other features also increases.

- Wetlands, floodplains and riparian areas are extremely dynamic. It is difficult, in advance, to determine future natural fluctuations in water levels and other features.

- There are many changes in wetlands and wetland water regimes due to human activities. It is difficult to anticipate these changes.

For these reasons, communities often require private and public developers proposing to alter a stream, wetland, floodplain, riparian area or other aquatic system to carry out a more detailed evaluation of the resources and project impact than would be possible for a larger area. This generates more detailed information on a site-specific basis and shifts a portion of the cost to developers.

♦ **Apply multiobjective management strategies.**

It is often easier and cheaper to develop several types of information for multiobjective management on a general scale than one type of information in great detail for special purpose management. For example, a combination of generalized flooding, pollution control, habitat protection and recreational use information may be used to identify potential stream corridors where lands should be acquired as a multiobjective greenway. However, much more extensive and expensive hydraulic and hydrologic studies may be needed for flood plain regulation alone where development will continue to be permitted within the floodplain and detailed information is needed to establish protection elevations and to assess the impact of proposed activities on flood flows.

Figure 14

Source: Greenways for Pittsburg: Produced by the City of Pittsburgh, Department of City Planning, 1979 and "Allegheny County Greenways" produced by the Allegheny County Planning Department, 1995. http://slaggarden.cfa.cmu.edu/dialogues/pittgreen.html

Box 28

Uses for Red and Yellow Flagging Procedures

Red* and yellow flagging** can be used to:

- **Identify, early-on, wetland, riparian area, floodplain and other aquatic ecosystem areas that should be protected outright.** Red flag procedures are used to determine whether an area should be protected outright or a permit should be denied immediately due to a single important problem or failure to comply with specific criteria.
- **Identify areas with potential problems and issues (e.g., increase in flood heights or erosion on other lands) that will need to be addressed by the regulatory agency**, **other agencies, or permit applicants through more detailed studies or analysis.**
- **Help determine, on a preliminary basis, the wetland/aquatic ecosystems functions that will need to be examined in greater depth (in more specific studies or at potential permit application sites essential from cost and time frame perspectives).**
- **Determine groups and individuals (e.g., adjacent landowners, downstream landowners, environmental not for profits, academics, others) who may have an interest in proposed areas or projects, who may be able to supply data, or who may wish to appear at a public hearing. These groups may then be involved in assessment.**

* Red flags indicate the need for outright protection of a wetland or another area.
** Yellow flags suggest a cautious approach is needed.

Box 29

Important Red and Yellow Flags — Wetlands and Related Ecosystems

The following wetland features may suggest significant functions and values that need outright protection or a cautious approach to alteration or destruction.

- **Wetland, riparian area, floodplain and related ecosystem types particularly rare within a community, region (e.g., bogs).** Rare types are often characterized by rare and endangered plant and animal species. How "rare" a wetland type or related ecosystem type is within a geographical area may be suggested through use of National Wetland Inventory maps, state Heritage Program surveys, general agency knowledge or other approaches.

- **Wetlands, riparian areas, and floodplains adjacent to rivers, streams, lakes, and coastal waters.** "Adjacent" wetlands are often characterized by a broad range of functions/values and natural hazards. They are particularly important for pollution prevention and treatment, fish propagation and feeding, waterfowl propagation and feeding, and water recreation (canoeing, bird watching). Many of these wetlands are also subject to deep and high velocity flood flows or wave action. Many of these wetlands are often partly or wholly in public ownership or subject to public trust. Finally, many of these wetlands are subject to a broad range of federal, state, and local regulations such as floodplain regulations, coastal zone management regulations, scenic and wild river regulations, shoreland zoning, etc. These areas can be readily identified from existing topographic, planimetric maps or air photos.

(Continued, pg. 55)

(Some Important Red and Yellow Flag Features, cont.)

•54 **Other wetlands, riparian areas, and floodplains lying on the paths of flow from upland areas to waters (lakes, streams, oceans, estuaries).** Such wetlands may play particularly important pollution control, flood storage, flood conveyance, and habitat functions/values. Significant habitat functions and values are particularly likely where the wetlands and floodplains form water-related corridors for wildlife. Such wetlands can often be identified from topographic maps and air photos.

- **Large wetlands, riparian areas, and floodplains in a natural or semi-natural condition.** Such areas are often important areas for biodiversity and as habitat for rare and endangered species. These can be identified from air photos, topographic maps, satellite imagery, soil maps, National Wetland Inventory maps or other sources.

- **Wetlands, riparian areas, and floodplains in source water supply watersheds.** Wetlands and floodplains in such areas may play particularly important pollution (viruses, bacteria, heavy metals, etc.) and sediment prevention roles. Often source water supply maps are available in a state. These can be used in combination with National Wetland Inventory Maps, air photos or other sources to identify these wetlands.

- **Wetlands, riparian areas, and floodplains in or immediately adjacent to federal, state, local parks, refuges, sanctuaries.** These areas are likely to play significant roles as part of larger intact ecosystems and may also act as buffers for such ecosystems. Maps showing areas in public ownership are often available at state or local levels. These can be used in combination with National Wetland Inventory Maps, air photos or other sources to identify these areas.

Box 30

Sources of Information for Red and Yellow Flagging

- Knowing the type of wetland, riparian area, or floodplain. For example, knowing the class or subclass of wetland may suggests possible ownership, delineation, natural hazards, special functions, and other issues. See Appendix H.
- Examining existing wetland, flood, topographic, soils, endangered species maps and other maps, plans, regulations, books, and other sources of information.
- Conducting one or more site visit (direct observation).
- Providing notices to specific groups, agencies, and organizations, and getting feedback from other regulatory agencies, not-for-profits, other governmental units, academic institution.
- Providing public notice and holding public hearings. Getting feedback from adjacent landowners, interest groups, other agencies, and members of the public at the hearing.
- Reviewing permits through joint permit processing procedures or through the use of multidisciplinary, interagency teams.

COMPUTER-ASSISTED ASSESSMENT AND GIS

Over the last decade, communities have increasingly used computers to assist watershed and ecosystem management efforts. See, for example, King County Washington's interact mapper at www.metrokc.gov/gis/mapportal/iMAP_main.htm which provides a broad range of GIS maps. Such systems show considerable promise for future use. Communities have used such systems to both analyze wetlands and water resources on a community-wide basis and to more specifically evaluate the impacts of development proposals, such as determination of the impacts of fills on flood conveyance through the use of backwater computations.

GIS systems allow storage and analysis of various types of information, such as topographic, vegetative, soils and other types of data and the analysis of the relationships between these data. Computerized water resource models (e.g., flood storage, flood conveyance, water quality) also utilize georeferenced information, but analyze it through the application of various mathematically-based water resources flow models.

The most common output from a GIS system is a map. But, it is also possible to develop lists, mathematical numbers (e.g., flood heights, backwater effects), three dimensional landscape models, and other outputs, depending upon the system.

Use of GIS and other computerized systems is not confined to wetlands, floodplains and water resources. Public land management agencies, local governments, states, consulting firms and academic institutions are interested in GIS systems to store and process many types of natural resource, tax, economic and census information.

Interest in GIS systems has grown exponentially as inexpensive personal computers have become available with large and rapid computing capacity (e.g., 486 Pentium processors) and large data storage capacity (e.g., ROM drivers). Relatively inexpensive software (e.g., ArcInfo, Mapinfo) with GIS capability and the availability of a great deal of natural resource information in a digital form, such as National Wetland Inventory maps, have also helped. New technologies, such as Global Positioning systems and low level digital imagery, hold promise for addressing some of the difficult georeferencing problems with GIS systems and for providing some of the detailed data which have been lacking.

Some of the strengths of GIS systems and computerized water resources flow models for wetland and water resources assessment include:

- GIS systems can store very large amounts of data,
- GIS systems can quickly process large amounts of data,
- GIS systems can combine, for analytical purposes, natural resource data with census, tax, economic, and other data,
- GIS systems can quickly analyze multiple scenarios (e.g., evaluate the impacts of various project designs), and
- GIS systems can print out analyses in a variety of formats (maps, charts, tables, 3-dimensional models, etc.)

With these strengths, one might expect widespread use of GIS and computerized information systems in wetlands and watershed assessment. Use is increasing for developing general plans, tracking development permits, analyzing functions and values, and identifying priority restoration areas. Computerized flow models have been broadly used for flood routing and backwater computations. But, there are limitations on the use of GIS and other computerized systems as well.

- "Garbage in, garbage out." The outputs of GIS and other computer modeling systems are no better (types of data, accuracy, scale) than the data imputed to the systems.

- Georeferencing data problems. GIS systems require more precise location of various types of information in relationship to selected coordinates than various manual analysis techniques (e.g., visually comparing maps) because data must be provided to the computer in a precise geocoded form. Georeferencing is often difficult because wetland information is often at a variety of scales (e.g., NWI maps, soils maps, land ownership maps, flood maps may be only available on unrectified map bases). Data is also typically subject to varying levels of inaccuracy. Human beings can make adjustments for such problems and limitations; computers cannot. For example, a regulator attempting to evaluate a proposed project at a specific site can often, with a little ingenuity, locate this site on varying scales of topographic maps, soils maps, NWI maps, property maps, and air photos and adjust to possible problems with map accuracy. But, a computer cannot.

- Aggregated information problems. There are financial limits to data encoding and computer storage and analytical capabilities despite the large capacity of computers. For this reason, computer specialists often attempt to encode information pertaining to a whole area (e.g., a polygon) rather than individual points. However, this also limits later disaggregation for various analytical purposes.

- Problems with updating wetland information due to the dynamic nature of water resources and anthropogenic changes. It is often as expensive and time-consuming to encode new, updated wetland, floodplain and other water information as encoding original information.

- Expense. Despite advances in technology, GIS systems are expensive. Hardware and software prices are now relatively low but developing adequate referencing for information, encoding, and checking for accuracy often requires a great deal of staff time despite some measure of automation (e.g., use of rastor scanners). Encoding, checking for errors, and even processing costs can also be significant.

- Lack of staff expertise. Most regulatory staff do have training to use GIS systems although this is changing.

Despite these limitations, computerized information systems have considerable potential for assisting managers in up-front, area-wide evaluations and in evaluating the hydrologic and hydraulic impact of proposed activities. But, GIS systems can typically supply only a portion of information needed for site-specific planning and analysis. GIS systems will need to be supplemented by some measure of case-by-case data gathering on individual areas and projects for the foreseeable future.

Box 31
GIS Applications in Wetlands and Watershed Assessments

GIS systems can assist area-wide wetland and watershed assessments in several ways:

- **Parcel analyses.** Wetlands and watershed assessment efforts can benefit from the parcel analysis capabilities of land information systems (LIS), which have already been implemented by many local governments and are being developed by others. LIS systems are a type of GIS effort that uses the ownership parcel to encode and analyze data. Types of information useful to wetland and related ecosystem regulation and available from these systems include:
  - Parcel ownership
  - Existing use of parcel
  - Property values, taxes
  - Zoning classification, other regulations
  - Public facilities (sewer, water, roads)
  - Demographic data (how many people nearby)
  - Topographic, soils, and other natural resources data (in some instances)

  Parcel-level approaches are often not specific enough to precisely delineate wetland boundaries, but they provide broader sorts of parcel information and can be used for red flagging or determining the overall suitability of wetlands for particular proposed activities.

- **Red and yellow flagging.** GIS systems with wetland and watershed components can also be used for broad inventory and red and yellow flagging, even if the system lacks data at the scale and degree of accuracy needed for site-specific regulatory analysis. This will depend, of course, upon the information available in the system. For example, a GIS with wetland, floodplain, riparian area data (e.g., digital NWI data) can be used to determine whether particular types of wetlands, floodplains, or riparian areas are "rare" in a locality. Such a GIS can be used to determine the proximity of wetlands to other wetlands and waters. The system might also be used to red flag flood hazards if flood maps have been encoded into the system.

- **Determining opportunity and social significance.** GIS systems can be used to determine the relationship of wetlands and other aquatic ecosystems to pollution sources, flood flows, public lands, and to population centers, and various users of wetlands.

- **Determining possible cumulative impacts, the implications of various development scenarios.** One of the strengths of GIS systems is their ability to analyze alternative development scenarios for a geographical area. For example, in processing a permit application for a one-acre fill for a ten-acre wetland, it might be useful to assume a one-acre fill in all similar wetlands in the region and to determine the hydrologic implications. Or it might be useful to determine changes in existing hydrologic regime due to projected urbanization of a watershed for a wetland restoration project.

- **Hydrologic analyses.** Computer models have become an essential tool in flood routing, determination of flood conveyance, determination of erosion and deposition potential, water pollution analysis and other types of water resources investigation that lend themselves to numerical modeling. Computerized hydrologic models are increasingly used for floodplain management planning, stormwater management, water supply and water quality planning to determine existing conditions (water depths, quantity, flood regimes, sediment regimes, pollution) and predict long-term changes. It is possible to project various "build out" scenarios (e.g. various densities and types of development), as well as the implications of various management schemes, such as flow diversions and operation of dams.

THE NIAGARA FRONTIER WETLANDS AND WATERSHED ASSESSMENT EFFORT

The Niagara Frontier New York wetlands and watershed management effort illustrates the importance of a sound information base and the role joint information gathering can play in bringing together key actors.

The problems that gave rise to this effort are rooted in the glacial history and topography of western New York. Much of western New York was inundated by glacial Lake Ontario which was much larger than present Lake Ontario. Sediments were deposited on the floor of the Glacial Lake, forming a semi-impermeable, almost level plain with many wetlands and serious flooding problems. Much of this area was at one time used for agriculture but has been slowly urbanized and incorporated into Buffalo and many surrounding towns and cities. Many wetlands have been further drained or filled, but many wetlands also remain, some of them reverting to semi-natural conditions.

Serious conflicts arose in 1989 and 1990 when the U.S. Corps of Engineers began to apply the 1989 Manual for the Identification of Jurisdictional Wetland to these areas. Pursuant to this Manual, large urban areas were considered wetland. However, the Corps of Engineers had inadequate staff and financial resources to carry out individual wetland delineations and to process Section 404 permits. There was huge public outcry, and a congressman from the area held congressional hearings on the problem. A congressman also requested that President Bush establish a moratorium on enforcement of Section 404 regulations for the area.

In 1991, to help address problems and conflicts, several concerned individuals from the environmental and development communities formed a Niagara Frontier Wetlands Roundtable. The Wetlands Roundtable, a group of 23 landowners, farmers, consultants, attorneys, town officials, federal and state administrators, environmentalists, developers, university professors and others first met in February, 1992. The Roundtable reached consensus on 14 recommendations that emphasized region-wide mapping, watershed-based planning and management of wetlands taking into account environmental factors, improved assessment procedures, reconciliation of delineation methodologies, the establishment of a mitigation bank, education, and public and landowner participation.

In response to these recommendations, the New York Department of Environmental Conservation formed a Western New York Wetlands Project in cooperation with local towns, landowners, developers, not for profits and federal and state agency staff. The project was funded, in part, through a $65,000 grant from the U.S. Environmental Protection Agency. Its immediate goals were to provide wetland maps. The longer-term goals were to streamline regulatory permitting and to prepare a wetland conservation plan for the area.

A broad range of activities has been undertaken as part of the project over the last six years and the project has proven to have considerable staying power. Much of the project has focused on developing an improved and mutually agreed upon wetland information base.

Many meetings were held by the advisory committee that has become, in effect, a wetlands coordinating committee for the region. A number of wetlands and wetlands-related workshops were also held, including a Wetlands and Watershed Management workshop in February, 1993, and a Wetlands in Western New York workshop carried out in 1997 by the Western New York Land Conservancy. Additional workshops concerning wetland maps were held in 1997.

Grants were provided to two county water quality committees to help with mapping and to identify restoration opportunities.

Digitized soil maps have been prepared on a watershed basis for the area by the U.S. Soil Conservation Service (now called USDA Natural Resources Conservation Service). This data is now available in GIS (Geoinformation system) format and can be shared electronically. Air photos were interpreted to identify areas subject to potential federal Section 404 jurisdiction and potential areas for wetland restoration and mitigation sites.

Composite wetland maps have been prepared by the USDA Natural Resource Conservation Service showing wetland boundaries as mapped by both the New York Department of Environmental Conservation and the National Wetland Inventory.

A broad range of information including watershed boundaries has been digitized and made available for GIS use by the USDA Natural Resources Conservation Service and the Erie County Soil and Water Conservation District. AmeriCorps has helped with this effort. This has included, but not been limited to, a GIS-based set of information on wetlands in the Tonawanda Creek Watershed in the northern third of Erie County and the southern third of Niagara County.

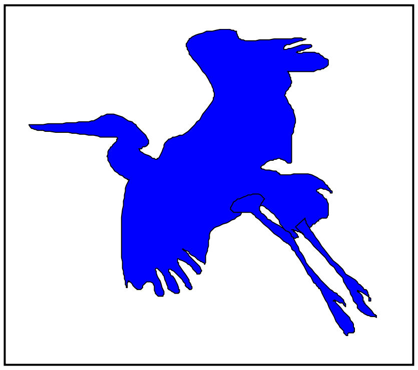
A pilot project has attempted to classify wetlands using the Hydrogeomorphic Wetland Classification. A joint New York Department of Environmental Conservation and U.S. Army Corps of Engineers permit application process has been established.

This effort is still a work in progress. However, much has been accomplished.

CHAPTER 5: REDUCING AND COMPENSATING FOR IMPACTS

Approaches for reducing and compensating for ecological impacts in water resources management include:

- *Apply multi-objective management strategies to simultaneously achieve both traditional water resource management and wetland/aquatic ecosystem protection and restoration goals.*
- *Avoid the most sensitive wetlands and other ecologically sensitive areas.*
- *Design projects to reduce impacts to wetlands and related aquatic ecosystems.*
- *Apply various ecological compensation measures (restoration, creation and enhancement) to address residual impacts.*



CHAPTER 5: REDUCING AND COMPENSATING FOR IMPACTS

In the past, water resources management programs have often conflicted with wetland, riparian, and floodplain protection efforts. Dikes, dams, channelization, levees and other structural projects have often destroyed wildlife habitat and related ecosystems without adequate consideration of the impact of such structures.

On the other hand, political and regulatory concerns about impacts on wetlands and related ecosystems have increasingly blocked water resources projects. Detailed environmental impact statements, as well as a wide variety of regulatory permits, are typically required for construction, dredging and other types of fills or structures in waters. Such permits are not granted if measures are not taken to both reduce and compensate for adverse project impacts on water and wetland ecosystems.

How can these conflicts be avoided or resolved?

Several approaches may be suggested.

MULTI-OBJECTIVE, "WIN-WIN" MANAGEMENT STRATEGIES

There are often several options in a specific watershed for achieving water resource management and ecosystem management goals. A wetland and watershed management effort will seek to identify the most effective "win-win," multi-objective management strategy. To illustrate single purpose versus multiobjective strategies, consider two community options for reducing flood losses in a community. Flood loss reduction can often be achieved (alternatively) by:

- Controlling flood waters through various control structures, such as dams and levees, and
- Preventing development or other flood damage prone activities in floodplains.

If flood loss reduction is the sole objective in a community, construction of a dam or levee may be the preferred alternative. However, if a community also wishes to control nonpoint pollution, protect and improve fisheries, provide outdoor recreation and protect wildlife, conservancy zoning or greenway acquisition for floodplain areas will often be the preferred alternative.

In some instances, protection of natural floodplains and wetlands may be justified based on flood loss reduction benefits. For example, the U.S. Army Corps of Engineers determined that the loss of 8,422 acres of wetlands in the Charles River Basin would cause $17 million in annual flood damages. The Corps decided to acquire the wetlands rather than construct extensive flood control facilities.

AVOID WETLAND/ RIPARIAN/FLOODPLAIN LOCATIONS

Conflicts may be reduced in some instances by "avoidance" and the utilization of low impact "alternatives" if total avoidance is not possible. Federal Section 404 regulations and similar state (and in some instances local) wetland and water regulations require "alternatives analysis" for projects in wetlands and other waters. Federal Section 404 regulations typically require that public and private landowners seeking to fill or dredge wetlands and waters first avoid wetland and water sites if it is practical to do so. This means placing roads, houses, parking lots and other structures in upland areas rather than wetlands or floodplains. It means taking special care with high value areas.

Avoidance is not possible or practical in all circumstances. For example, fill for a parking lot or house may intrude slightly into a wetland. In other instances, total avoidance is possible. For example, a stormwater detention facility may be excavated at an upland site.

APPLY A BROAD RANGE OF TECHNIQUES TO REDUCE PROJECT IMPACTS

Another approach for reducing conflicts and achieving multiple objectives is to carefully design and implement measures to reduce impacts on wetlands and related ecosystems.

To adequately assess project impacts, both individual and cumulative impacts need to be considered. Consideration of cumulative impacts is difficult on a case-by-case basis, particularly where a regulatory agency does not look beyond project boundaries. But, community-wide wetlands and watershed management plans that consider the hydrologic regime and ecosystem can help determine the potential, cumulative impact of the proposed activity and similar future activities.

Assessment of cumulative impacts also requires consideration of the reversibility of impacts. For example, tree-cutting and vegetation removal may have immediate, severe impact on the use of the wetland by certain animal species, but the long-term habitat may be little affected. In contrast, placement of fill in a wetland often destroys all future functions and values and may affect other areas as well by cutting off hydrologic connectivity for back lying areas.

Assessing impacts is a two-step process:

- Determine existing conditions, including functions, values and other characteristics,
- Determine future conditions with the proposed activity.

Many impact reduction approaches have been developed over the last thirty years. Some are outlined in Box 34.

Box 32
Project Impacts

Project impacts may include:

- Impacts on natural hazards, including possible increase of natural hazards on other lands
- Impacts on adjacent land and water uses (changes in flow regimes, navigation, recreation, etc.)
- Impacts on people (e.g., increased or lowered flood heights, increased or decreased recreational opportunities, etc.)

Box 33
Factors in Assessment of Project Impacts

- Type of activity
- Size of activity
- Type of wetland and characteristics of the wetland and related ecosystem (functions and values, hazards, etc.)
- Location of activity within wetland/aquatic ecosystem
- Existing condition of the wetland/aquatic ecosystem
- Reasonably anticipated future condition of wetland/aquatic ecosystem (e.g., will hydrology change? will the wetland be there in ten years?)
- The manner in which the activity will be carried out (e.g., use of erosion control measures)
- The time of the year the activity be carried out (e.g., growing season, non growing season)
- Natural sensitivity of wetland and other aquatic ecosystems to impacts and natural restoration potential of wetland
- Measures proposed to reduce impacts and the adequacy of these measures
- Measures proposed to compensate for impacts

Box 34
Examples of Generic and Special Impact Reduction Measures

Generic measures make sense in most contexts and can be applied to most projects

- Require that project design disturb natural hydrology as little as possible
- Require that as much fill be kept out of a wetland/floodplain ecosystem as practical
- Require the contouring of fills to provide as little change in natural topography and water regime as possible
- Require revegetation of fill and riprap to protect other areas of exposed soil from erosion
- Require revegetation or bioengineering to stabilize banks and other areas subject to velocity flows
- Require that fills, grading, vegetation removal, etc., not be undertaken during the growing season
- Require that dredge spoil be place outside of wetlands and waters if drainage, dredging or channelization is undertaken.
- Require that upland filter strips be constructed to reduce sediment and other pollutants entering waters where wetlands are disturbed or destroyed
- Require fencing of wetlands to keep out cattle and people

Special measures require more information and can be applied only in certain contexts

- Require design and operation of dams to mimic natural downstream flows, including flood flows
- Require design and operation of dams to release sediments, mimicking natural sediment regimes
- Require design of dams with fish ladders to allow passage of fish
- Require that levees and dikes be setback some distance from a river or stream to allow continued connections between river and adjacent lands
- Require construction of detention areas and artificial wetlands to intercept stormwater, pollutants and sediment before they reach natural wetlands
- Require control of exotic plants that may result from project disturbance
- Require controlled burns to compensate for suppression of natural fires

COMPENSATE FOR RESIDUAL IMPACTS

It is often difficult or impossible to reduce all wetland and related ecosystem impacts. For this reason, wetlands and watershed management programs typically incorporate a variety of measures to compensate for residual impacts. Compensation may take the form of onsite or offsite wetland/aquatic ecosystem restoration, creation or enhancement.

Compensation is an important option if impacts are truly unavoidable. But, there are limitations on scientific knowledge and practical know-how for compensation measures. They should also be approached with care. See Boxes 35, 36. Many compensation projects have failed due to inadequate hydrology, construction, expertise and other problems. Wetland restoration, creation and enhancement is often more of an art than a science.

Some of the lessons learned about successful restoration, creation and enhancement "compensatory" approaches including the establishment of mitigation ratios are summarized below.

Box 35
Compensatory Approaches

Compensation for wetland and related ecosystem losses includes the following options:

- ***Restoration.*** Bring back a wetland, floodplain, or riparian area to its former unimpaired state. Restoration generally begins with restoration of hydrology. Replanting and other restoration techniques may then be used. Restoration is the most common and most successful approach.

- ***Creation.*** Bring into existence a wetland or riparian area that did not exist before. Creation is less common than restoration and more difficult for most types of wetlands and settings since it involves changing upland or aquatic areas. Creation generally begins with establishing hydrology at a site through dredging, filling or impoundment, followed by replanting. Many creation projects fail due to inadequate hydrology or because they are unstable in their hydrologic/geomorphological setting.

- ***Enhancement.*** Increase or augment existing wetland, riparian area, or floodplain functions/values or size by impoundment, dredging or other techniques. It may involve altering the characteristics of an existing wetland, such as deepening one portion to enhance fisheries or waterfowl habitat. It may include the removal of litter, control of exotic species, control of pollution sources, installation of nesting boxes and replanting vegetation. Enhancement is often controversial because it invokes changing one type of wetland into another (e.g., forested to open marsh). Many enhancement projects provide only temporary benefits because they are unstable in the watershed context.

Box 36
Keys to Successful Restoration/Creation/Enhancement Projects

- **Establish clear and realistic goals.**
- **Understand wetland/floodplain and broader aquatic ecosystem hydrology.** Hydrology is the most critical parameter for restoration, creation, and enhancement because all wetland functions and values dependon the water regime. Relevant information includes:
  - Existing hydrology of a site
  - Nature and extent of alterations to original hydrology (e.g., fills, drainage, etc.)
  - Permanency of alterations and whether a wetland is or might naturally restore itself (e.g., original water levels returning due to filling of drainage ditches by sediment, collapse of subsurface drainage tiles)
  - Possible future changes in hydrology (It makes no sense to restore a wetland where there will be no water in ten years.)
- **Provide multidisciplinary hydrologic, soils and other expertise in project design/implementation.**
- **Design creation, restoration or enhancement projects as self sustaining and low maintenance.**
- **Use nearby, relatively undisturbed wetlands, floodplains and riparian areas as guides in restoration, creation and enhancement.**
- **Provide connectivity to other wetlands, floodplains and waters.** Many wetland functions/values — water recreation, fish habitat, wave retardation, erosion control and flood conveyance — depend on wetland connection to another waterbody. In addition, if a site is connected to other waters, there may be a natural source of seeds for revegetation, and fish, shellfish and other fauna.
- **Create buffers to provide ecotones and protect wetlands/floodplain and other aquatic ecosystems from incompatible uses.**
- **Monitor projects and modify strategies as needed.**
- **If necessary, provide active management, which may include:**
  - Control exotics
  - Remove sediment
  - Manipulate water levels
  - Stock fish
  - Provide nesting boxes

Box 37

Factors Relevant to Mitigation (Compensation) Ratios

Some factors relevant to determination of mitigation (compensation) ratios include:

- **The overall ecological condition (persistence, biodiversity, ecosystem integrity) of the original wetland/floodplain versus the probable ecological condition of the replacement (restoration/creation) wetland/floodplain.** Larger ratios are needed where a replacement wetland will be less persistent, less diverse or have less ecosystem integrity than the original wetland.
- **The opportunity that society has to make use of the original wetland versus the opportunity that society will probably have to make use of the replacement (restoration/creation) wetland/floodplain.** Larger ratios are needed where a replacement wetland will be less available for public use or will provide less public benefit.
- **The range and magnitude of functions/values of the original wetland/floodplain versus the probable range of functions/values of the replacement (restoration/creation) wetland/floodplain.** Larger ratios are needed where a replacement wetland will have a smaller number of functions/values.
- **The wetland/floodplain type and probable project success or failure for this type.** Larger ratios are justified for the wetland types that have proven more difficult to restore or create. The complexity of establishing or restoring wetlands or comparable hydrology determines the project's degree of difficulty.
- **Whether restoration or creation is involved.** Larger ratios are needed for efforts to create wetlands than for wetland restoration due to lower probabilities of success.
- **The types of functions involved.** Larger ratios are justified when functions/values are difficult to restore or create (e.g., endangered species).
- **The expertise of the agency/consultant proposing to carry out the project.** Larger ratios are justified for less experienced project proponents with greater possibility of project failure.
- **The length of time it will take for the restoration to become fully functioning.** Larger ratios are needed where it will take many years for a project to become fully functioning.
- **Threats (if any) to the restoration site.** Larger ratios are justified where there are threats to a restoration or creation site (changes in hydrology, sedimentation, water pollution, etc.).
- **Whether the site will be susceptible to midcourse corrections.** Larger ratios are justified where a site has little mid-course correction capability.
- **Whether there will be monitoring to provide the basis for midcourse corrections over time.** Larger ratios are justified where there will be little or no monitoring of success.
- **Whether active management will take place over time.** Larger ratios are justified where no active management (e.g., fencing, exotic weed control, controlled burns) will be take place.

ONSITE AND OFFSITE COMPENSATION; COOPERATIVE PROJECTS AND MITIGATION BANKS

Impact compensation measures may be undertaken onsite or offsite. Offsite measures may include the use of mitigation banks, which involve the restoration, creation, or enhancement of wetlands with the goal of providing credits for wetland destruction at other locations in the future. Individuals proposing such destruction buy these credits.

A number of local governments have established mitigation banks, including West Eugene, Oregon; Wayne County, Michigan; Snohomish County, Washington; The Harris County Flood Control District, and Volusia County, Florida.

Ecologists and wetland regulatory agencies generally favor onsite and in-kind measures as a first choice rather than offsite mitigation including mitigation banks for a number of reasons. Benefits are kept as close as possible to the original ecosystem and to the original landowners. Existing wetlands may be used to guide in-kind and onsite compensation.

Shifts in ecological and societal benefits and costs also occur when offsite restoration or creation are used to compensate for impacts. For example, an acre foot of flood storage may be created at an offsite location to compensate for the loss of an acre foot at an original location, but different properties and individuals will benefit from storage at this new location. In addition, the original, downstream ecosystem and landowners will suffer.

A combination of onsite and offsite compensation measures may be optional in some circumstances. For example, in an urban area, stream buffers and greenways may be used to compensate for loss of flood storage and conveyance, and loss of erosion and pollution control. But, it may be more realistic to provide offsite compensation of habitat functions through wetland restoration or creation at another site.

There are practical problems with onsite and in-kind compensation in some cases. There are circumstances in which offsite compensation may be desirable. No satisfactory or practical onsite location may exist for restoration or creation. In addition, the original hydrology and ecology of a wetland near a large subdivision or mall may be substantially changed even if development is kept out of the wetland. Often original plants will not grow in the new hydrologic conditions and original animals will have no upland or adjacent habitat.

Regulatory agencies have often responded to proposals for offsite and out of kind compensation by requiring large compensation ratios. Ratios of 3:1 to 20:1 have not been uncommon. See Box 37 for factors relevant to the establishment of ratios.

Regulatory agencies require such large ratios to reflect the many uncertainties in evaluating functions/values and project impacts, and the low rate of restoration/creation project success. They have also established large ratios because of the shifted benefits and costs and because inequities arise between landowners who provide onsite restoration/creation in urban settings at great cost per acre and landowners who are allowed to provide offsite restoration in rural settings at much lower per acre costs.

Wetlands and watershed management efforts can go beyond compensating for individual project impacts by undertaking proactive restoration to provide net increases in wetlands. Increasingly, communities, agencies and states are identifying restoration sites and looking to various sorts of proactive compensation measures to address existing problems and offset potential future impacts. See Box 38. Examples include Eugene and Portland, Oregon, and Phoenix, Arizona.

Box 38

Opportunistic Restoration/Creation/Enhancement

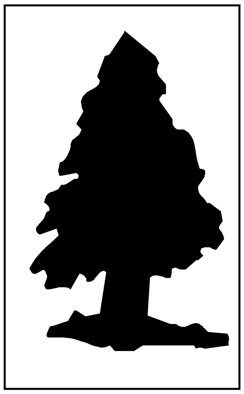
Wetlands/floodplain/aquatic ecosystems can often be created, restored or enhanced at reasonable cost when integrated into other activities, such as:

- **Reclamation of gravel pits and strip-mined lands**
- **Restoration of superfund dump sites (wastes were often in the past placed in wetlands)**
- **Stream bank stabilization efforts (i.e., use of bioengineering techniques)**
- **Construction of stormwater detention and retention facilities**
- **Retrofitting sanitary sewers, stormwater facilities**
- **Construction of farm ponds, other ponds**
- **Repair of damaged or destroyed levees after flood events by setting them back from a river or stream**
- **Large-scale grading and filling for land subdivision, industrial development, construction of roads and other infrastructure (often offers restoration opportunities)**

CHAPTER 6: INTEGRATING WATER RESOURCES MANAGEMENT AND ECOSYSTEM PROTECTION

"Floodplains are natural storage and conveyance facilities, and all stormwater management efforts should be directed toward helping them serve that function."

— From Rooftop to River: Tulsa's Approach to Floodplain and Stormwater Management; May, 1994.



CHAPTER 6: INTEGRATING WATER RESOURCES MANAGEMENT AND ECOSYSTEM PROTECTION

Many communities have adopted five somewhat distinct types of water resources management programs:

- flood loss reduction,
- stormwater management,
- water supply,
- point source pollution control, and
- nonpoint source pollution control.

All five types have traditionally involved construction of various types of structures in water bodies, wetlands and floodplains, although nonpoint source pollution control has also depended upon nonstructural approaches. All structural approaches modify basic hydrologic regimes and have the potential to severely impact wetland/floodplain/riparian ecosystems if measures are not taken to avoid and reduce impacts and if various sorts of compensation re not applied to address residual impacts.

Chapter 6 examines in greater depth these five types of water management programs and recommends strategies for reducing and compensating for ecosystem impacts.

Box 39

Use of Structures in Water Resources/Watershed Management

Construction of Dams

Dams are constructed for:

- Water supply
- Flood control
- Navigation
- Stormwater detention for flood loss reduction
- Creation of farm ponds
- Creation of recreational impoundments
- Stabilization of lake, pond levels
- Wildlife enhancement

Construction of Dikes, Levees, Seawalls

- Dikes, levees, and seawalls are constructed for flood and erosion control.

Channelization, Drainage

Ditching, dredging, channelization and subsurface drainage are undertaken for:

- Flood loss reduction
- Reduction in ground water levels for agriculture
- Conveyance of waste waters, irrigation waters
- Improvements to navigation
- Stormwater management

Erosion Control Measures

Erosion control measures, such as riprap, bank stabilization and groins are undertaken for:

- Stream bank stabilization and control of meander
- Control of soil erosion
- Stabilization of barrier islands and beach

Other Structural Approaches

Other structural measures are constructed for:

- Sewage treatment (waste treatment facilities, piping)
- Water supply (water treatment facilities, piping)

FLOOD LOSS REDUCTION

Overall Approaches

Until 1968, communities relied primarily on flood control structures to reduce flood damages. Public and private dikes, dams, levees, channelization projects, diversions, and drainage structures were widely used to reduce losses. (See profile on flood loss reduction measures on the next page).

Beginning with the adoption of the National Flood Insurance Act of 1968, emphasis shifted at all levels of government from the almost exclusive use of structural measures to a more balanced approach with extensive use of nonstructural measures as well, such as floodplain regulations, flood insurance, elevation of structures, flood warning systems, evacuation and relocation to reduce damage in undeveloped floodplains. Such nonstructural measures are more compatible with protection of wetland, floodplain, riparian and other ecosystems.

Since 1968, over 18,300 communities have adopted floodplain regulations. Most of these communities tightly control development in floodway areas along rivers and streams. Typically, ordinances permit some development in outer fringe areas. Some communities and states broadly define floodway areas, and some communities prohibit development in both floodway and outer fringe areas.

Nonstructural approaches to flood loss reduction have been encouraged by a number of factors: the escalating costs of structures, environmental impacts of structures, residual flood risks from structures (dams, dikes and levees are over topped or break) and an emerging philosophy that those who occupy the floodplain should bear the costs of occupancy (not the public). Community efforts that exceed the minimum standards of the National Flood Insurance Program are encouraged by the Federal Emergency Management Agency (FEMA) Community Rating System which provides lowered National Flood Insurance rates for communities whose regulations and other flood loss reduction measures which exceed FEMA's minimum standards. For example, Tulsa, Oklahoma, has reduced its National Flood Insurance rates by more than 30% by creating greenways, relocating structures and establishing stormwater detention areas.

Despite widespread application of nonstructural measures, proposals for public and private flood control structures continue to be made, particularly following severe flood events, such as the Great Flood of 1993 along the Mississippi River.

Options

How can communities reduce flood losses while also protecting and restoring wetland/floodplain/riparian ecosystems? Some options include:

1. Allocate floodplains (to the extent possible or practical) to open spaces uses. One strategy applied by thousands of communities to simultaneously reduce future flood losses while protecting and restoring wetland/floodplain ecosystems is to keep development partially or wholly out of flood hazard areas including wetlands and riparian zones contained in such floodplains. Communities can do this in many ways:

- Adopt stream and coastal setbacks and buffers. Many communities have adopted setbacks and buffers of 50 to 300 feet or more for buildings and septic tank/soils absorption systems (e.g., communities in Wisconsin, Minnesota, Massachusetts and Connecticut).
- Adopt floodway and floodplain conservancy zoning restrictions that prohibit development in floodplains and floodways (e.g., communities in Wisconsin, Minnesota, Massachusetts and New Hampshire).
- Adopt zero rise floodway (e.g., many communities in Wisconsin).
- Adopt combined floodplain and wetland protection ordinances that control development in floodplain areas and provide additional protection for wetlands (e.g., many Massachusetts communities).

- Adopt subdivision regulations prohibiting subdivision of flood prone lands unless such lands are used to meet open space requirements.
- Adopt building codes and sanitary codes that prohibit or restrict development and the use of septic tanks and soil absorption fields in floodplain areas.
- Acquire floodplains and create open space greenways in floodplains through park, recreation, flood loss reduction, waterfront renewal and other acquisition programs. Hundreds of communities have created greenways, and it is now hard to find a community that does not have some sort of greenway initiative for major streams (e.g., Minneapolis/St. Paul, St. Louis, Baltimore County, Milwaukee County, San Antonio, Boulder, Denver, King County, etc.)

2. Remove existing development from floodplains. Communities have encouraged removal of floodprone development from to achieve flood loss reduction and ecosystem restoration in a variety of ways:

- Thousands of communities have adopted nonconforming use provisions in floodplain zoning ordinances, which require that nonconforming structures be removed or brought in conformity with floodplain regulations if the structures are abandoned, improved or rebuilt beyond a stated amount of their value. However, these regulations have been only partially successful in encouraging removal of existing development. Some communities have also adopted floodplain zoning regulations that require the removal of floodplain or floodway structures over a specified period of time (amortization).
- Some communities have relocated floodprone structures out of the floodplain as part of community redevelopment or hazard mitigation projects. Examples include Lillydale, Minnesota; Baltimore, Maryland; and Prarie du Chien, Wisconsin. Since the 1993 flood, Mississippi Basin communities have removed more than 10,000 structures from the floodplain of the Mississippi and tributaries.

3. Use soft engineering and low impact techniques to control erosion and stream meander. Communities have increasingly used bioengineering techniques to control erosion and meander. These involve planting trees and other vegetation along riverbanks rather than using stream channelization, rip rap or structural measures. (e.g., Berkley, California; Portland, Oregon). Some communities have also used low impact river maintenance techniques such as manual removal of dead trees, which has less impact than mechanical removal.

4. Use set-back levees or remove levees to protect the riparian corridor and wetlands. Some communities have moved levees back from the immediate stream bank area. For example, the Iowa Natural Heritage Council has helped acquire a previously leveed area along the Mississippi and return it to wetland.

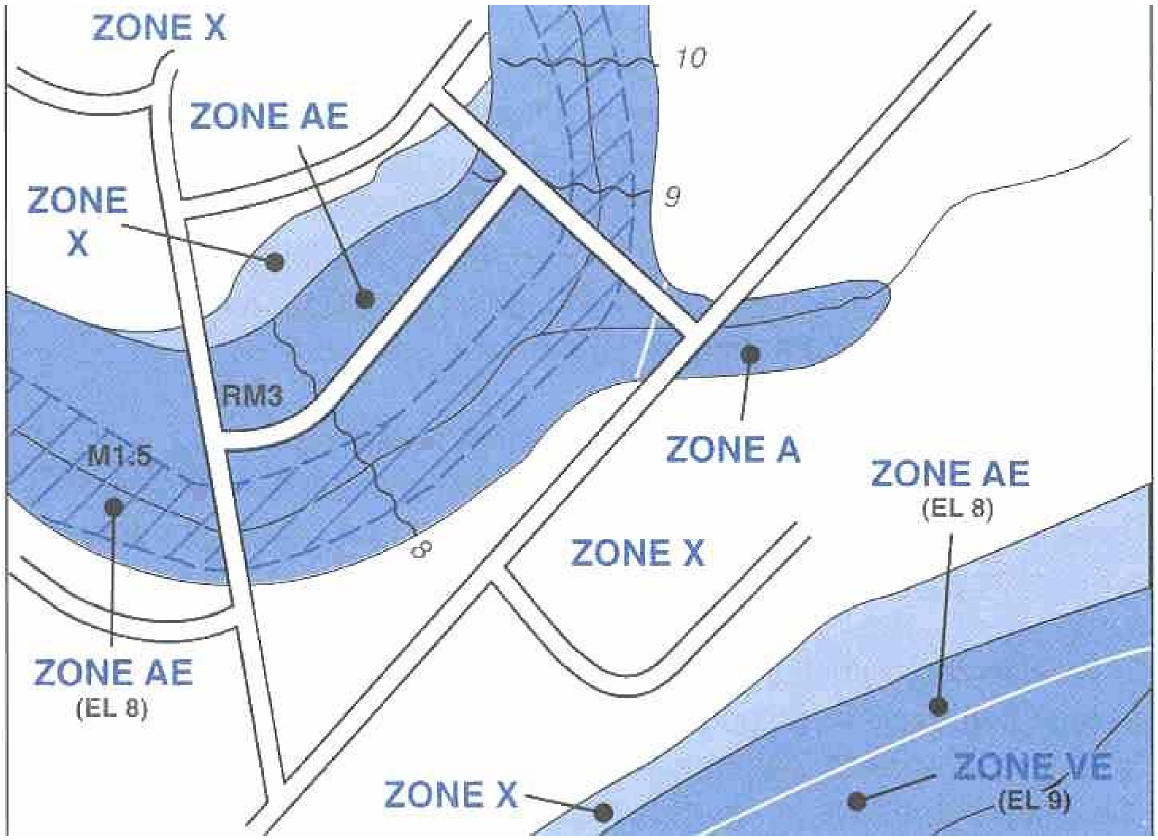
5. Restore wetlands, floodplains, riparian areas to a natural or semi-natural condition. Some communities have restored wetlands and related ecosystems to a natural or almost natural condition as part of greenway, stream restoration and stormwater projects. Examples include Littleton and Boulder, Colorado.

6. Design and operate dams to minimize impacts on wetlands and related ecosystems.

- Design dams to incorporate use of fish ladders, aeration devices and other impact reduction measures. Virtually all new hydroelectric and other dams incorporate some of these measures.
- Retrofit existing dams (e.g., installation of fish ladders in Columbia River dams).
- Operate dams to simulate natural flows (e.g., Grand Canyon and Glen Canyon releases).

7. Adopt stormwater regulations that encourage/require onsite detention.

Figure 15



Federal Emergency Management Agency (FEMA) flood map for Lake County, Illinois.

Box 40

Summary of Traditional Community Flood Loss Reduction Programs

Traditionally, communities have used two major approaches to achieve flood loss reduction: (1) control of flood waters and (2) control of land uses. Approaches for controlling water include dikes, dams, levees, channelization, rip rap, groins, etc. Approaches for controlling or guiding land uses include floodplain regulations, acquisition, relocation and flood warning systems.

Goals: The focus of most local flood loss reduction programs has been existing and future structures. The primary concern is threats to life and property from large flood events (e.g., the 100-year storm) at coastal and estuarine locations, and along major rivers and lakes. Protection of natural and beneficial floodplain values has also become a priority for many local floodplain management efforts. Additional goals include wise use of the floodplains to reduce losses, while permitting economic use.

Relevant hydrologic and hydraulic parameters: Information needed for flood loss reduction includes data and maps that identify areas subject to large, infrequent flows (e.g., the 100-year floodplain) and areas subject to high velocity winds and waves (hurricanes). Other needed studies include hydraulic and hydrologic conveyance, sediment regimes and stream meander.

Extent of programs: Many communities in the U.S. have adopted flood control measures for portions of their lands (drainage, dikes, levees). Almost all floodprone communities throughout the nation (more than 18,300) have also adopted some sort of floodplain regulatory ordinances.

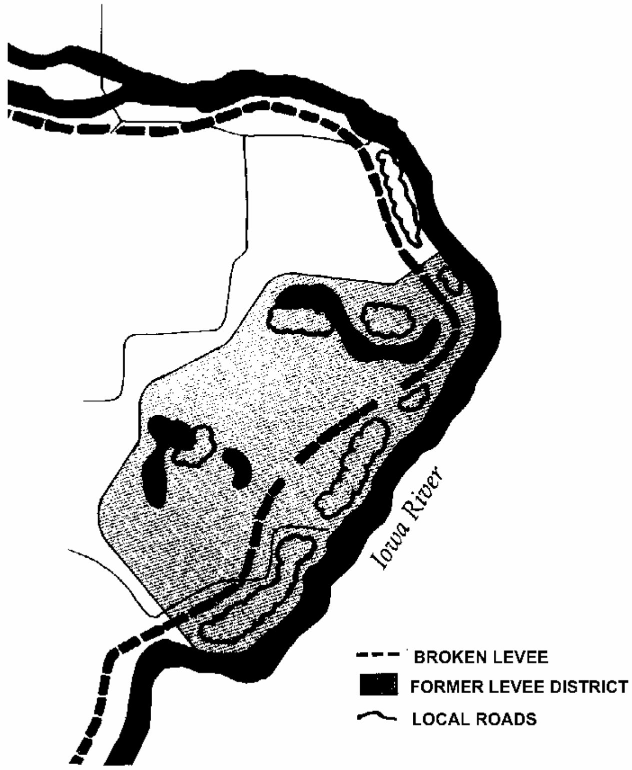
Responsible agencies: FEMA, U.S. Army Corps of Engineers (Corps), U.S. Geological Survey, and the USDA Natural Resources Conservation Service (NRCS); state floodplain management and water management agencies; and local planning, zoning, and public works departments.

Watershed perspective: Floodplain mapping has usually been carried out on a community-wide basis by FEMA, the Corps, NRCS and other federal and state agencies for major rivers and streams and for lakes and coastal areas. Watershed-based mapping has been carried out for some smaller streams in urban areas.

Benefits of wetlands/floodplain ecosystems to flood loss reduction: Wetlands and floodplain ecosystems store and convey flood waters, reduce wave heights (effects of vegetation) and reduce erosion by stabilizing banks and bottoms. Development in these areas may both increase flood losses. Wetlands are typically within the 100-year floodplain although the 100-year floodplain is more extensive.

Conflicts and problems: Flood control dams, dikes and levees and channelization programs (including agricultural drainage) have been the major causes of wetland and floodplain losses. Dikes have also cut off wetlands and floodplains from adjacent water bodies and substantially changed sediment supplies, water levels and hydroperiods. The 1990 Water Bill required the Corps of Engineers to achieve no net loss of wetlands for future water projects.

Figure 16
Wetlands and Flood Loss Reduction
Louisa Levee District 8



After the "Great Flood" of 1993 in the Upper Mississippi and its tributaries, The Iowa Natural Heritage Council helped facilitate a buy out for Lousia Levee District 8, six miles from the mouth of the Iowa River. (The levee protection of this 3000-acre parcel had broken 17 times.) This voluntary buyout to reduce flood losses, provide flood storage and restore wetlands was carried out under a cooperative agreement among the Soil Conservation Service, the U.S. Fish and Wildlife Service and the Iowa Natural Resource Council. It has been fully implemented. Source: National Park Service, Floods, Floodplains and Folks, National Park Service, Rivers, Trails, and Conservation Assistance Program (1996).

Box 41
Reducing Flooding and Enhancing the Environment — Minnesota's Red River Basin Flood Damage Reduction Agreement

After severe flood losses in the Red River Basin in 1996 and 1997, the Minnesota Legislature, in 1997, authorized funding for mediation to attempt to resolve disputes over proposed flood loss reduction measures, which had led to a court challenge and gridlock. As part of the process, a diverse partnership of government and nongovernmental groups, including environmental organizations, came together for six months of mediation. This resulted in the signing of a Red River Flood Damage Reduction Agreement in December, 1998. The final agreement has five important parts:

1. *Flood damage reduction goals*. Goals for reducing flooding were established so that a common basis could be used for evaluating proposed projects. Eight specific goals related to the protection of lives, communities and farmsteads, and to the reduction of agricultural damages were defined. A quantifiable goal for reducing farmland flooding was defined as protection from the ten-year summer storm event (i.e., a 3.5 inches rain in a 24-hour period). Other goals cover damage reduction to transportation infrastructure, water quality and natural resources.

2. *Natural resource goals*. The ten natural resource goals adopted by the Work Group emphasize protection and enhancement of stream corridors, wetland restoration and habitat diversity. The detailed objectives supporting the goals were developed by an interagency group of federal, state and tribal resource managers. The Work Group intends to incorporate these goals into watershed plans and to include natural resource enhancement features in specific flood control projects.

3. *Comprehensive watershed planning*. Agreement was reached on principles to be used in watershed planning in the Basin. These principles call for an integrated approach to water management for flood damage reduction, water quality protection and natural resource enhancement. The agreement directs watershed districts to establish locally specific goals and to make annual progress reports on achieving those goals.

4. *Project review and permitting*. A new review and permitting process was created that changed the way flood damage reduction projects are planned and revised the system for permitting those projects. The new process encourages early communication and coordination among watershed districts, government agencies and interested non-governmental groups on proposals that attempt to solve watershed problems.

5. *Implementation and conflict resolution*. This section establishes on-going processes for the implementation of the agreement and for resolving any future conflicts over proposed planning objectives. The Work Group agreed to continue, with the same membership, to oversee new planning and project coordination activities, and to devise a conflict resolution mechanism that will prevent the institutional gridlock of the past.

STORMWATER MANAGEMENT

Overall Approaches

Many mid-sized and larger communities have adopted stormwater management programs that involve above ground and below ground drainage ways and detention areas. Many have also adopted floodplain management efforts that overlap with stormwater management. Floodplain and stormwater management programs share many features, but floodplain management programs are typically applied to larger rivers and streams and larger flood events (e.g., the 100-year event). Stormwater programs deal with smaller streams, creeks, and drainageways, and surface runoff in urban areas. Stormwater programs also apply to smaller rainfall and flood events.

The principal goal of floodplain and stormwater management is to reduce flood losses. However, in the last decade, stormwater management has increasingly been concerned with protection of water quality, because stormwater contains large quantities of heavy metals, organic material, oils, pesticides and nutrients. Untreated stormwater discharge is a major source of pollution in rivers, lakes, streams and estuaries. The initial runoff that washes pollutants into waterways during the first part of a storm typically contains a large amount of pollutants. The EPA has adopted regulations that require communities of more than 100,000 residents to adopt pollution controls for stormwater runoff.

The traditional urban approach for addressing stormwater has been the construction of below ground stormwater drainage systems. In older cities, many small creeks and drainage ways in the core city were encased in concrete to convey stormwater. This approach is subject to a number of problems and limitations:

- Below ground systems have typically been designed to accommodate only limited rainfall events (7-10 year). Severe flooding often occurs with larger events.
- Structural stormwater management measures often accelerate natural runoff, increasing downstream flooding.
- Structural stormwater management severely and directly impacts the environment by destroying wetlands, floodplains, fisheries and wildlife in streams.
- Structural stormwater management often results in significant pollution of rivers, lakes, streams and estuaries.

As a result, many communities have taken multi-objective, stormwater management approaches. The Maryland Center for Watershed Protection has been particularly active in assisting communities. See http://www.cwp.org/. These approaches better address infrequent but large rainfall events, have less environmental impact, better address water quality concerns, and are often less expensive. The approaches typically include a combination of measures.

Options

How can communities reduce stormwater quantity and quality problems while protecting and restoring wetland and related ecosystems?

1. Protect natural drainageways, wetlands and other stormwater detention areas. One option for reducing stormwater losses and protecting water quality is to prevent development in natural drainage ways and preserve wetland and other natural stormwater detention areas. Communities can use a variety of techniques to do this:

- Adopt setbacks, open space zoning regulations and subdivision regulations to prevent development in and adjacent to creeks, streams, wetlands, floodplains and other natural drainage ways.

- Adopt zoning regulations to limit lot size, tree removal and creation of impermeable surfaces in the watershed, thereby reducing the quantity of stormwater runoff and water quality problems.

- Acquire lands and create greenways along creeks, rivers and streams.
- Remove structures from floodplains and maintain them as open space. For example, Tulsa has removed over 900 houses from floodplain.

2. Construct onsite detention to retain runoff and remove sediment and pollutants. For example, in 1993 Aiken, South Carolina began a program to create and restore a series of wetlands in the Hopelands area to alleviate downstream flooding and erosion and improve water quality. These wetlands have been so popular that a middle school has incorporated them into its educational program.

3. Utilize a combination of above ground greenways and below ground stormwater conveyance systems to store and convey infrequent flows. Above ground, open, grassed drainage ways can be used to convey stormwaters for infrequent flood events. These can include networks of floodplains and other open spaces. Below ground, concrete systems are used for more frequent flows.

4. Use combined sanitary and storm sewers with constructed wetlands to reduce water quality problems and to store stormwaters. Many communities use a combination of techniques. For example, after a watershed engineering study for the Bufferfield Creek Watershed in Northern Illinois revealed that flood damages would increase by up to 500% if wetlands and other natural storage areas in the watershed were destroyed, the Butterfield Creek Steering Committee created a model stormwater management code for the seven communities in the area. This code was developed with the help of the Northeastern Illinois Planning Commission; it protects natural flood storage areas and requires significant onsite detention. Four of the seven watershed communities have model projects that demonstrate detention methods using open space and bioengineering techniques.

For further guidance on wetlands and stormwater management, we suggest you see Brittingham, Providing Wetlands for Wildlife While Controlling Stormwater; Penn State Univ., College of Agricultural Sciences, Cooperative Extension (undated).

Figure 17

Flooding. *Source: Wisconsin Department of Natural Resources. Why Protect Floodplains? http://www.dnr.state.wi.us/org/water/wm/dsfm/flood/purpose.htm*

Box 42

Summary of Traditional Stormwater Management

Goals: The goal of traditional stormwater management has been to reduce urban drainage and flood losses along small creeks and streams (in contrast with floodplain management, which applies to larger bodies of water and larger watersheds). More recent goals include water quality protection and habitat protection. The EPA has adopted stormwater pollution control regulations for cities of more than 100,000 people.

Relevant hydrologic parameters: Information is needed on flood flow volumes and flow paths for flood events, sediment regimes and water quality.

Extent of programs: Most middle sized and larger cities have adopted stormwater management programs that involve a combination of surface and subsurface stormwater drainage facilities. Most communities also require that subdividers install stormwater drainage facilities. Many require on site detention for storms with specified occurrence interval.

Responsible government agencies: Local planning and public works departments, state floodplain and water quality agencies; the U.S. Environmental Protection Agency, Federal Emergency Management Agency, the U.S. Army Corps of Engineers and the Natural Resources Conservation Service.

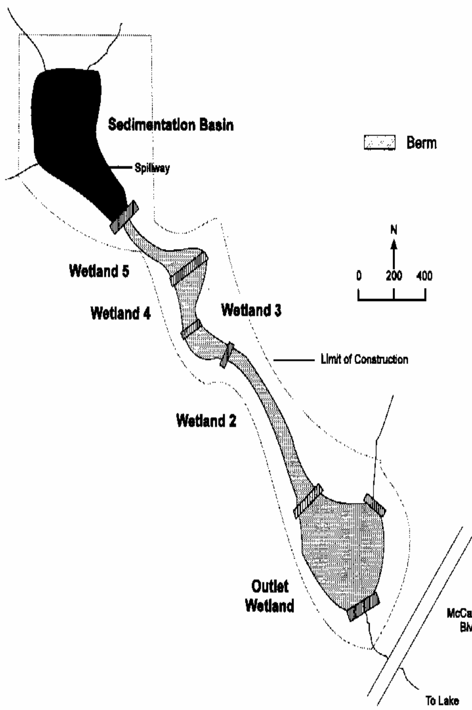
Watershed perspective: Stormwater planning and management efforts have often been carried out on a subwatershed basis. The rational formula, or some variation on the rational formula, is used to compute flows. Future watershed conditions are often assumed in project design.

Benefits of wetland/floodplain ecosystems to stormwater management: Wetlands and floodplains store stormwaters. They may also convey stormwaters. Wetlands and floodplains remove contaminates, litter, and sediments from stormwaters, preventing them from reaching lakes, rivers, and streams. They also remove nitrogen and phosphorous.

Problems, conflicts: Stormwater management may conflict with natural wetland protection and restoration because they involve drainage, channelization, and the establishment of detention areas. Traditional stormwater management practices have threatened smaller, isolated wetlands and wetlands along small creeks and streams. Pollution and sediment discharges into wetlands are another problem.

Figure 18

Wetlands and Stormwater Management
Lake McCarron's Stormwater Treatment System



This system was built in 1985 in Roseville, Minnesota, a suburb of St. Paul. About 85 percent of the runoff from the watershed is routed through this wetland prior to discharge to a lake. A sedimentation basin and low berms were installed in a degraded palustrine wetland, dividing the wetland into five consecutive chambers. Percent pollutant reduction (inflow versus outflow) for the combined wetland and pond over 21 rainfall events was 94% for suspended solids, 78% for total phosphorous, 88% for total Kjeidahl nitrogen, and 85% for total lead.

Source: U.S. Environmental Protection Agency,
Office of Water, Washington, D.C.
EPA 843-B-96-001 (October 1996).

WATER SUPPLY

Overall Approaches

Insuring ample supply of clean drinking water is a major concern of communities throughout the nation. States now inventory water supply sources and determining the adequacy of protection measures. Communities plan and implement a variety of programs to provide adequate water supply to residences, businesses and industries. Typically, these measures include:

- Wells or reservoirs
- Piping
- Treatment systems
- Water supply delivery systems

In the past, wetlands were often destroyed in the construction of water supply reservoirs and pipe systems. Draw-down from community, industrial, commercial and agricultural wells has destroyed or damaged wetlands.

Increasingly communities are turning to source water protection rather than expensive water treatment facilities. Communities are recognizing that wetlands, floodplains and riparian areas can play important roles in reducing and treating watershed sources of pollution, including viruses and bacteria such as <u>e-coli</u>, <u>giardia</u>, and <u>cyrptospiridium</u>. For example, New York City may be able to protect the water supply for 8 million people through a 1 billion dollar source water protection program. Treatment of the same water would cost 9 billion dollars. Protection and restoration of watershed wetlands is part of this effort.

Options

How can communities meet source water needs while protecting and restoring wetland and related ecosystems?

1. Protect wetlands and associated ecosystems to reduce nutrients, bacteria, metals and other pollutants. Communities have used a number of approaches to achieve this:

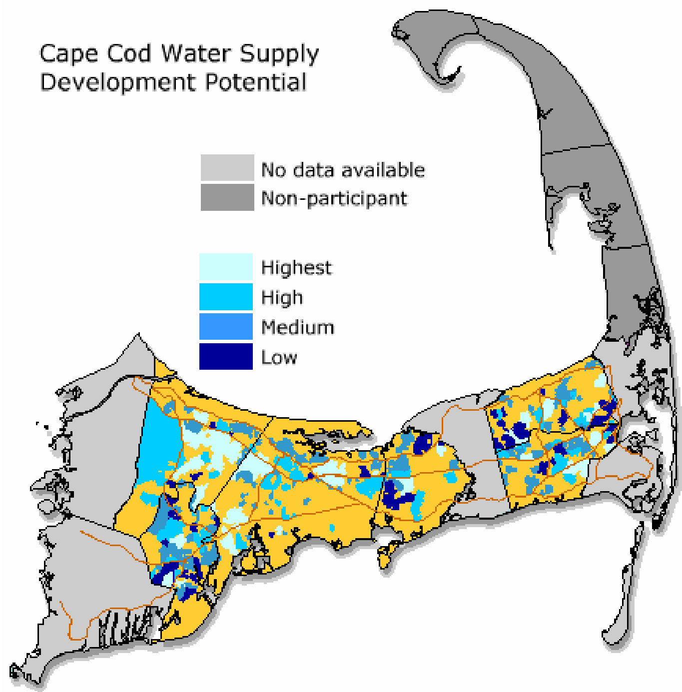
- Adopt stream, lake, well head and septic tank/soil absorption system set back requirements for sources of water supply. They may include zoning, subdivision regulations, building codes and other regulations.
- Acquire lands and create greenways and other open space zones around source water supplies.
- Adopt conservancy zoning for watershed lands that supply water.
- Adopt large, minimum lot size requirements for watershed lands that supply water.

2. Restore wetlands and related ecosystems in watershed areas to reduce pollution, restore and protect water quality. For example, New York City is planning to protect and restore wetlands in the Catskills to help preserve its water supply.

3. Incorporate various impact reduction measures in water supply reservoirs. Such measures may include:

- Reservoirs to provide minimum flows and to simulate downstream floods.
- Wetland restoration, creation and enhancement to compensate for residual impacts.

Figure 19



Map used with permission. Produced by the staff of the Woods Hole Research Center's GIS & Remote Sensing Laboratory using data obtained from the GIS Department of the Cape Cod Commission http://ww.capecodcommission.org, through their Priority Land Acquisition and Assessment Project.

Box 43
Summary of Traditional Community Water Supply Programs

Goals: The primary goal of community water supply programs is to meet present and future community water supply needs for industries, homes, agriculture, etc. Some community water supply reservoir projects also have recreational and other values. Additional goals added by some communities (e.g., the New York City Water Supply Program) include flood and erosion protection.

Relevant hydrologic parameters: Information is needed on water quantity (bacteria, viruses, heavy metals, pesticides nutrients, sediment), sediment regimes, average, minimum and maximum flows.

Extent of programs: Most cities and towns have established public water supply programs. The U.S. Environmental Protection Agency (EPA) has adopted a variety of regulations that require communities to protect the quality of surface water and groundwater. EPA has been funding state inventories of public water supply sources including water quality. States have adopted permitting requirements for diversion or pumping of surface water or (in many states) groundwater. Some states and communities have adopted well head and watershed protection regulations.

Responsible agencies: Local public works departments typically construct and maintain water supply systems. Responsible agencies at the federal level include the EPA (protection of water from pollutants); the Department of Housing and Urban Development; the U.S. Army Corps of Engineers; Bureau of Reclamation, and the U.S. Geological Survey. At the state level, responsible agencies include Departments of Natural Resources, water resource agencies, and Departments of Health; at the local level, public works departments, water utilities and water districts play key roles.

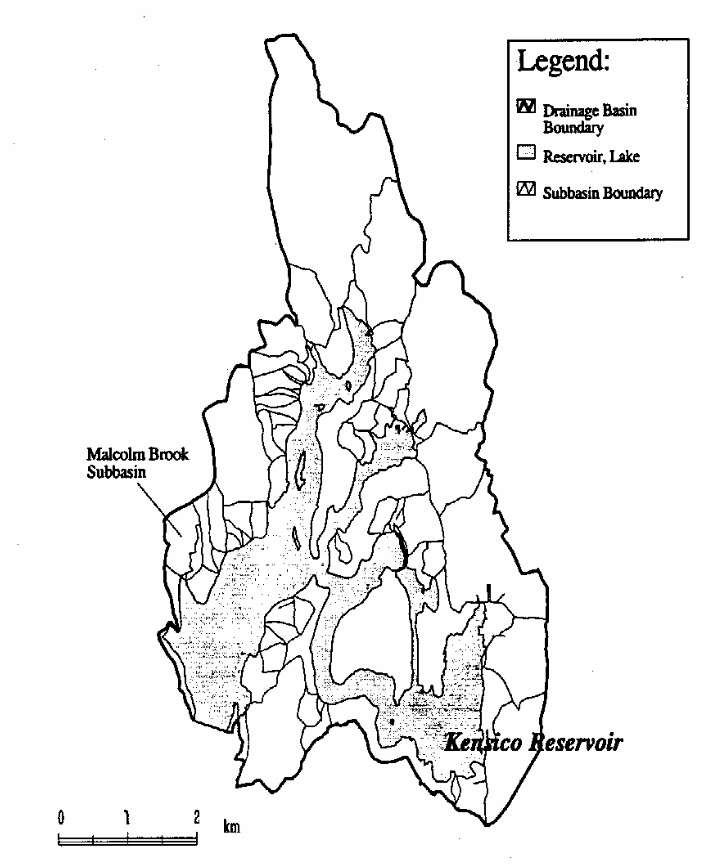
Watershed perspective: Water supply from surface water sources is now typically planned and managed from a watershed or subwatershed perspective. The watershed may be hundreds of acres to hundred or thousands of square miles.

Benefits of wetlands/floodplains ecosystems to water supply: Wetlands can help protect water quality in water supply rivers, lakes, reservoirs in ground water basins by reducing erosion, sediment, nutrients and other pollutants. Some wetlands have been created at the margins of reservoirs to reduce erosion.

Conflicts and problems: Dams and reservoirs have often displaced wetlands and altered the hydrologic and sediment regimes of downstream wetlands. Diversion and groundwater pumping have "dewatered" wetlands or affected wetland water supply. The impact of diversions and groundwater pumping is particularly severe in the West and near urban areas and has led to the adoption of minimum flow requirements in some areas.

Figure 20

Wetlands and Source Water Protection
New York Water Supply



The New York water supply system serves almost eight million residents of New York City and an additional one million people in outlying areas. Water is drawn from a watershed area that encompasses eight counties west and north of New York City, most of the Catskills, and includes 73 towns, villages, hamlets and 250,000 people. Faced with having to treat its water supply at an estimated cost of $9 billion, New York decided to protect the watershed instead. New York has an aggressive planning and land management program, which includes the detailed mapping of wetlands. Acquisition, protection and restoration of wetland areas are included. For several years, the New York Department of Environmental Protection and the City University of New York have been conducting a study to determine the effectiveness of wetlands in removing pollutants from waters in the Malcolm Brook Subbasin of the Kensico Reservoir Watershed.

Source: Energy Conservation through Watershed Management for the New York City Drinking Water Supply, Final Draft Report (1996).

POINT SOURCE POLLUTION CONTROL

Overall Approaches

In 1972 Congress adopted the Water Pollution Amendments, which established a national water pollution control program. These amendments emphasized control of point sources of pollution.

This program resulted in widespread construction of community and industrial pollution treatment facilities during the first twenty years of the program. From 1972-1988 alone, communities and industries spent more than $85 billion to control point sources of pollution. More recently, emphasis has partially shifted from point source to nonpoint source pollution control.

The principal approach for mitigating point sources of pollution and controlling new sources has been the construction of sewage treatment works. Federal construction grants have been broadly available to communities.

Pollution control works typically involve a collection system, primary treatment to remove sediment, biological matter, litter, and other major materials, and secondary and in some instances tertiary treatment to remove a portion of the nutrients and other residual materials.

Increasingly, communities and industries have used various types of tertiary treatment measures to reduce phosphorous and nitrogen. Many communities have created wetlands or used natural wetlands for such tertiary treatment. However, the use of natural wetlands for treatment has been controversial due to the impacts of nutrients, heavy metals and other substances on wetlands and wildlife.

Most states have adopted point source pollution regulations consistent with EPA guidelines, thereby establishing standards for waters throughout a state. A number of states, such as Wisconsin, have adopted water quality standards for wetlands as part of broader processes. Other states, such as Ohio and New York, have similar efforts underway.

Options

How can communities reduce point source pollution while better protecting and restoring wetland and related ecosystems?

1. Construct artificial wetlands for secondary and tertiary treatment of wastes. Many communities have constructed artificial wetlands for the tertiary treatment of wastes. In 1995 Phoenix, Arizona constructed a twelve-acre demonstration wetland to treat wastewater. This wetland is being monitored with the goal of expanding treatment in 2003.

2. Restore wetlands, riparian areas and floodplains located in lakes, streams and estuaries to help intercept pollution before it enters water bodies. For example, wetlands have been restored along streams feeding Lake Mendota in Madison, Wisconsin to reduce sediment and nutrient pollution. Wetlands have also been restored to intercept runoff from feedlet operations.

3. Use alternative treatment techniques for wastes. For example, communities can use land treatment and other methods of disposing of wastes to avoid or reduce discharges into waters.

Box 44
Summary of Community Traditional Point Source Pollution Control Programs

Goals: The principal goal of local, state and federal regulatory and point source pollution control programs is to "restore and maintain the chemical, physical, and biological" integrity of waters."

Relevant hydrologic parameters: Information is needed about water quantity, depth, temperature, and quality, average and minimum flows, wildlife and other uses.

Extent of programs: Most cities and metropolitan governments have constructed sewage treatment works. Virtually all states have adopted pollution control regulations following the 1972 Water Pollution Control Amendments. Point sources of pollution have been identified. Regulations utilize a combination of receiving water standards and effluent standards.

Responsible agencies: Local public works departments usually construct and operate sewage treatment facilities. The EPA is the governing agency at the federal level; state natural resource and pollution control agencies are responsible at the state level.

Watershed perspective: Most states have prepared water quality standards for receiving waters on a watershed and stream reach basis.

Benefits of wetland and floodplain ecosystems: Some communities have created wetlands specifically designed for tertiary treatment of pollutants. Wetlands in lakes, rivers and streams can help remove pollutants from water bodies.

Conflicts and problems: Industrial, commercial, domestic and other wastes have sometimes been discharged into wetlands or water flowing into wetlands with resulting degradation of wetland water quality, plants and organisms. Some sewage treatment facilities and sewage systems have been constructed in wetlands.

NONPOINT POLLUTION CONTROL

Overall Approaches

For many waters, nonpoint sources of pollution from agricultural and urban runoff are the most serious source of nitrogen, phosphorous, heavy metals, sediments and other types of pollution. Quite often in rural areas nonpoint sources of pollution are more detrimental than point sources.

Increasingly, communities, states, and the federal government have broadened pollution control programs to address pollution from a broad range of these nonpoint sources. Some communities have used structural measures, such as concrete channels to reduce river bank erosion, rip rapping of stream banks and combined sewers to deal with stormwaters, to reduce nonpoint pollution. However, nonstructural approaches are increasingly common because of their low cost and because they provide more protection for wetland and related ecosystems.

Options

Communities can reduce nonpoint source water quality problems while protecting and restoring wetlands and related ecosystems in the following ways:

1. Protect wetland/floodplain and riparian ecosystems that act as filters and buffers for lakes, streams, creeks, estuaries and the oceans. Communities can protect wetland/floodplain and related ecosystems through a variety of measures. Examples include:

- Adopt stormwater regulations
- Adopt regulations for fills, grading, other earth moving
- Adopt sanitary codes, septic tank regulations
- Adopt tree-cutting and other vegetation removal regulations
- Adopt conservation zoning for steep slope and erodible soil areas
- Adopt conservation zoning or other regulations for wetlands and floodplains
- Adopt setbacks and buffer strip requirements for rivers, lakes, streams, other waters
- Adopt pesticide usage regulations
- Create greenways
- Use bioengineering for stream bank erosion

2. Limit the density of watershed development and control the amount of impermeable surfaces. This can be achieved through large lot zoning and limitations on percentage of impervious surfaces allowed on lots. Open space nets and greenways can also limit density.

3. Restore natural wetlands, floodplains, streams and related ecosystems. This can be accomplished separately or in conjunction with greenway efforts, establishment of stream buffers, wetland restoration through Wetlands Reserve, as well as many other ways.

4. Construct artificial wetlands to intercept pollutants from agricultural activities and other sources.

5. Utilize and encourage the use of soil and water conservation practices (e.g., no till).

Figure 21
MESA COUNTY FLOODING

Source: Floodplain Management. http://www.co.mesa.co.us/pwadmin/Flood%20Plain/fldplweb.htm

Box 45
Summary of Traditional Community Nonpoint Source Pollution Control/Prevention Programs

Goals: The principal goal of community nonpoint pollution control programs is to reduce sediment, nutrients, toxic chemicals and other types of pollution. The more specific goals for nonpoint pollution control efforts are to identify sources of nonpoint pollution and reduce these sources through best management practices, regulations, restoration of wooded buffers and wetlands, erosion control measures and other techniques. Many nonpoint pollution control programs in recent years have included broader objectives, such as protection of flood storage and reduction in erosion.

Some principal information needs: Information is needed about sources of pollution, the quantity and quality of waters, average and minimum flows, wildlife and other use of waters.

Extent of programs: Many local governments have adopted pollution control programs, such as stream buffer requirements, sediment controls, and restrictions on tree-cutting, that address some aspects of nonpoint pollution. Such programs are extensive and highly varied in content.

Responsible agencies: Control of nonpoint sources of pollution has primarily been the responsibility of local planning and zoning departments. Responsible federal agencies include the EPA (primary), U.S. Army Corps of Engineers and Natural Resources Conservation Service. State water and pollution control agencies are responsible at the state level.

Watershed perspective: States and communities have many watershed-based studies underway to identify and control nonpoint sources of pollution.

Benefits of wetlands/floodplains: The role of wetlands and vegetated floodplain buffers and riparian areas in reducing sediment, nutrients and other pollutants reaching adjacent waters is increasingly recognized. Many efforts have been undertaken to protect and restore wetlands to reduce nonpoint source pollution.

Conflicts and problems: Nonpoint pollutants may destroy or degrade wetlands and floodplain habitats if discharged directly into them.

CHAPTER 7: LOOKING TO THE FUTURE

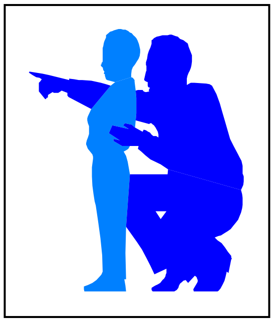
"While geographic-based planning relies on strong local leadership and is enhanced with state or tribal backing, federal agencies will contribute by strengthening existing assistance programs and developing new ways to provide support." *— Clean Water Action Plan: Restoring and Protecting America's Waters (1994)*

"The land belongs to the people. A little bit to the living; some to the dead, but most to those yet unborn." *— Just v. Marinette County*

"Without an active and ambitious restoration problem in the United States, our swelling population and its increasing stresses on aquatic ecosystems will certainly reduce the quality of life for present and future generations. By embarking now on a major national aquatic system restoration program, the United States can set an example of aquatic resource stewardship that ultimately will set an international example of environmental leadership." *— Restoration of Aquatic Ecosytems, National Research Council, National Academy of Sciences*

"The Green Infrastructure land network is a proposed concept to protect and link Maryland's remaining ecologically valuable lands. These lands would include, for example, large contiguous tracks of forest lands, important wildlife habitats, wetlands, riparian corridors and areas that reflect key elements of Maryland's biological diversity. The proposed network would be linked by a system that connects large contiguous blocks of natural resource lands (hubs) through corridors that encompass the most ecologically valuable areas between these hubs (e.g. areas of high aquatic integrity, wetlands, wildlife migration routes and important forest lands). This concept is not a plan or a mandate to protect these valuable lands but rather it envisions the cooperative efforts of many people and organizations including government agencies, land trusts and interested private landowners."

— The Green Infrastructure Land Network, Maryland Department of Natural Resources, June 10, 1999



CHAPTER 7: LOOKING TO THE FUTURE

THE WAY FORWARD

Looking to the future, there are compelling scientific reasons for communities to better coordinate or integrate water and land resources management with wetland-related ecosystem protection. Both types of programs depend on the same scarce community water resources. Both need sound hydrologic and ecological information. Both require landscape level surveys and analyses.

There are also strong political and budgetary reasons. Multi-objective, coordinated approaches are the only way to reconcile conflicting goals and programs, and to satisfy diverse constituencies. These approaches can cost effectively achieve diverse goals. And, as federal and state aid grants are reduced, communities will need to do more with less.

However, coordination or integration has been difficult in the past and undoubtedly will be so in the future due to fragmentation of programs, turf battles, conflicting philosophies, and lack of accurate and detailed resource inventories. There are technical issues as well.

Better-coordinated, integrated approaches will require creativity and new ways of thinking.

RETHINKING THE "PROJECT" CONCEPT

Engineers have traditionally approached water resources management in terms of "projects." Engineering projects have traditionally involved the use of structures and manipulation of natural systems.

The concept of water resources engineering needs to be broadened to include both structural and nonstructural approaches — whatever is most appropriate in the circumstance. Restoration of streams and wetlands, the use of bioengineering and "soft" engineering, relocation and other nontraditional approaches need to be part of the "project" concept.

Community water engineers need to ask themselves: "How can I best achieve multiple objectives, given a broad range of water and ecosystem management techniques, rather than how can I best apply specific techniques (e.g. levees)?" The full range of alternatives, not simply those involving structures must be considered. Cost/benefit criteria and funding for water projects must provide an even playing field for various implementation approaches.

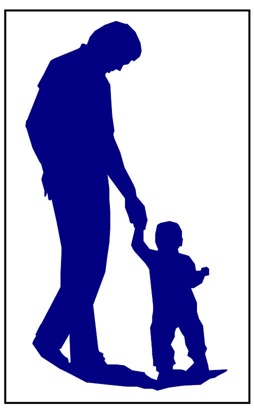


Figure 22
Dungeness River Greenways

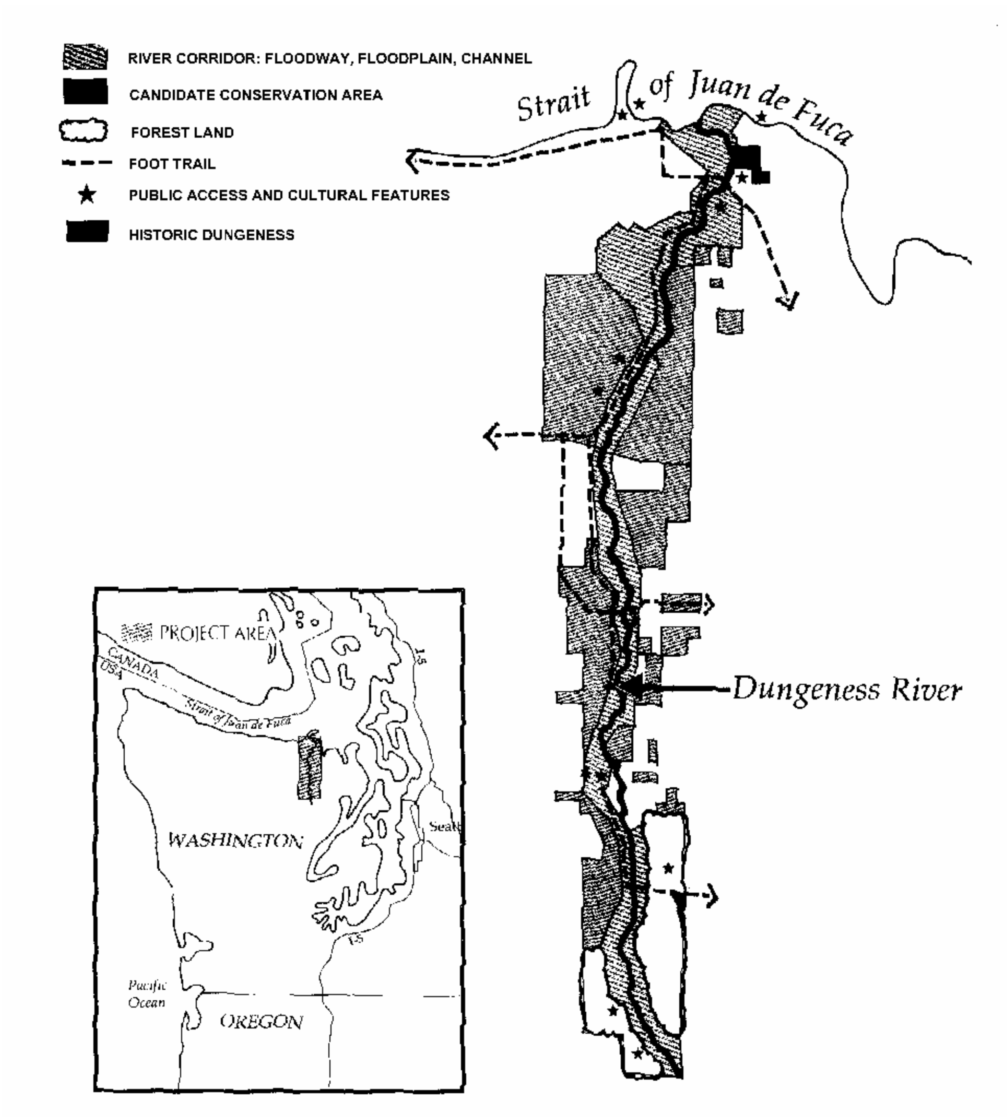
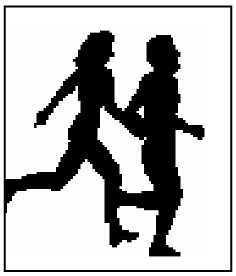


Illustration of a greenway approach. From: Floods, Floodplains and Folks, National Park Service Rivers, Trails and Conservation Assistance Program.

GREEN INFRASTRUCTURE

Networks of greenways and buffers along waterways can accomplish many water resource management and wetland protection objectives. For example, Maryland has adopted a "Green Infrastructure Land Network Program" to link all types of ecologically valuable land.

Greenways and buffers do not solve all ecosystem management problems, nor do they make sense in all instances. But, because they simultaneously serve many purposes, they are rationally and economically justified in a broad range of contexts.



IMPROVED DATA BASES AND ANALYTICAL CAPABILITES

Future programs need to be based on improved water resources and wetland ecosystem databases, maps and modeling capabilities. Increasing amounts of geo-referenced information on the Internet will facilitate such efforts as flood and wetland maps, rare and endangered species maps, and other types of maps.

To improve assessment of wetlands ecosystems, communities may establish "reference" wetlands, riparian areas, floodplains and water bodies. These can also aid restoration and enhancement efforts by providing models and seed stocks. To assist restoration efforts, communities may also identify potential wetland ecosystem and river and stream restoration sites.

RESTORATION

Wetland, riparian and floodplain restoration can play an increasing role in ecosystem functioning. Restoration can solve existing water resource and ecological problems, such as stream bank erosion and water pollution. It can provide flexibility for new development while meeting overall ecosystem goals. However, the use of restoration, creation and enhancement to justify further destruction of aquatic ecosystems must be approached with care as many projects fail to meet anticipated goals due to inadequate design, changed hydrology, inadequate implementation or lack of long term monitoring.

For a social equity perspective, care is needed where landowners and developers propose to destroy or damage existing wetlands ecosystems with the promise of restoring wetlands or replacing them through mitigation banks in other areas. For example, destruction of a wetland in an urban area with compensation through a rural mitigation bank will result in increased pollution and flooding and decreased fishing, recreation and bird watching for urban dwellers. Rural dwellers may benefit, but this does not help the large number of people who live in the cities. Shifts in costs and benefits have important public policy implications and are not simply a technical issue. They need public debate.

INCREASED ROLE FOR NONPROFITS

Looking to the future, not for profits will likely play an increasingly role in forming and implementing wetland management plans. Already local and national land trusts and other nonprofit organizations are facilitating many wetland and stream preservation and restoration. These include organizations like the Nature Conservancy, Audubon Society, National Wildlife Federation, Isaac Walton League, American Rivers and River Network.

At the local level, many of the more than 1,400 local land trusts are already protecting and restoring wetlands and streams. These groups are uniquely positioned to bring together stakeholders throughout a community. They have great flexibility in developing plans and policies, funding projects and ultimately managing lands such as wetlands.

For example, in 1997 the Nature Conservancy in Florida worked with other organizations to acquire 49,976 acres, 11,000 of which are along the Kissimmee River, to create the Latt Maxcy/Kissimee Prairie State Preserve.

Similarly, the Nature Conservancy in New York put together a watershed conservation strategy for Great Swamp. Great Swamp is a 6,768-acre wetland in a 62,343-acre watershed. It traverses five municipalities in two counties. The Conservancy is acquiring much of the land and has an aggressive planning and education effort underway for the watershed.

Many local nonprofits have spearheaded local wetlands and watershed planning efforts as well.

REGIONAL PLANNING ENTITIES

Regional planning agencies like the Lane County Regional Planning Agency have the potential for playing stronger roles in community wetlands and watershed management. They have the broad geographical perspective needed for conducting watershed inventories and bringing together local decision-makers. With local government support, regional planning agencies may be in a position to hire the experts needed for multi-objective inventories and planning. They may also be able to implement multi-objective geographical information systems.

STATE AND FEDERAL ASSISTANCE

State and federal assistance will continue to be essential to community wetlands and watershed efforts. State programs specifically developed to help local wetland and watershed programs include the wetlands and watershed restoration initiatives of Oregon and Massachusetts. Communities need continued state and federal technical and financial assistance to gather and analyze resource information, design projects, regulate wetlands and waters, and fund implementation.

However, some technical and financial assistance programs continue to encourage single objectives (e.g. stormwater, flood loss reduction). These programs would be more beneficial if they were revised to support multi-objective goals.

As community wetlands and watershed programs become more technical, federal assistance will be critical to providing data, technical support and funding. Federal agencies can better support community efforts by emphasizing multi-objective management in individual programs. Congressional help is also needed to provide direction to agencies and continued funding. Enhanced federal technical assistance is also needed. Congressional help could include programmatic guidance and funding included in Clean Water Act reauthorization, the Omnibus Water Bills, the Agricultural Bills and other statutes.

CONCLUSION

Engineers, biologists, botanists, planners, landowners, developers, environmental advocates and teachers, among others, are jointly responsible for the future of their communities. They must manage limited land and water resources to meet the needs of future generations. See Smart Growth Online www.smartgrowth.org/Default.asp?res=1024. This requires multi-objective approaches and creativity. It requires collective visions for the future and collaborative actions.

Box 46
Summary of Community Benefits

Wetlands and watershed planning and management can provide a wide range of community benefits:

- **Improved implementation of water resources and watershed programs, including flood loss reduction, stormwater management, pollution control and source water management**
- **Improved implementation of wetlands and ecosystem protection and restoration efforts, resulting in better fishing, swimming, bird-watching, canoeing, hiking and outdoor education**
- **Improved community ability to allocate lands for most appropriate uses**
- **Improved protection and restoration of community cultural and natural heritage values**
- **Improved sense of community through decreased conflicts and expanded citizen participation**

APPENDICES

APPENDIX A: SOURCES OF FINANCIAL AND TECHNICAL ASSISTANCE

SEEKING WETLAND EXPERTISE AND TECHNICAL ASSISTANCE

As a preliminary step in seeking wetland expertise, we suggest that you identify your needs as specifically as possible. This may not be so easy at an early stage. Most wetland experts are quite specialized. Experts in wetland vegetation often have little training in hydrology; conversely, wetland hydrologists often have limited expertise in vegetation.

For free assistance, concentrate your efforts on federal and state agencies, nonprofits and (possibly) academics. Often, they can help analyze the problem and steer you to others if they cannot provide all the help you need. Federal and state agency staffs are often excellent sources of assistance, but often their expertise is limited to a particular subject or program (e.g., Section 404 permitting).

PRINCIPAL SOURCES OF WETLAND EXPERTISE AND TECHNICAL ASSISTANCE

Wetland experts are located in federal, state, and local government agencies, nonprofits, consulting firms and academic institutions. Despite the relatively large number of wetland experts across the nation, many are not easy to locate because they are part of large agencies or organizations and are not specifically identified by title as a wetland specialist.

Below is a brief, general description of the main sources of available wetland expertise and technical assistance.

FEDERAL AGENCIES

U.S. Fish and Wildlife Service (USFWS) maintains a large number of programs that provide wetland or wetland-related data and expert assistance.

- **Maps.** National Wetland Inventory (NWI) maps and help interpreting and using maps can be obtained by contacting the NWI coordinators.
- **Endangered Species Sites.** Information concerning endangered species can be obtained from endangered species coordinators in the USFWS regional offices.
- **Restoring Private Wetlands.** Technical, and to a lesser extent, financial help restoring private wetlands can be obtained from the USFWS regional private lands coordinators.
- **Wetland Educational Materials.** Wetland educational materials can be obtained from the USFWS education division and from the regional wetland offices. They can also be obtained from many local National Wildlife Refuge offices.
- **Wetland Interpretation and Management.** National Wildlife Refuge office staff is often very knowledgeable in wetland interpretation and management, and willing to provide guidance to nonprofits, governmental units, landowners and others.

U.S. Environmental Protection Agency (EPA) also provides a variety of wetland or wetland-related expertise and technical assistance programs.

- **Hotline.** The wetlands hotline number is 1-800-832-7828.
- **The EPA Wetlands Division,** Washington, D.C., and regional wetland coordinators provide guidance on Section 404 permitting, water quality standards for wetlands, advanced planning of wetland, State 401 water quality certification for wetlands, wetlands and stormwater, state wetland conservation planning, state assumption of Section 404 permitting, wetland education and other matters.
- **Wetland Publications.** EPA Wetlands Division, Washington, D.C., and regional wetland offices have published a many wetland pamphlets, which are available free of charge. For more information, please call the EPA Wetlands Hotline 1-800-832-7828.
- **State Grants.** EPA Wetlands Division, Washington, D.C., and regional offices provide grants to states for wetland conservation planning and wetland program development. EPA Division of Waters, Washington, D.C., and regional offices provide watershed planning grants (Section 319) to states and local governments.

U.S. Army Corps of Engineers (Corps) provides wetland expertise and technical assistance through a number of programs.

- **Wetland Delineation and Technical Assistance With Section 404 Permitting.** The District and Division offices of the Corps, Regulatory Branch, has a large staff dedicated to regulatory permitting.
- **Mitigation Banks and Research.** The Corps Water Resources Research Center, in Fort Belvoir, Virginia can provide information about mitigation banks. The Corps Waters Experiment Station in Vicksburg, Mississippi provides research information about wetland research, assessment and restoration, among other subjects.
- **Water Resources Planning and Wetland Restoration.** The Corps Water Resources staff provides technical and planning assistance to states, local governments and others.

USDA Natural Resources Conservation Service provides a variety of wetland expert and technical assistance.

- **Financial Assistance to Protect and Restore Wetlands**. State conservationists can provide technical and financial assistance to landowners pursuant to the Conservation Reserve Program and Wetland Reserve Programs.
- **Delineation of Wetlands.** Staff of regional offices can sometimes help landowners identify wetlands.
- **Restoration of Wetlands.** Staff of regional offices can provide technical assistance to landowners who are restoring wetlands.

National Marine Fisheries Service. Staff of the regional offices of the National Marine Fisheries Service provide technical assistance for marine resources protection and restoration, including protection and restoration of coastal and estuarine wetlands.

STATE AGENCIES

The types of state agencies with wetland expertise differ significantly from state to state. However, here are several general suggestions:

State Wildlife Agency (or division within an agency). In many states, the wildlife agency is part of a department of natural resources or department of conservation. Waterfowl, fisheries, endangered species, and other experts are typically found here.

State agencies or divisions dealing with water-related lands — e.g., water resources management, coastal zone management, shoreline or shoreland management, floodplain management, rivers management and pollution control. In most states, these are divisions of Departments of Natural Resources or Departments of Environmental Conservation.

State Department of Parks, Recreation and/or Public Lands and Waters. State agencies managing lands, including submerged lands, are another source of technical assistance.

State Departments of Agriculture, Forestry. These state agencies may provide assistance to landowners who seek to better manage their lands, including soil and water conservation, pollution control and sustainable use.

LOCAL GOVERNMENTS

The capability of local governments to provide wetland expertise and technical assistance varies greatly from large, well-trained staffs of metropolitan governments to no paid natural resource staff and voluntary conservation commissions in smaller, less-populated rural areas.

Some common sources of assistance include:

- The **local zoning administrator** can usually provide information about local, state and (in some instances) federal permits required for a proposed activity, including zoning, building code, subdivision approval and other regulatory permits. The administrator can also provide copies of local regulations, zoning maps and permit application forms. In some instances, the administrator may have a list of local consultants or may be able to suggest local experts.
- The **local government planning board or planning commission** can provide more detailed information on subdivision approval, rezoning proposals and infrastructure, among other matters.
- A **local conservation commission** or its individual members may assist landowners in identifying mitigation and restoration opportunities, and designing projects to reduce impacts.
- **Local surveyors, consulting firms and landscape architects** can often provide expert help in delineating wetlands, permitting, and restoration. Please consult your Yellow Pages.

EDUCATORS: UNIVERSITY AND COLLEGE STAFF; SCHOOL TEACHERS

Many university and college educators, as well as those in primary and secondary schools, have developed an interest in wetlands and may be able to provide expertise and technical assistance, including wetland delineation, assessment and impact reduction techniques. Educators may also be willing to make creative use of interpretative facilities, impact assessment, or restoration projects.

Academic staff with wetland expertise can most likely be found in:

- **Wetland Centers.** A number of universities, such as the University of Florida at Gainesville and the University of Louisiana at Baton Rouge, have established wetland centers with multi-disciplinary experts in a range of wetland topics (soils, hydrology, botany, bioengineering, ecosystem management, etc.)
- **Water Resources Centers and Multi-Disciplinary Natural Resource or Environmental Study Centers** often hire experts in lakes, streams, estuaries, coastal waters and multi-disciplinary experts in ecosystem management.
- **Botany Departments** may have experts in wetland plants, delineation, restoration and bioengineering.
- **Biology Departments** may have experts in particular wetland animal species, ecosystem management and wetland restoration.
- **Soils Departments** may have experts in wetland soils, hydrology and the use and modification of such soils.
- **Geology and Geography Departments** may have experts in wetland geology and hydrology.
- **Engineering Departments** may have experts in hydrology, soils engineering, structural design and mitigation measures.

Academics are often willing to provide some free technical assistance to governmental units, nonprofit organizations and landowners interested in protecting and restoring wetlands. Many academics also provide paid consultations.

APPENDIX B: USEFUL INTERNET ADDRESSES

The following list of Web sites has been compiled from many sources and appears in alphabetical order.

Association of State Wetland Managers
www.aswm.org

Ducks Unlimited Canada
www.vm.ducks.ca

Ducks Unlimited Canada - Nature Notes
www.vm.ducks.ca/naturenotes

EcoScope
www.wetlands.ca/EcoScope/ecopage.html

Educating Young People About Water
www.uwex.edu/erc/eypaw/

Environmental Law Institute On-line
www.eli.org

Federal Emergency Management Agency (FEMA) **www.fema.gov**

GOSWAMPY - Wetlands Information
www.swampy.org

The Great Lakes Program at the University of Buffalo
www.wings.buffalo.edu/glp/

National Oceanic Atmospheric Administration (NOAA)
www.noaa.gov

NOAA - National Marine Fisheries Service
www.nmfs.noaa.gov/

National Park Service
www.nps.gov

National Wildlife Federation - Wetlands Table of Contents
www.nwf.org/wetlands/

Native American Fish and Wildlife Society
www.nafws.org

The Nature Conservancy
www.nature.org

Society of Wetland Scientists
www.sws.org

U.S. Army Corps of Engineers
www.usace.army.mil

U.S. Army Corps of Engineers – Points of Contact
www.usace.army.mil/inet/information

U.S. Army Corps of Engineers Hydraulics Laboratory
www.chl.wes.army.mil

U.S. Army Corps of Engineers Wetlands Research and Technology Center
www.wes.army.mil/el/wrtc/wrtc.html

U.S. Army Corps of Engineers, Sacramento District Regulatory
www.spk.usace.army.mil

U.S. Bureau of Reclamation - Upper Colorado Region
www.uc.usbr.gov/uc/

U.S. Congress on the Internet - Legislative Information
www.thomas.loc.gov

USDA Forest Service
www.fs.fed.us

USDA Natural Resources Conservation Service
www.nrcs.usda.gov

USDA Natural Resources Conservation Service Wetland Science Institute
www.pwrc.usgs.gov/wli/

U.S. Environmental Protection Agency (USEPA)
www.epa.gov

USEPA Wetlands Information Hotline
www.epa.gov/owow/wetlands/wetline.html

USEPA Federal Register-Water
www.epa.gov/fedrgstr/EPA-WATER/index.html

USEPA Regulation Summaries
www.epa.gov/OW/regs/

USEPA Office of Water Publications
yosemite.epa.gov/water/owrccatalog.nsf/

USEPA Wetlands Division Office of Wetlands, Oceans and Watersheds
www.epa.gov/OWOW/wetlands/index.html

USEPA Surf Your Watershed
www.epa.gov/surf/

USEPA Mid-Atlantic Region (Region 3)
www.epa.gov/region03/

USEPA Southeast Region (Region 4)
www.epa.gov/region4/

USEPA Great Lakes Region (Region 5)
www.epa.gov/region5/

USEPA Pacific Southwest (Region 9)
www.epa.gov/region9/

USEPA Wetlands, Oceans and Watersheds On-line: Browse EPA newsletters, fact sheets, brochures, publications, regulations, press releases and Congressional testimony; order EPA publications on-line; request STORET water quality data; join in a nonpoint source discussion group; visit Know Your Watershed and Surf Your Watershed; and more.
www.epa.gov/OWOW/

USEPA Office of Wetlands, Oceans and Watersheds Publications-Part 1.
yosemite.epa.gov/water/owrccatalog.nsf/

Federal Emergency Management Agency Flood Maps
www.esri.com/hazards

U.S. Fish and Wildlife Service (USFWS)
www.fws.gov

USFWS - National Wetlands Inventory (NWI) **wetlands.fws.gov**

U.S. Geological Survey (USGS)
www.usgs.gov

USGS Coastal and Marine Geology Program
marine.usgs.gov

USGS – U.S. Water Resources
water.usgs.gov

USGS List of Publications
www.usgs.gov/pubprod/

USGS National Wetlands Research Center
www.nwrc.gov

U.S. House of Representatives Internet Law Library
www.lawguru.com/ilawlib/1.htm

U.S. House of Representatives Internet Law Library - Environmental, Natural Resource, and Energy Law
www.lawguru.com/ilawlib/101.htm

U.S. House of Representatives Internet Law Library - Law School Law Library
www.lawguru.com/ilawlib/114.htm

U.S. House of Representatives Internet Law Library - Code of Federal Regulations (searchable)
www.lawguru.com/ilawlib/4.htm

U.S. House of Representatives Internet Law Library - Federal Register
www.lawguru.com/ilawlib/7.htm

U.S. House of Representatives - 108th Congress, 1st Session
www.house.gov

University of Maryland Center for Environmental Science
www.umces.edu

WetNet-Texas Wetland Information Network
www.glo.state.tx.us/wetnet

Model Ordinances to Protect Local Resources
www.epa.gov/owow/nps/ordinance/

Smart Growth Online
www.smartgrowth.org/Default.asp?res=1024

WETNET: The Wetlands Network
www.wetlands.ca

APPENDIX C: FEDERAL, STATE AND LOCAL WETLAND REGULATIONS

Regulations are a principal means by which wetlands and watershed management plans and policies are implemented. The following federal, state and local permits are usually required for altering wetlands.

FEDERAL SECTION 404 PERMITS

The Section 404 permit program, adopted by Congress in 1972, is implemented jointly by the U.S. Army Corps of Engineers (Corps) and the U.S. Environmental Protection Agency (EPA); it is the only nationwide wetland regulatory program. The Corps issues individual permits for activities in wetlands, with some oversight by the EPA, which can veto permits. The U.S. Fish and Wildlife Service, National Marine Fisheries Service and the USDA Natural Resources Conservation Services play lesser roles in permitting and, in the case of NRCS, carrying out wetland delineations on agricultural lands. Most states also comment on proposed Corps permits through the 401 Water Quality Certification process.

The 404 program is implemented through federal regulations, adopted in part by the Corps and in part by the EPA. Program policies are also contained in "nationwide permits" issued by the Corps; in Regulatory Guidance Letters issued by the Corps; and in various Memoranda of Understanding between the Corps and other agencies. Some of the Corps' permitting powers have been delegated to states pursuant to state program assumption (2 states) or state programmatic general permits (13 states). The EPA supervises state-assumed programs; the Corps supervises state programmatic permits.

By involving the U.S. Army Corps of Engineers (Corps) in the preparation of local wetlands and watershed management plans, local governments can help the implement the Section 404 program, and the Corps can help local governments protect wetlands. Local governments can ask the Corps to submit to them 404 permit application from their area; conversely, they can send the Corps notices regarding wetland applications filed with the local government. While local governments can adopt their own wetland regulations, they can also monitor activities in wetlands and notify the Corps when violations in Section 404 permitting occur.

Permits Required

Individual Permits: An individual or organization that proposes to alter or drain "waters of the U.S.," including a coastal or estuarine wetland; a wetland adjacent to a major river, stream or lake; and some smaller, wetlands connected to navigable waters requires a Section 404 permit from the Corps. The scope of individual permit requirements for smaller, wetlands, depends on the state and whether a state has approved various Corps nationwide permits.

For issuance of an individual permit, the Corps must conclude that the permit is in the public interest and in compliance with the policies set forth in the regulations. In general, a permit applicant must also:

- establish that there are no alternatives sites for the proposed activity
- apply impact reduction techniques
- apply mitigation measures to achieve no net loss of functions and values

General Permits: The Corps has issued general permits for 42 classes of activities to streamline the permitting process and reduce the need for individual permits. These permits are presently being revised. In general, individuals or organizations proposing to alter or drain wetlands for activities covered by such permits need to reduce and mitigate impacts, but do not need to apply to the Corps for an individual permit. In some instances if impacts will be substantial, the Corps must be notified of the proposed activity and may require an individual permit.

STATE PERMITS

Local governments can help state agencies implement wetland programs by adopting local wetland regulations. They can involve state agencies in the preparation of local wetlands and watershed management plans, and can request that copies of all wetland permit applications pertaining to their geographical area be sent to the state. They can provide comments on permit applications, participate in public hearings, monitor wetland activities and report violations.

Permits Required

Wetland. Virtually all states now require permits for major alteration of coastal wetlands, although the scope of permitting varies from state to state. Almost half of the states also require permits for alteration of freshwater wetlands. More than one permit may be required, depending upon the type of area and type of activity. In about half of the states, the permit is required from a state agency; in the remainder a permit is required from a local government.

Floodplain. More than one half of the states require a state or local permit for alteration of floodplains.

Public land waters. Most states require state permits for the alteration of public lands lying under public waters.

Coastal zone, other. Most states require state permits for major activities in their coastal zones.

LOCAL PERMITS

Local governments may implement wetland and watershed management plans through a variety of local planning and regulatory efforts.

Permits Required

Wetland alteration permits. Over 5,000 local governments have adopted specific wetland regulations. Most of these have been adopted pursuant to wetland statutes or shoreland zoning, or coastal zone management.

Local zoning and building permits. Most local governments require them. Typically, such permits must be obtained from a city in urban areas, and from a county or rural office in rural areas. Often, wetlands are indicated as conservation areas on zoning maps. Wetland designations are typically based on state wetland maps, aerial photos, National Wetland Inventory maps, USGS topographic maps, or NRCS soil maps. In some instances, local governments have independently mapped wetlands based on aerial photos and field surveys.

Subdivision regulations. For division of land into smaller parcels, subdivision regulations require permission from the local planning board. Most regulations require sewer, water, roads and open space. Many local government subdivision regulations prohibit division of flood hazard areas.

Floodplain permits. Over 18,300 local governments have adopted floodplain regulations. These regulations usually include a map showing the boundaries of the 100-year floodplain. In approximately half the communities, more restrictive floodway areas are also shown. Many coastal floodplain maps also designate high hazard areas. In general, regulations prohibit fills and other development in floodways that will increase flood heights. Structures and other uses may be permitted in outer flood fringe areas if they are elevated or otherwise protected to the 100-year flood elevation.

Virtually all coastal wetlands and most wetlands along major rivers and lakes lie within 100-year floodplain areas.

Septic tank/soil absorption field permits. Virtually all states or local governments require a sanitary or septic tank permit for houses or commercial development without sewers. Typically, regulations require that a percolation test be carried out prior to permit issuance. The percolation test involves digging a small hole and testing the absorption rate of the soil for water placed in the hole. Septic tanks/soil absorption systems are not usually permitted in areas with limited absorption capability, including most wetlands with high ground water and organic soil areas.

APPENDIX D: SUMMARIES OF KEY FEDERAL PROGRAMS

A variety of federal programs may provide assistance to local governments.

REGULATORY PROGRAMS

Principal federal regulatory programs that can help local governments implement wetlands and watershed management include:

Section 10 Permit Requirements. River and Harbor Act of 1899, Section 10 (33 USC 403). Permits are required from the U.S. Army Corps of Engineers (Corps) for activities in traditionally navigable waters.

Section 404 Permit Requirements. Clean Water Act (33 USC 1344). Permits are required from the Corps for discharges into traditionally navigable waters and many other waters and wetlands. References for such programs include:

1. The Corps Permit Program Regulations (33 CFR 320 et. seq.), which establish the procedures and criteria for individual Section 404 permits in wetlands and other waters.

2. The U.S. Environmental Protection Agency (EPA) Section 404(b)(l) Guidelines (40 CFR 230), which establish guidelines for discharges into wetlands and waters. Section 404 permits must comply with these regulations, as well as the Corps regulations. Section 230.80 of the guidelines provides an advanced planning procedure that allows the Corps and the EPA to identify, in advance of any permit application, wetlands that are unsuitable for discharges (EPA Section 404(c) Veto Procedures) (40 CFR 231 et. seq.). The EPA may veto Corps Section 404 permits prior to issuance under certain conditions.

3. EPA Section 404 Program Regulations Including Exempt Activities and Definitions. (40 CFR 231 et. seq.)

State Water Quality Certification Requirements. Clean Water Act, Section 401. (33 USC 1341) State water quality certifications are required for federal Section 404 and Section 10 permits. Federal permits may not be issued without state approval.

Section 404 State Program Assumption (40 CFR 233 et. seq.) allows states to assume Corps Section 404 permitting responsibilities for some waters and wetlands, but not traditionally navigable waters and adjacent wetlands.

Other Federal Regulatory and Planning Programs

- **Coastal Zone Management Act** (16 USC 1454 and 1464) provides funding to coastal states for the preparation of comprehensive coastal zone management plans consistent with federal regulations. The federal government does not directly regulate activities in the coastal zone. Federal guidelines require that states demonstrate they have enforceable standards for the protection of specified coastal resources, including tidal and coastal wetlands. States may also veto federal Section 404 and other federal permits through federal consistency requirements. The Coastal Zone Management Act also authorizes the National Estuarine Reserve System.

- **National Flood Insurance Act** (42 USC 4001-4128) allows the Federal Emergency Management Agency (FEMA) to provide federally subsidized flood insurance to communities that adopt regulations in 100-year floodplain areas. These regulations allow flood-protected structures in outer flood fringe, and they control development and fills that may increase flood heights in inner floodways. More than 18,000 communities have adopted floodplain regulations to comply with this act.

- **Endangered Species Act** (16 USC 1531 et. seq.) requires that federal agencies conserve endangered and threatened animal species. It also prohibits any person from killing, harassing or harming a protected species. The federal government is supposed to designate critical habitat for endangered and threatened animal species, and the U.S. Fish and Wildlife Service is expected to prepare recovery plans for them.

- **Wild and Scenic Rivers Act** (16 USC 1278 et. seq.) lists rivers with outstanding recreational, ecological, aesthetic and other values for federal protection. States may also designate additional rivers.

- **Fish and Wildlife Coordination Act** (16 USC 661 et. seq.) requires consultation with the U.S. Fish and Wildlife Service, the National Marine Fisheries Service and the state wildlife agency for federal activities that might affect fish and wildlife populations or habitat. See also U.S. Fish and Wildlife Service Mitigation Policy (51 Fed. Reg. 7656).

- **National Environmental Policy Act** (42 USC 4321-4361) requires that all federal agencies consider environmental issues in decisions, including the preparation of environmental impact statements for major federal actions that may affect the environment.

- **Wetlands Executive Order 11988** (42 Fed. Reg. 26951 (1977)) recognizes the values of wetlands and directs federal agencies to minimize the destruction or degradation of wetlands and to preserve and enhance their natural values. It does not apply to permits.

- **Floodplain Management Executive Order 11988** (42 Fed. Reg. 26951 (1977)) applies primarily to public land management and public actions. It directs federal agencies to protect lives and property from flood losses, and to restore and preserve the natural values of floodplains.

- **Coastal Barrier Resources Act** (16 USC 3501-3510) and its amendments reduce federal development subsidies, including flood insurance for development within the Coastal Barrier System, which includes many wetlands, estuaries and near shore waters on the coasts and Great Lakes.

FEDERAL FUNDING FOR PUBLIC WETLANDS ACQUISITION

Land and Water Conservation Fund (16 USC 460 1-4 to 460 1-11) provides federal matching grants for land acquisition and recreation development to states and communities. States must prepare State Comprehensive Outdoor Recreation Plans with a wetland component to qualify for such grants. The fund receives revenues from offshore oil and gas leasing.

Emergency Wetlands Resources Act of 1986 (Public Law 99645) promotes the conservation of migratory waterfowl, and acquires wetlands with support from the Land and Water Conservation Fund. The act directs the U.S. Fish and Wildlife Service to develop a National Wetlands Priority Conservation Plan and to continue the National Wetland Inventory.

Marine Sanctuaries Act and Estuarine Sanctuary Program (16 USC 1431-1434, 16 USC 1461) provides for the establishment of nationally significant marine and estuarine sanctuaries, and provides funding for research, planning and management of such areas.

Pittman-Robertson and Dingell-Johnson Acts (16 USC 669-669I; 16 USC 777-777K). Under these acts states and territories receive up to 75% funding for comprehensive fish and wildlife resource management plans, as well as restoration and management projects. These programs are funded by excise taxes on fishing and hunting sales.

Coastal Wetlands Planning, Protection and Restoration Act (16 USC 3951-3956) authorizes the U.S. Fish and Wildlife Service to make matching grants to coastal states to acquire, manage, restore and enhance wetlands. The act focuses primarily on Louisiana's wetlands.

North American Wetlands Conservation Act of 1989 (16 USC 4401-4413) makes grants available to states and private organizations for wetland conservation partnership projects that further the goals of the North American Waterfowl Management Plan and international migratory bird treaties. Ordinarily, acquired land becomes part of the National Wildlife Refuge System.

FEDERAL FUNDING FOR PROTECTION AND RESTORATION OF WETLANDS BY PRIVATE PROPERTY OWNERS

Water Bank Act of 1970 (16 USC 1301, et. seq.) provides funding for farmers in participating states in the form of annual rental payments, for up to 10 years, for protecting and restoring inland, agricultural wetlands and adjacent uplands that are important to migratory waterfowl.

Conservation Research, Conservation Easement and Wetlands Reserve Provisions (Food Security Act of 1985, Public Law 99-198, Title XII; Food Agriculture, Credit and Trade Act of 1990, Public Law 101-624) provides cost-sharing and rental payments (10-15 years) to farmers for protection and restoration of farmed wetlands. This program is designed to protect wetlands, highly erodible uplands and filter strips adjacent to wetlands.

Wetland Reserve Program (16 USC 3877a-373871) was authorized by the 1990 Farm Bill, which provides financial incentives to landowners for protection and restoration of up to 1 million acres of wetlands through easements ranging from 30 years to permanent. This program applies to farmed or converted wetlands, adjacent buffers and riparian areas linking wetlands.

Watershed Protection and Flood Protection Act (16 USC 1001-1009) authorizes the Natural Resources Conservation Service to provide financial and technical assistance to local governments carrying out projects for watersheds smaller than 250,000 square miles. The 1990 Farm Bill amended this program to allow 50 percent federal cost-sharing for the acquisition of perpetual easements in wetlands and floodplain areas for flood prevention and conservation purposes.

Farmers Home Administration Wetland-Related Programs (7 USC 1985, 1987) may forgive loans to borrowers who grant conservation easements.

Farm Program: Swampbuster (16 USC 3821-3824) denies federal farm subsidy benefits to agricultural landowners who drain or destroy wetlands, or plant commodity crops on wetlands converted after December 23, 1985. The USDA Natural Resources Conservation Service and the U.S. Fish and Wildlife Service implement this act. Wetlands conversion is allowed only if it will cause minimal effects on hydrologic and biological values. Minimal effect is determined jointly by the NRCS and the FWS, with NRCS having the final say. A producer may drain frequently cropped wetlands if the producer provides mitigation by restoring a converted wetland to provide comparable value.

APPENDIX E: RELEVANCE OF HYDROLOGIC CHARACTERISTICS TO ECOSYSTEM PROTECTION AND WATER RESOURCE DEVELOPMENT

Many types of hydrologic and hydraulic information are relevant to both ecosystem management and broader water resources/watershed management. Some include:

1. Average water levels and depths

Relevance to wetlands/floodplain/aquatic ecosystem protection and restoration: Depth of surface water or soil saturation during the growing period determines the plant and soil development in wetland, floodplain and riparian zones. Depth of water is important for fish and animal use of wetland systems, pollution control and recreation functions/values.

Relevance to broader water resources management: Average water levels and depths of water in a wetland, river, lake, stream, estuary or the groundwater system are important for water resources planning for pollution control (e.g., "dilution is the solution to pollution") and for stormwater and floodplain management, as flood damages depend on the depth and frequency of flooding, among other factors.

2. Maximum depths of water (e.g. flooding)

Relevance to wetlands/floodplain/aquatic ecosystem protection and restoration: Maximum depths on even a short-term basis can result in drowning of certain animals if they cannot escape to high ground. Maximum depths are also relevant to flood storage and flood conveyance functions, flood damage potential at sites, and erosion.

Relevance to broader water resources management: Maximum depths of flood waters determine flood and stormwater hazards as well as the flood conveyance and flood storage potential of sites. Flood and stormwater management programs typically require that floodplain or water alternations do not increase peak water elevations. Maximum water elevations and flows are also relevant to water supply because they determine quantity of available water.

3. Minimum depths of water

Relevance to wetlands/floodplain/aquatic ecosystem protection and restoration: Minimum depths, including depths during dry periods, determine the use of wetland/floodplain systems by fish, shellfish and other aquatic animals. Minimum depths also determine plant species (where a wetland is dry part of the time), food chain support, pollution control, flood storage and conveyance (since storage and conveyance capacity partly depends on water levels prior to and during a flood), and recreational and scientific use of wetlands.

Relevance to broader water resources management: Minimum water depths and flows are important to point and nonpoint source pollution control functions since pollution becomes a particular problem during low flows when there is little dilution. Minimum water depths and flows determine the water supply potential of a water body since the goal in construction and operation of reservoirs, diversions, pumping systems, etc. is usually to provide sufficient water to users at all times including low flow periods.

(continued, pg. 118)

4. Quantity of water

Relevance to wetlands/floodplain/aquatic ecosystem protection and restoration: The total quantity of water flowing through a wetland and related ecosystem is often less relevant than average depths, maximum and minimum flows, and hydroperiod to flora and fauna. Quantity of water, which is also affected by velocity, vegetation, etc., is relevant to wetland flood storage, flood conveyance and pollution control functions.

Relevance to broader water resources management: The total quantity of water passing a particular point along a river or in a reservoir, groundwater aquifer, or other system is relevant to flood and erosion hazards. It is also important in determining the water supply (reservoir storage), pollution control and recreation potential.

5. Water Velocity

Relevance to wetlands/floodplain/aquatic ecosystem protection and restoration: High velocity water often destroys wetland, floodplain, and riparian vegetation and causes erosion. It may also carry large amounts of sediment, which destroys wetlands. Wetland plants can only resist moderate velocities. The total amount of water that a wetland, riparian area, or floodplain stores and conveys depends on water velocity, making velocity relevant to flood storage and conveyance. Velocity is also important for pollution control and food chain support because high velocity flows tend to flush sediments, organics and other materials from wetlands, floodplains, and riparian areas.

Relevance to broader water resources management: High velocity water can destroy buildings and cause flash floods, deaths and damages. It causes bed and bank erosion and sediment transport. It is relevant to point and nonpoint source pollution control since it helps determine total water quality, sediment loadings and flushing rates.

6. Hydroperiod

Relevance to wetlands/floodplain and related ecosystem protection and restoration: The timing and duration of water depths, velocities and other features determines the types and diversity of plant species, use of the system by various fish and wildlife, pollution control functions, flood storage and conveyance and other functions. It is relevant to successional sequences in wetlands (or the lack thereof).

Relevance to broader water resources management: The issue for most water resources planning is not simply the total quantity of water or depth of water, but the timing of various levels of inundation. The timing and length of particular water levels, depths, velocities, etc., is also relevant to water resources planning, including floodplain and stormwater management, water supply and point and nonpoint pollution control.

7. Water quality and temperature

Relevance to wetlands/floodplain/aquatic ecosystem protection and restoration: Water quality and temperature, including turbidity, nutrient loadings, toxics, and sediment are relevant to fishery, habitat, recreational, research, pollution control and most other functions and values of wetlands, floodplains, and riparian areas. Flood storage and conveyance are not substantially affected by water quality, although they may be affected by sediment loadings.

(continued, pg. 119)

Relevance to broader water resources management: Water quality is relevant to water supply and to point and nonpoint source pollution control efforts. It is also increasingly relevant to stormwater management as stormwater is now subject to pollution regulations.

8. Sediment regime

Relevance to wetlands/floodplain/aquatic ecosystem protection and restoration.
Sediment regime is relevant to all wetland functions because it affects water depths and the very existence of wetlands. Sediment loadings are important because they affect fisheries, shellfish and vegetation types. They affect recreation and water supply uses. They determine depositional in wetlands (and indirectly depth of water) and the erosive force of moving waters. Water with a high sediment loading may quickly fill a wetland unless the sediment is periodically flushed from a wetland by high velocity flows. On the other hand, a stream with too little sediment may also destroy a wetland by down cutting through the wetland and lowering water levels.

Relevance to broader water resources management: Sediment regimes are relevant to floodplain and stormwater management because they determine flood conveyance capacity and bed and bank erosion, including stream meander. Sediment also fills flood control reservoirs and stormwater detention facilities. Sediment regimes are relevant to water supply because they affect water quality and because they fill reservoirs. They are relevant to navigation and recreation because sediment regimes determine water depth and quality. They are relevant to point and nonpoint pollution controls, particularly from sediment and turbidity perspectives.

9. Interconnections between waters

Relevance to wetlands/floodplain/aquatic ecosystem protection and restoration: Most wetland functions/values depend, in part, on the connections between wetlands and other water bodies. For example, wetland flood storage and conveyance functions are limited if flood waters cannot enter and leave due to dikes, dams, berms or other measures. Similarly, wetlands cannot provide fish spawning, food chain support, pollution control, wave retardation, erosion control or recreation functions for an estuary, lake, or stream if they have been cut off from other water systems.

Relevance to broader water resources management: Interconnections between various wetland, surface water and groundwater systems are relevant to water supply, flood and stormwater management, navigation, recreation and point and nonpoint source pollution control efforts. The relevance of the interconnections varies, however, depending on the management objective.

APPENDIX F: WETLANDS/RIPARIAN/ AREA FUNCTIONS AND VALUES

ECOLOGICALLY OR HYDROLOGICALLY-BASED FUNCTIONS/VALUES

Function/Value:
Provide flood storage by storing and slowly releasing flood waters.

Value: Reduce downstream flood heights, velocities and flood damages; protect health and safety; prevent nuisances; reduce the economic impacts of flooding.

General discussion: Flood storage has been recognized as a wetland and floodplain/riparian area function for many years, although there are only a small number of reports dealing specifically with wetland flood storage. Storage has proven difficult to evaluate on a case-by-case basis because the flood storage capability of a floodplain or wetland depends upon the size, configuration and outlet of the floodplain or wetland. Flood storage also depends on antecedent conditions (water levels). The importance of a given amount of flood storage on downstream water levels depends on the synchronization and desynchronization of flood flows from multiple sources reaching a particular area at a particular point in time. Flood storage is susceptible to quantitative evaluation if adequate time and money are available for detailed topographic mapping and flood flow analysis (e.g., HEC models).

Features determining function/value:

- Existing and reasonably anticipated overall flood/flow regime
- Size (magnitude) of study flood
- Nature of floodplain/wetland topographic depression (includes floodplain or wetland and surrounding lip)
- Size of floodplain and surrounding depression
- Outlet size and depth
- Vegetation type and density
- Present or reasonably anticipated flood damage prone activities

Wetland/floodplain/riparian types: Primarily riverine; some other types.

Difficulty in evaluation: Quantitative evaluation with HEC or other hydrologic models is possible, but time consuming and quite expensive.

Sources of useful information: NWI maps (vegetation), stream gauge records, other water level records, topographic maps, FEMA and other flood maps.

Red and yellow flagging (some features to look for):

- FEMA or other flood maps showing deep inundation for floodplain/wetland
- Physical evidence of deep flooding in wetland, widely fluctuating water levels
- Much of the watershed is developed, much impermeable surface
- Rarity of floodplains/wetlands in a watershed
- Significant topography in a watershed with resulting steep hydrograph
- Large floodplain in deep topographic depression with restricted floodplain outlet
- Upstream from existing or anticipated substantial, low-lying development now suffering flood losses or susceptible to losses

Sources of expertise: Local floodplain management agency, state floodplain management agency, Corps, FEMA, USGS, NRCS or U.S. Bureau of Reclamation.

Measures to reduce project impacts on function:

- Protect topographic configuration of floodplain/wetland and surrounding depression from filling, grading
- Protect outlet
- Prevent channelization and ditching, which increases runoff

Function/value:
Convey flood waters

Value: Reduce flood heights and velocities at upstream, adjacent, and downstream points; protect health and safety; prevent nuisances; reduce economic damages and losses.

General discussion: Flood conveyance is a function that has been considered in floodplain management for many years. It is also subject to quantitative evaluation through backwater models, such as HEC. The calculation of flood conveyance requires the calculation of a flood discharge (Q) for a specific frequency of flood, and the determination of the valley profile and stream valley cross sections. Backwater computations can then be carried out to calculate increases in flood heights that would occur if a wetland or portion of a wetland were filled.

Assessment of this function may be particularly important in addressing "taking" issues because it is one of the few functions subject to clear nuisance implications and quantitative evaluation.

Features determining function/value:

- Hydrologic regime (the quantity of flood waters for particular frequencies of floods that can be expected to flow through a valley cross section)
- Location of wetland and floodplain/riparian area in relationship to stream channel
- Configuration of the wetland relative to the flow regime
- Topography of a wetland, floodplain and stream bed or bank
- Vegetation (in general, more vegetation results in less conveyance capacity)
- Soils (erodibility)

Wetland/floodplain/riparian types: Riverine

Difficulty in evaluation: Quantitative evaluation with HEC or other hydrologic models is possible, but time consuming and quite expensive.

Sources of useful information: Federal and state agency floodplain and floodway maps, topographic maps (stream gradient, topography), aerial photos (vegetation), NWI maps (vegetation, location) and stream gauging records.

Red flagging and yellow flagging (some features to look for):

- Floodplain/wetland is in a FEMA, Corps, USGS, NRCS, state or local mapped floodway
- Wetland/floodplain in or adjacent to a river or stream with history of deep, high velocity inundation
- Wetland/floodplain in or adjacent to a river or stream with documented "flashy" hydrologic characteristics (stream gauging, flood maps, other flood data)
- Wetland/floodplain in or adjacent to a river or stream in an urban or urbanizing area with much impermeable surface and substantial drainage area
- Wetland/floodplain in or adjacent to a river or stream in an area of steep topography
- Wetland/floodplain with large stones and gravel (indicates high velocity flows)
- Narrow valley cross section with floodplain/wetland occupying much of the cross section
- Substantial, low-lying development now suffering flood losses or susceptible to losses or anticipated development in nearby upstream, adjacent, downstream areas

Sources of expertise/data: Local floodplain management agency; state floodplain management agency; Corps of Engineers, USGS, FEMA, NRCS, U.S. Bureau of Reclamation, Tennessee Valley Authority, and other agencies.

Measures to reduce project impacts on function:

- Locate all fills as far from the center of a river or stream as possible.
- Contour any fills, other alterations to compensate for loss of hydraulic conveyance.

Function/value:
Induce waves to break before reaching shore, thereby reducing the force of waves and retarding flows

Value: Reduce wave and erosion damage to back-lying properties; reduce economic losses.

General discussion: Waves may add 3-15 feet or more to standing water flood elevations along some major rivers, lakes and estuaries, and in coastal areas. Large waves often destroy houses, roads and other structures; they can also erode foundations and pilings (resulting in building collapse), roads, lawns, parking lots, agricultural fields, etc.

High velocity waves are generated when there is a combination of high winds (particularly common in hurricanes and Northeasters along the coast), wide fetch (width of open water) and at least moderate water depths.

Vegetated floodplains/wetlands can help reduce wave and erosion damage by causing waves to break at offshore locations, and binding and holding the soil.

The Federal Emergency Management Agency (FEMA) has identified high velocity wave zones on some coastal flood hazard maps, and requires protection of mangroves in local coastal floodplain regulations where mangroves reduce flood damages.

Features determining function/value:

- Whether a wetland/floodplain is directly adjacent to a major water body
- Width and depth of adjacent water body including bottom topography
- Wind and flood history and characteristics for an area
- Vegetation type, density, height
- Width of wetland/floodplain (wave action is often more of a problem where there are narrow wetlands)

Wetland/floodplain/riparian types: Coastal, estuarine fringe, some lake and river fringe, floodplains and wetlands.

Difficulty in evaluation: Moderate

Sources of useful existing information: FEMA flood maps, flood records, topographic maps, water resource maps, bathymetric maps, aerial photos (water body characteristics, wetland characteristics)

Red and yellow flagging (some features to look for):

- Wetland/floodplain adjacent to a water body with high wind and flood history, large width (fetch), and at least moderate near-shore depths
- Wetland/floodplain with thick wetland vegetation (e.g., mangroves, other trees)
- Existing or potential back lying development or other activities subject to flood/erosion damage, past flood and wave damage (e.g., disaster payments)

Sources of expertise: FEMA, Corps, USGS, NRCS, local floodplain management agency; state floodplain management agency, and Soil and Water Conservation District.

Measures to reduce project impacts on function:

- Replant vegetation where disturbed
- Install compensatory wave reduction and erosion control measures

Function/value:
Reduce erosion by slowing velocity of water and by binding and retaining soil

Value: Reduce erosion property losses, ecological damage, and sedimentation of lakes, streams, reservoirs, estuaries and other wetlands**.**

General discussion: Vegetated floodplains and wetlands may reduce erosion in a broad range of contexts by slowing the velocity of waters and binding the soil. Wetlands located in and adjacent to streams with high velocity waters may be particularly important.

Features determining function/value:

- Overall hydrologic regime, including velocity of water at a site (particularly important)
- Type of wetland/floodplain
- Location within the wetland/floodplain
- Vegetation types, densities and condition

Wetland/floodplain/riparian types: Primarily river and river fringe (river bed, stream bank, floodplain), but also some lake fringe, coastal and estuarine fringe, and slope wetlands. Often one portion of a wetland/floodplain is more important than another in reducing erosion.

Difficulty in evaluating: Moderate

Sources of information: Topographic maps, FEMA and other floodplain and floodway maps, soil maps and aerial photos.

Red and yellow flagging (some features to look for):

- Large gravel, boulders in wetland/floodplain (indicates high velocity flows)
- Wetlands/floodplains in or adjacent to high velocity stream
- Wetlands/floodplains in wave action zones along lakes, rivers, estuaries and coasts

Sources of expertise: NRCS, USGS, Corps, resource agencies, floodplain management agencies, soil and conservation groups and organizations (e.g., Soil Conservation Districts) and academics.

Measures to reduce project impacts on function:

- Replant erosion-prone areas
- Use rip rap, other erosion control measures
- Contour fills and other alterations to reduce water velocities

Function/value:
Provide natural crops and timber

Value: Produce natural crops of commercial and recreational value, such as cranberries, blueberries, salt marsh hay, timber and wild rice.

Features determining function/value:

- Water salinity
- Water quality
- Water depths and velocities, hydroperiod
- Soil
- Size of floodplain/wetland
- Vegetation type, density, condition

Wetland/floodplain/riparian area types: Many types, but primarily seasonally flooded, freshwater wetlands.

Difficulty in evaluating: Moderate. There are many types of natural crops and wetland forest species with differing requirements.

Sources of information: NWI maps (vegetation, overall hydrologic regime), soil surveys, aerial photos and topographic maps.

Red and yellow flagging (some features to look for):

- Visible evidence of cranberry, blueberry, wild rice salt marsh hay, forestry or other natural crops

Sources of expertise: NRCS, U.S. Forest Service, Cooperative Extension staff, groups and organizations representing various agricultural groups, environmental nonprofit organizations, academics.

Measures to reduce project impacts on functions:

- Maintain the natural hydrologic regime as much as possible
- Require replanting of disturbed areas

Function/value:
Prevent and treat pollution

Value: Prevent and treat pollution in lakes, streams, estuaries, coastal and ground waters.

General discussion: Many wetlands and some floodplains/riparian areas serve two related functions:

- Prevent pollution from entering water bodies — Wetlands and vegetated floodplains intercept and trap debris, toxics, nutrients and other pollutants, which would otherwise reach water bodies from upland sources, by slowing the velocity of water, causing sedimentation and providing an opportunity for chemical transformations in wetland soils and water.
- Treat (remove) pollution in water bodies — Wetlands (and some frequently flooded floodplain areas) in water bodies or inundated by fluctuating water levels from such adjacent water bodies (tides, floods) may also remove pollutants that have already reached water bodies. For example, riverine wetlands may slow river velocities, causing precipitation of sediments and attached pollutants.

Features determining function/value:

- Overall flow regimes including detention times, quantity of water, and hydroperiod
- Sediment regimes
- Type of vegetation, density, and condition
- Soils
- Location of wetland/floodplain in relationship to other water bodies
- Connectivity of wetlands to other water bodies
- Existing or reasonably anticipated pollution sources which may be intercepted or treated by wetlands.

Wetland/floodplain/riparian area types: All types may help prevent pollution for upland sources reaching water bodies if they lie between the pollution sources and the water bodies. Lake fringe, estuarine and coastal fringe, and riverine wetlands may remove pollutants from water bodies.

Sources of information: NWI maps (water regimes, vegetation), topographic maps (water flows), soils maps, aerial photos (vegetation, flow regimes, land uses), and land use plans (future development).

Red and yellow flagging (some features to look for):

- Slope, flats, river fringe, lake fringe, coastal fringe, estuarine fringe and other wetlands that lay between an existing or potential pollution source (e.g., nutrients, sediment)
- River fringe, lake fringe, coastal fringe, or estuarine fringe wetland adjacent to a water body with high levels of nutrients, sediment, etc., and fluctuating water levels
- Sediment deposition visible in a wetland area
- Wetland, floodplain, or riparian area with dense vegetation located in an area (agricultural, urban, other) with high pollution potential

Sources of expertise: NRCS, EPA, Corps, USGS, state pollution control agencies, other regulatory and resource agencies, environmental not-for-profits, land trusts, and academics.

Measures to reduce project impacts on function:

- Do not allow drainage, channelization or other measures that decrease water detention time in wetland/floodplain/riparian area
- Require replanting of vegetation where natural revegetation may not occur
- Require upland vegetated buffers where wetland buffers may be disturbed

Function/value:
Provide habitat for fish and shellfish

Value: Provide sport and commercial fisheries, food, recreation, cultural value and food chain support.

General discussion: The importance of coastal and estuarine wetlands to fish and shellfish are well known coastal and estuarine wetland functions/values. The importance of freshwater wetlands to northern pike spawning and other fish is also well recognized.

Features determining function/value:

- Fish/shellfish capacity of adjacent waters (depth, salinity, water quality, velocity temperature, substrate)
- Depth of water
- Salinity
- Velocity
- Water temperature
- Connectivity between wetland/floodplain and adjacent waters
- Substrate, soil
- Water quality (including sediment loading)
- Size of wetland/floodplain area

Wetlands/floodplain/riparian area types: Primarily wetlands, but also some floodplains and riparian areas adjacent to lakes, streams, estuaries or the ocean.

Difficulty in evaluating: Moderate

Sources of information: NWI maps (size, water regime, salinity, vegetation type), soils maps, topographic maps, fisheries studies and instream flow studies.

Red and yellow flagging (some features to look for):

- Wetland/floodplain is adjacent to and connected to a water body with fish/shellfish
- Adequate depth and size for fish with good water quality during normal water levels or flood stage
- Observed fish or shellfish
- Observed spawning areas

Sources of expertise: U.S. Fish and Wildlife Service, National Marine Fisheries Service, and other organizations and groups representing commercial and private fisherman, shell fishermen, resource agencies and academics.

Measures to reduce project impacts on function:

- Insure that connection between wetland and adjacent waters is maintained (essential to passage of fish)
- Ensure that adequate depths are maintained in wetland and adjacent water body
- Require revegetation of fills to reduce erosion and sedimentation
- Minimize tree cutting and vegetation removal adjacent to wetland and water body where water temperatures are critical

Function/value:
Provide habitat for amphibian, reptile, mammal and insect species

(Note: this overlaps with other types of habitat.)

Value: Provide ecological, heritage, recreation, aesthetic and cultural values.

General discussion: Wetlands and floodplains provide critical habitat for many amphibians, reptiles, mammals and insects. Functions/values depend not only on wetlands/floodplain/riparian area characteristics, but also relationship to uplands and deepwater habitat because most amphibians, mammals and reptiles spend only a portion of their time in wetlands.

Features determining function/value:

- Water depth, velocity
- Water level fluctuations
- Water quality
- Salinity
- Sediment regimes
- Vegetation types, density
- Size of wetland/floodplain
- Edge ratio of wetland/floodplain
- Relationship of wetland to other wetlands, floodplains, water bodies, and upland habitat, availability of corridors and passageways between wetland and other habitat
- Presence or absence of buffers

Wetland/floodplain/riparian area types: All types may be valuable habitat, depending on the circumstances, for reptiles, mammals, birds, amphibians and insects.

Difficulty in evaluating: May be difficult due to the large number of habitat ranges and niches for different amphibian, mammals, reptiles, insects and other animals. Different portions of a wetland are important to different species.

Sources of information: NWI maps (vegetation, size, overall water regime, substrate), soils maps, topographic maps, various mammal, reptile, amphibian and insect surveys.

Red and yellow flagging (some features to look for):

- Directly observe amphibians, reptiles, mammals, insects or other signs (e.g., tracks, scat, egg cases or pupa shells)
- Wetlands/floodplains are rare in locality or region; wetland type is rare
- Wetlands/floodplains adjacent to parks, refuges or other public lands
- Wetlands/floodplains adjacent to large undeveloped private tracks
- Wetland/floodplains with significant open water or adjacent to a lake, river, or stream with open water (otter, beaver)
- Undisturbed wetlands/floodplains

Sources of expertise: Academics, resource agencies, environmental nonprofit organizations.

Measures to reduce project impacts on function: Varied, depending upon the situation and type of wildlife.

- Maintain wetland/floodplain to water and upland connections
- Employ erosion control and sediment control measures, such as detention areas and grass strips, to reduce sediment and pollutant contributions
- Fence

Function/value: Provide habitat for waterfowl species

(Note: this overlaps with habitat.)

Value: Provide food, recreation, aesthetic, economic and cultural value.

General discussion: Waterfowl nesting, resting and feeding were some of the most widely recognized functions of wetlands. Adjacent floodplains and riparian areas may also be important nesting and feeding areas. The prairie pothole wetlands and wetlands in various flyways are particularly important. Because waterfowl fly from wetland to wetland, they can make use of many types of isolated and semi-isolated wetlands not used by other forms of wildlife that depend on ground pathways.

Features determining function/value:

- Salinity, water quality
- Presence of open water in wetland or floodplain or adjacent open water in a lake, river, stream, estuary or ocean
- Types, densities, and condition of wetland and floodplain vegetation
- Size of wetland and floodplain
- Water quality
- Food chain support, availability of nearby sources of food (e.g., corn fields)
- Buffers
- Presence or absence of predators; numbers of predators

Floodplain/wetland/riparian area types: Depressional, lake fringe, river fringe, ocean and estuarine fringe, as well as other wetlands and floodplains.

Difficulty in evaluating: Moderate

Sources of existing information: NWI maps (water regime, vegetation, size, substrate, relationship to other waters), soil maps, topographic maps, land cover maps, waterfowl inventories and special maps.

Red and yellow flagging (some features to look for):

- Wetland or floodplain with significant open water or adjacent to a lake, river or stream with open water
- Waterfowl directly observed
- Wetland in flyway
- Wetlands and floodplains adjacent to parks, refuges or other public lands

Sources of expertise: FWS, NMFS, NRCS, state wildlife agencies, groups representing waterfowl hunters, duck clubs, resource agencies, environmental nonprofit organizations and academics.

Measures to reduce project impacts on function:

- Use wetlands and floodplains for agriculture only when they are not being used by waterfowl
- Install nesting boxes
- Fence wetlands and floodplains
- Protect wetlands and floodplains from pesticides, nutrients and sediment with buffer strips.
- Provide nearby upland food sources

Function/value:
Provide habitat for birds

(Note: this overlaps habitat.)

Values: Ecotourism, recreation, education and research.

General discussion: In the past 20 years, bird watching has become a widespread activity, with bird watchers often outnumbering hunters. Bird watching is sometimes important to local economies. A great deal of bird watching takes place in wetlands, floodplains and riparian areas due to the large numbers of waterfowl, wetland birds and many upland species that feed in wetland areas.

Features determining function/value: A broad range of features affect the bird habitat potential of wetlands, since birds occupy a wide range of niches:

- Size
- Open water
- Water quality
- Vegetation types, conditions, densities
- Other wildlife
- Public access
- Rareness of wetland/floodplain/riparian in the region
- Adjacent upland and deepwater habitat
- Adjacency of wetland/floodplain/riparian area to trails, roads, parks, refuges, sanctuaries

Wetland/floodplain/area types: Many types

Difficulty in evaluating: Difficult; birds are too small to be seen on aerial photos and do not use wetlands all the time.

Sources of information: NWI maps (wetland types, vegetation, substrate, proximity to other waters, overall water regime), aerial photos (vegetation), local birding clubs and field observations

Red flagging (some features to look for):

- Rareness of wetlands/floodplains in the region
- Adjacent upland and deepwater habitat
- Adjacency of wetland/floodplain to trails, roads, parks, refuges, and sanctuaries
- Public access
- Wetland/floodplain is well known in a region for bird watching
- Wetland/floodplain is relatively undisturbed
- Wetland/floodplain has open water (water birds)

Sources of expertise: The U.S. Fish and Wildlife Service, schools, universities, bird watching groups environmental nonprofit organizations, land trusts, resource agencies and museums.

Measures to reduce project impacts on function:

- Require revegetation
- Require upland screening of fills and structures to protect aesthetic values
- Install nesting areas
- Maintain connectivity between open waters and wetland for canoe access

Function/value:
Provide habitat for endangered or threatened species of plants and animals

(Note: this overlaps with other habitat categories.)

Value: Protect gene pools; provide ecotourism, birdwatching, research and education.

General discussion: Many endangered or threatened plant or animal species depend on wetlands, floodplains and riparian areas. Some spend their entire lives in wetlands; others only use wetlands some of the time. Therefore, upland and deep water habitat, and the connections between wetlands and these other habitats, are very important. Connections are also important for providing refuge during droughts and periods of fluctuating water levels. Because of the sensitivity of many of these species and their narrow ecological niches, it is particularly important to protect not only habitat, but also water regimes.

Features determining function/value: A large number of features are relevant to the ability of wetlands, floodplains and riparian areas to provide habitat for endangered and threatened species, since the requirement of individual species vary greatly.

- Rareness of wetlands, floodplains, riparian areas
- Rareness of habitat types
- Adjacent upland and aquatic habitat; connections with broader habitat
- Soils
- Substrate
- Size
- Vegetation
- Water depth, velocity and quantity
- Salinity
- Water temperature
- Buffers (if any)

Wetland/floodplain/riparian area types: All types may be important. Many endangered plant and animal species are located in rare wetland types such as bogs, vernal pools and saline ponds.

Difficulty in evaluating: Difficult due to the number of habitat ranges and niches of different endangered species, and because endangered and threatened species are often difficult to locate and observe.

Sources of information: NWI maps (overall vegetation, water regime, substrate, connections with other wetlands), aerial photos (vegetation), lists of sites in federal inventories, state inventories, nature conservancies and other inventories for endangered, rare or threatened species.

Red and yellow flagging (some features to look for):

- Wetlands/floodplains/riparian areas are rare in a locality, region or state
- Wetland/floodplain is a known habitat for endangered species
- Sitings of endangered or threatened species in a wetland/floodplain or similar areas

Sources of expertise: The U.S. Fish and Wildlife Service and other resource agencies, environmental nonprofit organizations, bird watchers and academics.

Measures to reduce project impacts on function:

- Use of buffers, detention basins or other measures to protect water quality and reduce intrusions in remaining areas
- Fencing
- Control of exotic species; other active management

Function/value:
Recharge ground water

Value: Maintain and enhance quantity and quality of ground water supplies for domestic, commercial, industrial, agricultural, wildlife protection and other purposes; maintain base flow of rivers and streams.

General discussion: In general, wetlands and floodplains are not recharge areas. However, some depressional, lake fringe and river fringe wetlands and other seasonally flooded wetlands and floodplains may be recharge areas at least some of a year, or may serve as both recharge and discharge areas.

Features determining function/value:

- Ground water levels in comparison with wetland/floodplain water levels
- Yearly fluctuations in ground water levels compared with yearly fluctuations in wetland/floodplain water levels
- Whether the bottom of a wetland is sealed by organics, silt, etc.
- Overall porosity and permeability of wetland/floodplain/riparian soils
- Amount of impermeable surfaces in the watershed
- Proximity of wetland/floodplain/riparian area to water supply wells

Wetland/floodplain/riparian area types: Most wetlands/floodplains are discharge areas (slope, riverine, lake fringe, coastal and estuarine fringe, depressional). However, some act as recharge areas some of the year when water elevations exceed wetland/floodplain/riparian area water elevations due to precipitation or surface runoff. For example, many prairie potholes, flats and riparian wetlands may be recharge areas during the spring after spring, summer or fall rains.

Difficulty in evaluating: Difficult, time-consuming and expensive to conduct accurate studies. May require long-term use of piezometers to track ground and surface water levels.

Sources of information: Topographic maps; water level records for wetlands or adjacent lakes, stream; ground water levels for well logs or piezometers.

Red and yellow flagging (some features to look for):

- Seasonal fluctuations in wetland/floodplain water levels, particularly long-term fluctuations
- Sand or gravel substrate
- Nearby water supply wells
- Wetlands have inlet and no outlet

Sources of expertise: USGS, NRCS, state water supply agencies, geologic agencies, other resource agencies and academics.

Measures to reduce project impacts on function: Maintain natural fluctuations in wetland/floodplain/riparian water levels, make sure water levels continue to exceed adjacent ground water levels at least some of the year.

Function/value:
Discharge ground water

Value: Prevent damaging increases in ground water levels; maintain water levels and flow regimes

General discussion: Many depressional, slope, lake, estuarine and river fringe wetlands, floodplains and riparian areas are ground water discharge some year. If a wetland or floodplain is filled, reducing ground water discharge, ground water levels in the fill and surrounding landscape may rise. Basements may flood, and septic tanks and soil absorption systems may stop working, among other problems.

Features determining function/value:

- Wetland/floodplain/riparian area surface water elevation versus groundwater elevation in nearby upland areas (piezometric surface)
- Outlet level
- Permeability and porosity of soils

Wetland/floodplain/riparian area types: Riverine and some lake, coastal and estuarine fringe.

Difficulty in evaluating: Discharge may be directly observed in some instances (e.g., springs in wetland/floodplain), but is otherwise difficult to evaluate.

Sources of information: NWI maps (overall water regime, wetland type), topographic maps, well logs and USGS maps.

Red and yellow flagging (some features to look for):

- Visible springs
- Wetland water temperature during fall and winter is higher than expected, suggesting ground water input

Sources of expertise: USGS, state geologic and water resource agencies, and academics.

Measures to reduce project impacts on function:

- Minimize fills, impermeable structures in wetland/floodplain/riparian area which would reduce discharge

Function/value:
Modify micro-climate

Value: Reduce temperatures in nearby areas.

General discussion: Wetlands and floodplains along with other open spaces moderate temperatures and affect circulation patterns and humidity, particularly in urban areas.

Features determining function/value:

- Size of wetland/floodplain/riparian area
- Vegetation type
- Open water
- Location in relationship to urban areas, etc.

Wetland/floodplain/riparian area types: All types of wetlands/floodplains and other open space.

Difficulty in evaluating: Difficult

Sources of information: NWI maps (wetland size, location, type, vegetation, open water, other wetlands and waters), detailed climatological data and topographic maps.

Red and yellow flagging (some features to look for):

- Location adjacent to an urban area
- Size

Sources of expertise: Academics, resource agencies.

Measures to reduce project impacts on function:

- Replant
- Maintain alternative open spaces

ECOLOGICALLY AND MORE BROADLY ENVIRONMENTALLY BASED FUNCTIONS/VALUES

(Humans enter the picture — accessibility and other factors).

Function/value:
Provide recreation, ecotourism opportunities

Value: Health, economic value, fisheries, ecotourism

General discussion: Recreation is one of the most important uses of wetlands and related water and floodplain resources. Some common water-based recreational activities include fishing, canoeing and boating; land-based recreation includes bird and nature watching, and hiking or biking along trails.

Features determining function/value: A broad range of wetland/floodplain/riparian characteristics and physical processes are important to particular types of recreation. They include but are not limited to:

- Size
- Type
- Vegetation
- Bird species
- Animal species, including endangered species
- Fish species
- Waterfowl species
- Rarity of wetlands in a state or region
- Rarity of wetland type in a locality, state.
- Open water
- Public access
- Adjacency to other waters
- Adjacency to roads, bike paths, etc.
- Adjacency to parks, refuges, sanctuaries

Wetland/floodplain/riparian area types: Many have recreational and ecotourism potential. However, wetlands adjacent to lake, river and estuarine/coastal waters are often more important for water-based recreation.

Difficulty in evaluating: Difficult to evaluate because there are many types of recreation and because functions/values are not based upon ecological considerations alone. For example, accessibility and location are relevant.

Sources of information: State and local recreation plans and surveys; NWI maps and other wetlands maps; public land ownership maps.

Red and yellow flagging (some features to look for):

- Observed use of areas by canoeists, birders, other recreation users
- Adjacency to other waters
- Public access through roads, trails, boat launching sites, public waters
- Proximity to urban centers
- Large size
- High water quality (swimming, boating, wildlife)
- Rarity of wetlands in state region
- Rarity of wetland type in locality, state
- Open water
- Bird species
- Animal species, including endangered species
- Fish species
- Waterfowl

Sources of expertise: FWS, NPS, state park and recreation agencies at all levels of government, environmental nonprofit organizations and land trusts.

Measures to reduce project impacts on function:

- Maintain connectivity between open waters and wetlands/floodplains/riparian areas for boat access
- Maintain vegetation
- Require upland screening of fills, structures to protect aesthetic values

Function/values:
Provide historical, archaeological, heritage and aesthetic experiences

Value: Heritage, cultural, educational, research and aesthetic.

General discussion: Some wetlands, floodplains and riparian areas have important historical or archaeological value. Examples include the confluence of the Mississippi River where Lewis and Clark began their westward journeys, the Concord Marshes and the Everglades. Many other wetlands have heritage and cultural value for biodiversity, rare and endangered species, and open space.

Features determining function/value:
A broad range of characteristics and ecological processes are relevant. However, value does not derive from ecological processes alone. Relevant features include:

- Archaeological sites in or adjacent to wetland/floodplain/riparian areas
- Historical use of areas (battles, etc.)
- Aesthetic features of wetland/floodplain, including topography, vegetation, open water and edge ratio
- Size of area
- Wildlife
- Diversity of plants/animals
- Public access
- Adjacency to parks, historical monuments, sanctuaries, preserves

Wetland/floodplain/riparian area types: All types (not dependent upon natural resource considerations alone)

Difficulty in evaluating: Moderate

Sources of information: Lists of archaeological sites, historical sites, heritage sites and park maps. Topographic maps; vegetation maps; aerial photos.

Red and yellow flagging (some features to look for):

- Shell mounds
- Historical markers
- Adjacency to historic, archaeological, park and other areas
- Rarity of wetlands/floodplains/riparian areas
- Biodiversity
- Endangered and threatened species

Sources of expertise: National Park Service, state Heritage Programs, schools, universities, environmental nonprofit organizations, land trusts, resource agencies and museums.

Measures to reduce project impacts on function:
Varied, depending upon functions/values and impacts.

Function/Value:
Provide education and interpretation opportunities

Value: Educate students at all levels

General discussion: Many types of education and nature interpretation are carried out in wetlands and floodplains at K-12 and adult education levels. These range from observation of frogs and birds to sophisticated restoration projects by university students. Many boardwalks and interpretative centers have been constructed in wetlands.

Features determining function/value: A broad range of physical processes give rise to various characteristics important to education. Some include:

- Vegetation type and wildlife, including diversity of wildlife
- Presence of endangered, threatened or rare plants or animals
- Degree of alteration or disturbance
- Rarity of wetland/floodplain type
- Rarity of wetlands/floodplains in the locality, region
- Proximity to schools, urban centers
- Public accesibility, ease of access
- Boardwalks, trails

Wetland/floodplain/riparian area types: All types

Difficulty in evaluating: Difficult to evaluate potential education and interpretation potential since needs are diverse and depend on opportunity and social significance, as well as natural resource characteristics.

Sources of information: NWI maps (size, vegetation, water regime), FEMA flood maps (areas subject to flooding), maps of public lands, lists of interpretative trails and centers, rare and endangered species maps.

Red and yellow flagging (some features to look for):

- Wetland/floodplain/riparian area is habitat for rare or endangered species
- Wetland/floodplain/riparian area is in or adjacent to parks, refuges, or marine sanctuaries
- Public trails near wetland/floodplain or wetland/floodplain readily accessible to the public by canoe or boat
- Schools and colleges nearby
- Boardwalks, interpretative facilities in or near a wetland/floodplain/riparian area
- Experiments going on in a wetland/floodplain, riparian area
- Rare wetland/floodplain/riparian type in locality, state or region
- Wetlands, floodplains, riparian areas rare in locality, state or region
- Lands in unaltered, natural condition

Sources of expertise: Schools, universities, environmental nonprofit organizations, land trusts, resource agencies and museums.

Measures to reduce project impacts on function:

Varied, depending upon education, interpretation needs and interests.

Function/value:
Provide scientific research opportunities

Value: Advance scientific knowledge, improve understanding of natural systems.

General discussion: Schools, universities, resource agencies and nonprofit organizations carry out a large amount of scientific research in wetlands and, to a lesser extent, floodplains and riparian areas.

Features determining function/value: A broad range of physical processes may be important to research (which is highly varied):

- Vegetation types and wildlife including biodiversity
- Presence of endangered, threatened, or rare plants or animals
- Degree of alteration, condition
- Rarity of wetland/floodplain/riparian type
- Rarity of wetlands/floodplains/riparian areas in the locality, region
- Degree of disturbance
- Proximity to schools, urban centers
- Proximity to public lands such as parks, refuges and sanctuaries
- Public access, ease of access
- Boardwalks, trails
- Previous research and establishment of baseline conditions

Wetland/floodplain/riparian area types: All types

Difficulty in evaluating: Moderate to difficult due to many types of potential research

Sources of information: NWI maps, maps of endangered or threatened species, maps or lists of natural areas, soils maps or maps showing locations of schools.

Red and yellow flagging (some features to look for):

- Schools, colleges nearby
- Wetlands/floodplains/riparian areas are rare in a locality, state or region
- Rare or endangered plants or animals
- Special biodiversity, other characteristics worthy of research
- Visible evidence of ongoing experiments
- Wetland/floodplain, riparian area is in or adjacent to parks, refuges or marine sanctuaries
- Public trails near wetland or wetland easily accessible by canoe or boat

Sources of expertise: Resource agencies, schools, universities, environmental nonprofit organizations, land trusts and museums.

Measures to reduce project impacts on function:

Varied by type of area and research. Measures should maintain area and hydrologic regime in a natural condition.

APPENDIX G: WETLAND FUNCTION/VALUE ASSESSMENT METHODS

Rapid and more detailed function and value assessment techniques have been developed specifically for wetlands or developed for other uses and applied to wetlands and floodplains. Some include:

RAPID ASSESSMENT APPROACHES FOR FUNCTIONS/VALUES

Generalized functions/values assessment methods using lists of questions and matrices. A relatively large number of rapid assessment methods have been developed to provide generalized assessment of wetland functions/values through the use of various lists of questions and matrices, which the evaluator must complete. See Larson, J.S., ed., 1976. Models for Assessment of Freshwater Wetlands, Publication No. 32, Water Resources Research Center, University of Massachusetts, Amherst, MA.

WET and WET2 was the first wetland assessment approach developed to evaluate the broad range of functions/values for specific wetlands in a regulatory context. See Adamus, P.R. et al. 1987. Wetland Evaluation Technique (WET), Technical Report Y-87, Volume II. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

The method was designed to evaluate 11 functions/values and the impact of proposed activities on a number of targeted animal species. Wetlands are qualitatively evaluated through the use of a series of questions that the assessor must answer. This creates a matrix. Capacity, opportunity and social significance are considered. Hollands/Magee developed a similar approach, with numerical scores and weights. See Hollands, G.G., and D.W. Magee. 1985. "A Method for Assessing the Functions of Wetlands," pp. 108-118; *in* J. Kusler and P. Riexinger (eds.), Proceedings of the National Wetland Assessment Symposium (1985), Association of State Wetland Managers, Berne, NY.

Many state and academic matrix analysis models were subsequently developed in Connecticut, New Hampshire, Maryland, Wisconsin, Oregon, Minnesota and Ontario based on the Larson, WET and Hollands/Magee approaches. See U.S. Army Corps of Engineers. 1988. The Minnesota Wetland Evaluation Methodology for the North Central United States. Minnesota Wetland Evaluation Methodology Task Force and U.S. Army Corps of Engineers, St. Paul District; N. Y.; Ammann, A.P. and A.L. Stone. 1991. Method for the Comparative Evaluation of Nontidal Wetlands in New Hampshire, NHDES-WRD-1991-3, New Hampshire Department of Environmental Services, Concord, NH. Euler, D.L. et al. 1983. An Evaluation System for Wetlands of Ontario South of the Precambrian Shield. Ontario Ministry of Natural Resources and Canadian Wildlife Service, Ontario, Canada.

With some of these matrices approaches (e.g., WET) wetlands are rated as high, medium and low with regard to specific functions and values. With others (e.g. Hollands, Magee) nominal (non interval) numeric scores are assigned to specific functions and values. Some approaches then weigh function scores to provide overall scores by function or wetland.

WET and similar matrices analysis approaches were used extensively in the late 1980s and early 1990s for regulatory permitting and assessment of wetlands for planning purposes (Advanced I.D.'s, Special Area Management). Use has diminished, however, because these procedures are time consuming, complicated and have proven inadequate for evaluating impact reduction and compensation measures, including compensation ratios. In addition, the accuracy of these evaluations is often limited by simplifications, assumptions and the failure to consider many relevant factors. Nevertheless, some elements of these approaches — lists of functions, lists of red flag issues, indicators and annotated bibliographies — continue to be widely used.

Qualitative analysis of functions/values. The U.S. Army Corps of Engineers. 1995. The Highway Methodology Workbook Supplement, Wetland Functions and Values, A Descriptive Approach, NEDEP-360-1-30a, New England Division's descriptive approach is quite different from other approaches, and retreats from the attempt to assign numerical scores to functions and values. It is more qualitative; it is the only approach that has been developed primarily by regulators and the regulated community; it has been developed in a region of the country where there has been extensive experimentation with WET, Hollands/Magee and other approaches; and it is based on what has proven to be workable on individual permits.

This approach uses a multidisciplinary regulatory team (applicant's consultant, Corps of Engineers staff, and State and Federal agency staff) to evaluate the impact of project proposals upon 13 wetland functions and values, including ground water recharge/discharge, floodflow alteration, fish and shellfish habitat, sediment/toxicant/pathogen retention, nutrient removal/retention/transformation, production export, sediment/shoreline stabilization, wildlife habitat, recreation, education/scientific value, uniqueness/heritage, visual quality/aesthetics and threatened or endangered species habitat.

The approach recommends that a landowner/consultant first seek guidance from the Corps of Engineers, then evaluate the wetlands. The evaluation team will either be a party to this effort directly or review work products and offer comments.

ISSUE-SPECIFIC APPROACHES

These approaches or models focus on a specific feature or issue (e.g. flooding, specific functions, values). They are not, in general, comprehensive in their scope, nor do they attempt to evaluate all issues, lands or waters. They do not determine overall suitability or appropriateness of a site for development, and have typically been used only where a particular problem or issue has emerged from preliminary analysis.

- **More Detailed Field Observations/Surveys.** The most common approach for gathering more detailed information on a particular wetland feature, problem or issue is to carry out (or to require a landowner/consultant carry out) a more detailed field survey of the site to directly observe waterfowl, fish, mammals, reptiles, etc. or other feature.

More detailed field observations and surveys may be used to determine:

- presence of rare or endangered species or representative ecosystems
- presence of archaeological or historical sites
- use of wetlands by waterfowl for breeding, nesting, feeding
- use of wetlands by fish and shellfish for propagation
- use of wetlands by mammals, reptiles, amphibians and other species
- recreational use of wetlands by birders, canoeists, fisherman
- presence of natural crops, such as wild rice, cranberries and timber
- evidence of flooding or erosion (natural hazards)
- public/private ownership boundary (e.g., high water mark)

Some field surveys may involve the use of named techniques or approaches, such as application of the 1987 U.S. Army Corps of Engineers manual for the Delineation of Jurisdictional Wetlands. Formal use may be made of transects and sampling procedures. More often, field surveys primarily involve visual observations, with note-taking and photographs rather than named assessment methods.

- **Hydrologic and hydraulic models (e.g., HEC, TR 20 others).** Regulatory agencies or landowners/consultants can use a variety of hydrologic and hydraulic models to investigate flood conveyance, flood storage, erosion control, wave attenuation and other hydrologic functions/values. They can also use the models to determine flood and erosion natural hazards at a site and determine the impact of a proposed activity upon flood, wave and erosion hazards.

For example, the Rational Formula, variations and computerized models can be used to compute the quantity of runoff from a defined watershed area based on rainfall, slope, area and other factors. See NRCS (SCS) TR-20 computer program for Project Formulation Hydrology and TR-55 Urban Hydrology for Small Watersheds.

The Computer Program HEC-2, "Water Surface Profiles," is widely used by engineers in hydrologic studies to determine floodplains and floodways and the effects of fills, culverts, bridges and other obstruction upon water surface elevations.
See U.S. Army Corps of Engineers, Hydrologic Engineering Center, Floodway Determination Using Computer Program HEC-2 (l988)
U.S. Army Corps of Engineers, Hydrologic Engineering Center, Training Document No. 26, Computing Water Surface Profiles With HEC-2 on a Personal Computer (1992)
Chow, V.T. Open Channel Hydraulics. McGraw-Hill; New York, 1959
Chow, V.T. Handbook of Applied Hydrology. McGraw-Hill: New York

Hydrologic and hydraulic models have been used for floodplain and stormwater management, watershed planning and other water-related programs to predict runoff, floodplain and floodway boundaries and elevations and flow velocities, among other features. These models have been used to evaluate the seriousness of flood hazards at a site (e.g., the 100-year flood elevation) and the impacts of fills and other activities upon such hazards (e.g., backwater computations using HEC). They can also be used to project future hydrologic conditions by assuming various degrees of urbanization, impermeable surface and density of development.

Hydrologic and hydraulic models typically use information from stream gauging, rainfall estimates and other sources with topographical, soils, vegetative cover and land use information. These models provide quantified, real number outputs for analysis of project impacts and evaluation of impact reduction and compensation. These models do not evaluate social significance. But, they can be used to determine the impact of various activities, including land use changes, on specific downstream flood heights at specific locations (e.g., groups of residential structures). Hydrologic and hydraulic models are increasingly combined with GIS models to help predict future changes in hydrology.

Hydrologic information generated by these models can be useful in evaluating all wetland functions/values since all functions/values depend, in part, on water regime. They can be used to determine flood conveyance and flood storage potential for a wetland and wave retardation and erosion control potential; they can be used to determine flood and erosion threats at a site and the impact of proposed wetland activities upon those threats; and they can be used to evaluate project impact reduction and compensation measures.

Data necessary for these models is often expensive to obtain since detailed topographic and hydrologic (e.g., steam gauging) information is needed. However, use of Global Positioning Systems and other techniques reduces the cost of detailed topographic information. In addition, hydrologic information gathered for floodplain management, stormwater management, and other purposes can often be used for assessment of activities in wetlands, including wetland functions/values.

- **Stream hydrologic/geomorphic assessment approaches (e.g., Rosgen).** Regulatory agencies can use several models to evaluate the morphology and condition of streams to help determine functions/values and restoration and management needs. The models evaluate the condition of streams versus natural streams in terms of stream slope and form. These approaches are increasingly used to determine possible erosion, flooding and other problems, the impact of activities upon these problems and the adequacy of compensation measure. See Rosgen, Dave. Applied River Morphology. Wildland Hydrology; Pogosa Springs, Colorado (1997). Leopold, L.B. A View of the River. Harvard University Press; Cambridge, MA (1994).

- **Animal species and biological community evaluation models (e.g., HEP, WETHINGS, IBI, Instream Flow Models).** Regulators can use a combination of field observations and various inferential (deductive) models to determine the capacity of particular wetland environments to serve as habitat for particular fish, amphibian, mammal or other species. These models can be used to determine functions and establish water quality standards for wetlands, to enforce such standards and to assist monitoring efforts. These models do not evaluate opportunity or social significance.For examples of these models see HEP (Habitat Evaluation Procedures), U.S. Fish and Wildlife Service. (1980) Habitat Evaluation Procedures (HEP) Manual (102ESM), U.S. Fish and Wildlife Service, Washington, D.C; Cable, T.T., V. Brack Jr., and V.R. Holmes. (1989) "Simplified Method for Wetland Assessment." Environmental Management 13, 207-213; Whitlock, A.L, N. Jarman, J.A. Medina and J. Larson. (1995) WETHINGS. The Environmental Institute, University of Massachusetts; Adamus, P.R. and K. Brandt. (1990) Impacts on Quality of Inland Wetlands of the United States: A Survey of Indicators, Techniques, and Applications of Community-level Biomonitoring Data. EPA/600/3-90. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C.; Davis, W.S. and T.P. Simon, eds. (1995) Biological Assessment and Criteria. Tools for Water Resource Planning and Decision Making. Lewis Publishers: Boca Raton, FL.

Habitat models have been principally used for mid-sized or large projects, such as proposed dams, dikes and levees. They have generally been expensive and time-consuming.

- **Approaches to evaluate restoration potential, identify restoration sites.** A number of models have been developed to help identify potential wetland restoration sites and to evaluate the restoration potential and needs of wetlands, related floodplains and aquatic ecosystems. See C. Bartoldus, E.W. Garbisch and M. Kraus. Wetland Replacement Evaluation Procedure, Environmental Concern, St. Michaels, Maryland (1994), which recommends a procedure for calculating differences between the wetland to be impacted and replacement wetland in terms of six functions and 82 two determinants. These functions include shoreline bank erosion control, sediment stabilization, water quality, wildlife, fish and uniqueness/heritage.

For other guidance concerning evaluation of restoration potential see Bureau of Land Management, Riparian Area Management, Process for Assessing Proper Functioning Condition, U.S. Department of Interior, Bureau of Land Management, Service Center, Denver, Colorado (1993, 1995); Rosgen, Dave (1997) Applied River Morphology, Wildland Hydrology, Pogosa Springs, Colorado; Brown, C.R., F.O. Stayner, C.L. Page and C.A. Aulback-Smith (1993) Toward No Net Loss, A Methodology for Identifying Potential Wetland Mitigation Sites Using a Geographic Information System. South Carolina Water Resources Commission Report No. 178, USEPA Report No. EPA904-R-94-001.

- **Assessment of overall ecological processes ("functions") through HGM.** The HGM wetland assessment method was formally proposed by the Corps of Engineers and other federal agencies for use on Section 404 regulatory permits (see work plan published in the Federal Register, August 16, 1997. See also Appendix D of Assessment Technical Report 3 for more detailed discussion). So far, the Corps has published two documents in addition to this action plan, describing this approach in greater detail.

One is a procedural HGM document: Smith, D., A. Ammann, C. Bartoldus and M. Brinson (1995) An Approach for Assessing Wetland Functions Using Hydrogeomorphic Classification, Reference Wetlands, and Functional Indices, U.S. Army Corps of Engineers, Waterways Experiment Station, Wetlands Research Program Technical Report WRP-DE-9. More documents are in publication or preparation. At least nine states are attempting to implement or explore the use of HGM approaches.

HGM was designed to help regulators assess the overall ecological condition of a wetland and to establish compensation ratios. This approach has a number of significant new and interesting features in comparison with earlier rapid wetland assessment approaches. It requires classification of wetlands by hydrogeomorphic setting (classes and subclasses), the establishment of profiles of classes through reference sites, and evaluation of wetland functions. It is the first technique to shift analysis from end result—function/value—to the underlying biological, chemical and other processes. This shift in emphasis encourages users to understand how wetlands work and facilitates analysis of the changes that projects will cause in wetlands.

However, the technique is quite complicated and time-consuming. It is represented as a rapid assessment technique, but cannot be quickly undertaken without prior subclass guidebook development and perhaps selection of regional reference sites. It develops only a small portion of the information needed for analysis of functions/values and other factors for regulatory permitting. It does not consider opportunity or social significance, nor have the relationships between functions and values been clarified. It also does not provide species-specific information, such as identification of rare and endangered species.

The practicality of this approach for routine permitting activities remains to be seen. It has received limited use in a regulatory context to date, and questions remain concerning its application. However, both the classification system and the establishment of reference sites hold potential for improving assessment of wetland functions/values and those of related aquatic and floodplain/riparian ecosystems. Regional subclass guidebooks should also be very useful in helping regulatory agencies evaluate capacity and the impact of activities on capacity.

APPENDIX H: WHAT CAN BE LEARNED ABOUT WETLANDS FROM THEIR OVERALL TYPES?

The functions and values and other characteristics of wetlands/related resources are complex and varied. Nevertheless, some assumptions about wetland and related waters/floodplain and riparian ecosystems are possible with regard to functions/values, ownership and natural hazards. The categories of wetlands established in the Hydrogeomorphic Assessment Method — Lake Fringe, River Fringe, Coastal/Estuarine Fringe, Slope, Organic/Mineral Flats, and Depressional can serve as a guide.

Common Denominators

Regulatory jurisdiction under federal, state, local wetland statutes, regulations and ordinances. Major riverine, lake fringe, and coastal/estuarine fringe wetlands and related waters are subject to federal (Section 404, Section 10) regulations and to state or local wetland regulations. Some slope, depressional and flat wetlands are also subject to federal Section 404 regulatory jurisdiction. However, many smaller slope, depressional, and flat wetlands are not subject to federal, state or local regulations due to size limitations on regulated wetlands, limitations on the types of regulated wetlands, or because they are not included on wetland maps (mapping is required for exercise of regulatory jurisdiction in many state and local regulatory efforts).

Ownership; public rights. Lake fringe, estuarine fringe and coastal fringe wetlands and related waters are often partially in state ownership (beds of public water bodies below the high water mark). They are also subject, in many instances, to "public trust" and "navigable servitude" legal doctrines. Slope, depressional and flats are usually privately owned. They are not generally subject to federal navigable servitude or state public trust doctrines.

Recognition by landowners that areas are wetlands, delineation of wetland boundaries. Landowners more easily recognize coastal fringe, estuarine fringe, lake fringe and riverine wetlands as wetlands due to their proximity to other waters and relatively stable water levels. Delineation of boundaries for these wetlands is also generally easier than for depressional, slope and flats in many (but not all) instances because of more stable water levels, existing wetland maps, visible adjacent water bodies, salinity gradients (estuarine, coastal), and other factors. It is often more difficult to delineate the boundaries of slope, depressional and flats boundaries that may be wet only a portion of the time.

Other applicable regulations. A broad range of state, local and federal regulations typically apply to wetlands and related areas adjacent to rivers, lakes, coasts and estuaries. These include coastal zone management regulations, shoreland and shoreland zoning programs, floodplain regulations, scenic and wild river regulations, public water programs and various critical area programs. Few regulations apply to slope, depressional and flat wetlands, particularly those smaller in size.

Natural hazards, impact of activities on other lands. Riverine, lake fringe and coastal/estuarine fringe wetlands and related lands are often characterized by moderate to severe natural hazards, such as flooding and erosion (in some instances). Development in riverine wetlands will often increase flood heights on other lands. Slope, depressional and flats are also subject to some flood and erosion hazards, but hazards are usually less serious.

Fishing and water recreation functions/values. Riverine, lake fringe and coastal and estuarine fringe wetlands and related floodplain/riparian areas are often characterized by fishing and water recreation functions/values because they contain or are adjacent to open water where fish live and feed. They protect adjacent waters from upland pollution by intercepting pollutants and sediment before they reach adjacent waters and remove pollutants from adjacent waters that may pulse into and out of wetlands (tides, floods, fluctuations in water levels). Slope, depressional and flats usually do not have fishing and major water recreation functions/values, such as boating and canoeing. However, they may have pollution buffering and habitat functions/values.

Susceptibility to watershed alterations. Lake fringe, river fringe and coastal/estuarine fringe wetlands and related water/floodplain/riparian ecosystems are less susceptible to changes in water regime due to development in the immediate watershed since water levels in these wetlands are dependent, in large measure, upon water levels in the adjacent water bodies. And, water levels in adjacent water bodies are dependent upon the much broader water regimes (e.g., ocean levels, river watersheds). In contrast, water levels in many slope, depressional and flat wetlands depend, to a considerable extent, on precipitation on the immediate watershed.

Data availability. Much more data is typically available to help regulators, landowners and others evaluate coastal fringe, estuarine fringe, lake fringe and river fringe wetlands and related areas than slope, depressional and flat wetlands. These include National Wetland Inventory Maps, state and local wetland maps, FEMA flood maps, surface water elevation and flood elevation records, fish surveys, recreational use surveys, bird surveys, etc.

Availability of regulatory agency technical assistance personnel. Federal, state and local regulatory personnel are usually located in towns and cities. Towns and cities are (in general) located on the coasts and estuaries and on larger lakes and streams. This means that there are more wetland regulators near to coastal fringe, estuarine fringe, lake fringe, and riverine wetlands waters and related resources. Fewer regulatory personnel are located in rural areas where many freshwater slope, depressional and slope wetlands are located.

CHARACTERISTICS BY WETLAND TYPE (OVERALL HGM TYPE)

(Note: this does not strictly follow the HGM classes)

River Fringe Wetlands

Settings: In rivers, creeks, stream beds, river banks or floodplains. Riverine wetlands are particularly extensive along large, low gradient rivers but also occur as broken thin bands or ribbons in and along many smaller perennial creeks, streams, and drainage ditches. They are generally characterized by unidirectional, flowing water.

Wetland Regulatory Jurisdiction: Most riverine wetlands are regulated by the Section 404 program, although individual permits may not be required pursuant to Nationwide 26 or other permits in headwater areas above the 5 cfs point. Most larger riverine wetlands are also regulated at state levels by freshwater wetland programs, floodplain, scenic and wild river, shoreland zoning, public water, or other programs. Most riverine floodplain wetlands along major rivers are regulated by local governments.

Ownership: Some river beds, and wetlands in such beds, are publicly owned to the high water mark, but most are in private ownership. Whether publicly or privately owned, most wetlands along navigable rivers are subject to navigable servitude and state public trust doctrines.

Hazards: Virtually all riverine wetlands are subject to flood hazards and many lie within floodways. Some riverine wetlands adjacent to large rivers are also subject to wave action. Many riverine wetlands along high gradient streams are also subject to erosion during large flood events. Activities in floodways may be subject to particularly deep and high velocity flows. Fills or other structures may block flood flows, causing increased heights on adjacent and upstream lands and increased downstream velocities.

Other Applicable Regulations: Local and state floodplain, local wetland, state dam, public water statutes, scenic and wild river statutes.

Common Functions/Values:

- Flood conveyance
- Flood storage
- Wave buffer and retardation
- Erosion control
- Pollution prevention and treatment
- Water recreation
- Fishery (larger rivers and streams)
- Waterfowl (larger rivers and streams)

Delineation: Riverine wetlands are often quite easy to identify and delineate since they are located along or in rivers and streams, and many wetlands have relatively sharp landward boundaries. However, it is often difficult to identify the landward boundary of large, low gradient floodplain wetlands, particularly forested wetlands.

Some Special Characteristics Relevant to Assessment: Determination of boundaries and ownership, and identification of functions and values may be complicated by several factors which need to be considered in each circumstance:

- Natural water regimes have often been altered. Dams control water levels in many wetlands on major rivers, and channelization has taken place on many others.
- Often sediment regimes have also been changed, affecting erosion and depositional processes.

(continued, pg. 148)

- Wetlands along smaller creeks are particularly susceptible to watershed changes that affect flow rates and water quality.
- Many riverine wetlands have been partially isolated from adjacent waters by levees.
- Many riverine wetlands are subject to severe flooding, with resulting temporary removal of vegetation and deposition of sediments or erosion.

Susceptibility of Hydrology to Change:
- Riverine wetlands change location over time as rivers migrate back and forth over a floodplain.
- Periodic floods deposit silt, erode wetlands and deposit silt again.
- Watershed changes and resulting changes in flow regimes can result in dramatic changes.

Restoration Potential: Often high for riverine marshes and shrub wetlands due to relatively predictable adjacent water sources; restoration more difficult for forested floodplain wetlands due to problems predicting and duplicating sensitive water regimes.

Data Availability: Certain types of data are quite broadly available for larger rivers and streams; less is available for smaller streams, creeks and drainageways. For example:
- NWI maps exist for most wetlands along most major rivers in the lower 48 states.
- Many state wetland maps exist for wetlands along major rivers.
- FEMA flood maps exist for major rivers and streams.
- Stream gauging records are available for many larger rivers and streams.
- Water quality information is available for many larger rivers and streams.

Lake Fringe Wetlands

Settings: Great Lakes, inland lakes, reservoirs and ponds. Most common in the northern tier of glaciated states (e.g., Wisconsin, Minnesota, Michigan, New York), but occur elsewhere as well. These wetlands are typically characterized by multidirectional flows.

Wetland Regulatory Jurisdiction: All major lakes and reservoirs are subject to Section 404 regulation. Virtually all larger lakes and reservoirs are also regulated by states pursuant to water quality statutes, public water and shoreland zoning statutes. Local governments regulate many privately owned lake fringe wetlands.

Ownership: The beds of most large lakes and some lake fringe wetlands (up to the high water mark) are publicly owned. Most others in private ownership are subject to public trust and/or navigable servitude doctrines.

Delineation: Lake fringe wetlands are often relatively easy to delineate due to fairly stable water levels, proximity to visible waters, availability of existing wetland maps and easily identifiable soil types.

Hazards: Flood hazards are common for lake fringe wetlands, including long-term flooding for groundwater fed lakes and closed basin lakes (e.g., the Great Salt Lake, Lake Elsinor). Lake fringe wetlands may also be subject to wave action and erosion along larger lakes and ice threats in the northern states.

Other Applicable Regulations: Lake fringe wetlands are typically regulated by a variety of local and state floodplain, and state dam, public water and shoreline zoning statutes.

Common Functions/Values:
- Fisheries
- Water recreation
- Pollution prevention and treatment

(continued, pg. 149)

- Water supply protection
- Erosion control
- Bird habitat
- Waterfowl habitat
- Mammal and amphibian habitat

Some Special Characteristics Relevant to Assessment:
- Many lakes have been dammed, which controls water levels and reduces wetland diversity and long-term sustainability.
- Strict water quality standards have been developed for most lakes because of their use for water-based recreation and water supply.

Susceptibility of Hydrology to Change: Relatively low susceptibility to drainage and other hydrologic changes unless filled or diked because of the constant source of water from the adjacent lake.

Restoration Potential: High restoration potential for partially drained lake fringe wetlands. Restoration is facilitated because lake elevations are often known with fair accuracy for larger lakes. This helps establish restoration elevation requirements. Other lake fringe wetlands may act as reference sites and may help guide elevation determinations. Seed stock will also be brought in by water from other wetlands along the lakeshore.

Data Availability: Relatively good for larger lakes; moderate to poor for others.
- NWI maps, state and local wetland maps are available for larger lakes in many states.
- Relatively precise lake elevation data is typically available for larger lakes, particularly those with water control structures.
- Good FEMA flood maps are available for Great Lakes, some other larger lakes and lakes with flood problems.

Estuarine and Coastal Fringe Wetlands

Settings: In deltas, behind barrier islands, along shores and estuarine rivers and in low energy, open coastal environments (e.g., Gulf Coast).

Wetland Regulatory Jurisdiction: All estuarine and coastal fringe wetlands are subject to the Section 404 program. Virtually all of these wetlands are also regulated by states pursuant to wetland, coastal zone management, water quality and public water statutes, as well as shoreland zoning statutes. Local governments regulate some of the privately owned wetlands.

Ownership: Most coastal and estuarine wetland beds are publicly owned (public ownership to ordinary high watermark). Even those privately owned are subject to state public trust and federal navigable servitude doctrines.

Delineation: It is usually easy to delineate estuarine and coastal fringe wetland boundaries due to the availability of existing wetland maps, proximity to coastal or estuarine waters, limited plant species due to salinity and easily observed fluctuations of the tides. However, there can be problems, particularly for altered wetlands and for larger tidal/freshwater wetlands, locating the inland boundary.

Hazards: Most estuarine and coastal wetlands are subject to deep flooding and, in some instances, significant wave action and erosion during hurricanes or storms. Inundation to depths of 10-15 feet is common during a 100-year hurricane or storm.

Other Applicable Regulations: Local and state floodplain, local wetland, state public water statutes, and coastal zone management statutes and plans broadly apply.

(continued, pg. 150)

Common Functions/Values:

- Fisheries and shellfish
- Water-based recreation
- Pollution prevention and treatment
- Wave retardation and erosion control
- Shorebird habitat
- Waterfowl habitat

Some Special Characteristics Relevant to Assessment:

- Tidally controlled, at least to the high tide line
- Periodically flushed by hurricanes and coastal storms

Susceptibility of Hydrology to Change: Coastal estuarine wetlands have a constant source of water—the ocean and tides. But, they are susceptible to human influences, such as diking and channelization. They may be particularly susceptibile to climate change and sea level rise where coastal and inland wetlands cannot migrate inland. This is particularly true where dams intercept riverine sediment sources (e.g., the Mississippi Delta and other deltas, wetlands behind barrier islands).

Restoration Potential:
High restoration potential for partially drained and diked coastal and estuarine wetlands if tidal action is restored. Restoration is facilitated because tides provide a constant and reliable water supply. Tidal elevations are often known with fair accuracy. Seed stock may be brought in by tides.

Data Availability: Relatively good

- Good NWI maps, state and local wetland maps in virtually all states.
- Recent aerial photography for many areas.
- Tide data and coastal flood data available in many locations.
- Good FEMA flood maps available for many coastal locations.

Slope Wetlands

Settings: Wide range of settings but principally on the sides or at the bottoms of hills and mountains; also in some river fringe, lake fringe and coastal/estuarine fringe settings. Ground water and surface runoff are the principle sources of water.

Wetland Regulatory Jurisdiction: Some slope wetlands are subject to the individual permits pursuant to the Section 404 program. Few smaller slope wetlands are regulated by states and local governments pursuant to wetland statutes. Although they may be subject to general zoning regulations.

Ownership: Unlike wetlands adjacent to navigable waters, most slope wetlands are privately owned except where they are on public lands. Public trust and navigable servitude do not generally apply.

Delineation: Often moderate to difficult due to fluctuations in water levels by season. Wetland soils may be poorly developed.

Hazards: Moderate to low although high ground water and ground water discharge may cause some flooding and some slope wetlands may be subject to high velocity surface runoff from adjacent hills or mountains.

Other Applicable Regulations: Usually few, other than general zoning.

(continued, pg. 151)

Some Functions/Values:

- Habitat for mammals, reptiles, amphibians and endangered species
- Pollution prevention
- Erosion control
- Bird habitat

Some Special Characteristics Relevant to Assessment:

- Dependent upon ground water discharge and, to a lesser extent, surface runoff
- Large numbers throughout landscape in humid and temperate climates particularly in mountain states
- Many isolated from other waters and wetlands during normal hydrologic conditions

Susceptibility of Hydrology to Change: High due to land uses such as grazing, development and drainage.

Restoration Potential: Varied. Relatively high for partially drained (as opposed to filled) slope wetlands where the ground and surface water regimes are intact. However, restoration potential is poor where wetlands are filled or water regimes have been altered.

Data Availability: Poor

- Poorly identified on wetland maps because maps do not show smaller wetlands. These wetlands may also be difficult to spot on aerial photos.
- Flood maps are almost never available for such wetlands.
- Surface water elevations and hydrologic records are almost never available for such wetlands.

Organic and Mineral Flats

Settings: Wide range of settings with low topographic gradients and moderate to abundant rainfall. These wetlands include wetlands in old glacial lake beds, coastal plain wetlands and bogs.

Wetland Regulatory Jurisdiction: Some, but not all are subject to the individual permits pursuant to the Section 404 program. Some larger, flat wetlands are regulated by states and local governments pursuant to wetland statutes or broader zoning.

Ownership: Most are privately owned except where they are part of large blocks of public lands. Some bogs may be considered lakes and therefore publicly owned.

Delineation: Relatively easy for some (e.g., bogs) with stable water levels and easily observed characteristics. Moderate to difficult for others due to low topographic gradients and fluctuating water levels.

Hazards: Usually low flood hazards, although high ground water levels and ground water discharge or runoff may cause some flooding. Many flats without outlets are subject to long-term fluctuations water levels.

Other Applicable Regulations: Usually few, local zoning.

Common Functions/Values:

- Habitat for mammals, reptiles, amphibians, endangered species
- Pollution prevention
- Flood storage
- In general, not flood conveyance areas, not fisheries habitat
- Limited water recreation value

(Continued, pg. 152)

Some Special Characteristics Relevant to Assessment:

- Many isolated during normal hydrologic conditions, not during times of floods
- Many altered, partially drained and partially filled
- Most are sinks and particularly susceptible to sedimentation, pollution
- Highly dependent upon runoff from the immediate watersheds

Susceptibility of Hydrology to Change: Moderate to great (depending upon the circumstances). Flats are quite susceptible to change because they depend on watershed runoff and ground water levels, which change due human influence (land clearing, development, drainage, dams, etc.). They are also susceptible to pollution and filling by sediment. They are, in general, sinks. Many are also susceptible to direct intrusion by dogs, cats, fills, lawn-moving, agriculture, etc. because of their small size, location in proximity to development activities and lack of buffers.

Restoration Potential: Varied. Relatively high for only partially drained (as opposed to filled) wetlands. However, restoration potential is poor where wetlands are filled or subject to high sedimentation or pollution rates.

Data Availability: In general, poor.

- Poorly identified on wetland maps because maps do not show smaller wetlands and these wetlands are difficult to spot on aerial photos.
- Flood maps almost never available for such wetlands.
- Surface water elevations and records are almost never available for such wetlands.

Depressional Wetlands

Settings: Wide range of settings, but mostly in the northern tier of glaciated states (kettleholes, potholes). Here there are millions of depressions in glacial till and moraines created by melting ice blocks during the retreat of the glaciers. Some depressional wetlands have also been created by solution (karst), wind action (Sand Hills of Nebraska), erosion and deposition (oxbows, vernal pools), and human activity (e.g., gravel pits,). Some depressional wetlands depend almost entirely on surface runoff (e.g., vernal pools); others depend on ground water (e.g., potholes), and many depend on a combination of ground and surface runoffs (e.g., potholes).

Wetland Regulatory Jurisdiction: Some depressional wetlands are subject to the individual Section 404 permits. Some depressional wetlands are regulated by states and local governments pursuant to wetland statutes, public water statutes or broader zoning statutes.

Ownership: Most are privately owned except where they occur on public land. Depressional wetlands are not, in general, subject to state public trust or navigable servitude doctrines.

Delineation: Quite easy for wetlands with relatively stable water levels and steep shoreland gradients (many potholes). But, difficult for vernal pools, potholes and others with widely fluctuating water levels over a period of years, and fluctuations in vegetation. Many are not shown on wetland maps due to small size (hard to see on a small-scale aerial photo).

Hazards: Flood hazards are moderate to low, although long-term fluctuations in high ground water levels can cause significant flooding (e.g., western Minnesota).

Other Applicable Regulations: Often few other than general zoning.

(continued, pg. 153)

Some Functions/Values:

- Habitat for mammals, reptiles, amphibians and endangered species
- Pollution prevention
- Erosion control
- Bird habit

Some Special Characteristics Relevant to Assessment:

- Dependent on ground water discharge and surface runoff
- Large numbers throughout the landscape in some states
- Many isolated or partially isolated from other rivers, streams during normal hydrologic conditions
- Many highly susceptible to watershed changes and resulting changes in runoff, sediment regimes and water quality.

Susceptibility of Hydrology to Change: Variable. Often high where watershed changes are occurring.

Restoration Potential: Variable. Relatively high for partially drained depressional wetlands (e.g., partial drainage for agricultural purposes). Poor for wetlands filled by sediment, pollutants or other materials because there is no or limited flushing action and long detention times.

Data Availability: Often poor

- Poorly identified on wetland maps because maps do not show smaller wetlands and are difficult to spot on aerial photos due to small size.
- Flood maps are rarely available for such wetlands.
- Surface water elevations and records are rarely available for such wetlands.

APPENDIX I: GLOSSARY, ACRONYMS

Adjacent Wetlands: Wetlands that border, are contiguous to, or neighbor another body of water and have a hydrological connection to that body of water.

Alternatives Analysis: The regulatory requirement contained in most wetland regulations that activities be located on upland rather than wetland sites, unless there are no practical alternatives.

Assessment: Gathering and analyzing data and information needed for various types of wetland decision-making.

Biochemical Oxygen Demand (BOD): The demand for dissolved oxygen needed for decomposition of organic matter in water.

Buffer: An area adjacent to a river, stream, wetland or other water body that serves to lessen the impact of wave action, storms, floods, the input of excessive nutrients or other impacts.

Cooperative Mitigation Ventures (Cooperative Projects): A wetland restoration, creation or enhancement project undertaken jointly by one or more parties. These parties often include one or more private landowners and one or more government agencies, but may also include nonprofit organizations and other parties.

Capacity: The ability (based on natural resource characteristics) of a wetland to produce various goods and services of use to society. Capacity depends primarily on natural hydrologic, biological, and chemical processes, but also depends on soils, topography and size.

Cumulative Impact: The sum total of the impacts caused by separate activities.

Data: Raw information, such as aerial photos, vegetation information, soils information, topography, etc., not yet analyzed for a specific purpose.

Dike: A bank or structure constructed to control or confine water (usually flood waters).

Delineation: Determination of wetland boundaries.

Environmental Impact Statement (EIS): Written reports that assess the environmental impacts of and alternatives to actions that may significantly affect the environment. The EIS is required by the National Environmental Policy Act.

EPA: The U.S. Environmental Protection Agency.

Estuary: A tidal habitat that is semi-enclosed by land but has open, partially obstructed, or sporadic access to the ocean, and in which ocean water is at least occasionally mixed with freshwater runoff from the land.

Floodplain: That portion of the land bordering a river, stream, lake or ocean that is periodically inundated with floodwater.

Floodplain Management: A program of corrective and preventive measures for reducing flood damages. It may include floodplain mapping, analysis, planning, regulation, acquisition, construction of flood control works, warning systems and other measures.

Floodway: That portion of the flood-prone zone along a river or stream that is needed to convey a specified (e.g., 100-year flood) with only a specified (usually one foot) rise of water level above the height of an unconstricted flood.

Functions: Used in a technical sense to mean normal or characteristic natural processes that take place in wetland ecosystems, or simply the things that wetlands do. Some examples: surface water storage, cycling of elements and maintenance of plant communities. It is more broadly used to indicate the various services wetlands provide (also called wetland values, functional values or functions/values).

GIS. Geoinformation System. A geo-referenced information storage and analytical system, usually computerized.

General Permit: A permit issued by the U.S. Army Corps of Engineers, pursuant to the Section 404 program, on a regional basis for categories of activities that are substantially similar in nature, are deemed to cause only minimal adverse environmental effects when performed separately, and are deemed to have only minimal cumulative adverse effects on the environment.

Gradient: A rate of inclination; a slope.

Groundwater: Water that normally is located below the ground surface.

HEP: Habitat Evaluation Procedure; a wildlife assessment procedure developed by the U.S. Fish and Wildlife Service.

HEC: Hydrolgic Engineering Center; a series of hydrologic and hydraulic assessment techniques developed by the Hydrologic Engineering Center, U.S. Army Corps of Engineers.

HGM: Hydrogeomorphic Assessment Method; this method is being developed by the Army Corps of Engineers in cooperation with other agencies.

Headwaters: For regulatory (Section 404) purposes, the point on a non-tidal stream above which the average annual flow is less than five cubic feet per second.

Hydric Soil: A soil that is saturated, flooded or ponded long enough during the growing season to develop anaerobic conditions that favor the growth and regeneration of hydrophytic vegetation.

Hydrologic Regime: The distribution and circulation of water in an area during a given period including fluctuations and periodicity.

Hydrophyte: A plant growing in water or on a wetland substrate that is at least periodically deficient in oxygen as a result of excessive water content.

IBI: Index of Biological Integrity; a biological reference standard of biological health and condition developed pursuant to various biological indicator assessment approaches, collectively referred to in this report as IBI assessment approaches.

Mitigation Plan: A plan for replacing lost functional capacity resulting from project impacts.

NRCS: The Natural Resources Conservation Service, United States Department of Agriculture.

NWI: National Wetland Inventory, conducted by the U.S. Fish and Wildlife Service.

Offsite Mitigation: Mitigation conducted at a location physically separated from the site at which the original impacts occurred.

Out-of-kind Mitigation: Mitigation in which lost wetland functions and or/values are replaced by a wetland of a different type.

Project Alternative(s): Different ways in which a given project can be carried out. Variables include: project location, design, method of construction, amount of fill required, among others.

Red Flag: In this report, an issue or problem of sufficient magnitude to require total protection for an area or the denial of permission for a project.

Riparian Areas: Vegetated corridors along rivers or streams that are occasionally flooded.

Sedimentation: Sediments entering and being deposited in wetlands and other water bodies.

Value of Wetland Function(s): The importance of a wetland function or functions to an individual or group.

Watershed: The geographical area that contributes ground or surface water to a lake, river, wetland or other point of reference.

WET: Wetland Evaluation Technique; a rapid assessment approach developed by the Federal Highway Administration in cooperation with the Corps of Engineers and other agencies.

Wetland: Pursuant to the Section 404 program, "(A)reas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (Corps Regulation 33 CFR 328.3 and EPA Regulations 40 CFR 230.3).

Wetland Banking: The process of creating a bank of created, enhanced or restored wetland to serve at a future date as mitigation for project impacts.

Wetland Creation: The process of creating a wetland in a location where a wetland did not previously exist.

Wetland Enhancement: The process of increasing the capacity of a wetland to perform one or more functions and serve one or more values.

Wetland Restoration: The process of restoring a wetland to previous (often more natural conditions.)

Yellow Flag: In this report, an issue or problem requiring more detailed investigation or study. A yellow flag issue may become a red flag after additional data gathering (e.g., confirmation of an endangered species).

APPENDIX J: RECOMMENDED READING

(Note: not all are cited in this guidebook.)

<u>Landowner Assistance</u>

Arkansas Game and Fish Commission. 1995. Landowners Guide to Voluntary Wetland Programs in Arkansas

Georgia Department of Community Affairs. Landowners' Guide to Wetlands and Watersheds. Office of Coordinated Planning, Atlanta, Georgia

Texas Parks & Wildlife. Wetlands Assistance Guide for Landowners. Austin, Texas

U.S. Department of the Interior. 1992. Wetlands Stewardship. Washington, D.C.

U.S. Environmental Protection Agency. 1992. Private Landowner's Wetlands Assistance Guide: Voluntary Options for Wetlands Stewardship in Maryland. Wetlands Protection Hotline, Washington, D.C.

Wiebe, K., A. Tegene, and B. Kuhn. 1996. Partial Interests in Land: Policy Tools for Resource Use and Conservation. U.S. Department of Agriculture, Washington, D.C.

<u>Regional Guidebook Materials</u>

1994. Science for Floodplain Management Into The 21st Century. Washington, D.C.

American Farmland Trust. Private and Public Options for Protecting Agricultural Land. Washington, D.C.

Bowmaster, J.P. and S.J. Young. 1993. Missouri Wetlands and Their Management. Missouri Department of Conservation. Conservation Commission, State of Missouri, Jefferson City, Missouri.

Association of State Floodplain Managers, Inc. 1996. Using Multi-Objective Management to Reduce Flood Losses In Your Watershed. Madison, Wisconsin.

Association of State Floodplain Managers. 1994. A Primer for Hosting Buyout Workshops. The Mitigation Assistance Corporation, Boulder, Colorado

Association of State Floodplain Managers. 1987. Reducing Losses in High Risk Flood Hazard Areas: A Guidebook for Local Officials. The Federal Emergency Management Agency

Cwikiel, W. 1996. Living With Michigan's Wetlands: A Landowner's Guide. Tip of the Mitt Watershed Council, Conway, Michigan

Cwikiel, W. (Ed.). 1995.Citizen Wetland Initiatives: Stories from the Great Lakes. Tipp of the Mitt Watershed Council, Conway, Michigan

Diamant, R., J.G. Eugster, and C.J. Duerksen. 1984. A Citizen's Guide to River Conservation. The Conservation Foundation, Washington, D.C.

Federal Interagency Floodplain Management Task Force. 1995. Protecting Floodplain Resources: A Guidebook for Communities. Washington, D.C.

Federal Interagency Floodplain Management Task Force. 1994. A Unified National Program for Floodplain Management. Washington, D.C.

Federal Interagency Foodplain Management Task Force. 1992. Floodplain Management in the United States: An Assessment Report. Volume 2: Full Report

Kusler, J.A. 1982. Innovation In Local Floodplain Management A Summary of Community Experience. Natural Hazards Research and Applications Information Center Special Publication 4. University of Colorado, Institute of Behavioral Science

Lincoln Institute of Land Policy. 1994. Community Land Policy and River Flooding: The Great Floods of “93. 1994 Cambridge Conference

Marolf, J., M. Hagerty, and J. Pyland. 1989. Wildlife and Man in Missouri. Conservation Commission of the State of Missouri. Jefferson City, Missouri

Michigan Department of Natural Resources. 1993. A Wetland Conservation Strategy for Michigan. Lansing, Michigan

Michigan Department of Natural Resources. 1989. Michigan Wetlands: A Guide for Property Owners and Home Builders. Lansing, Michigan

Michigan Department of Natural Resources. 1988. Wetland Protection Guidebook. Lansing, Michigan

Michigan Department of Natural Resources. 1982. Michigan’s Wetlands. Lansing, Michigan

Ministry of Natural Resources. 1994. Natural Channel Systems: An Approach to Management and Design. Ontario, Canada

Mississippi Headwaters Board. 1992. Mississippi Headwaters Management Plan. Walker, Minnesota

Mississippi Headwaters Board. 1992. Shoreland Zoning Manual: A Guide to Protecting Lakes and Streams through Local Land Use Controls. Walker, Minnesota

Missouri Department of Conservation. 1991. Landscaping for Backyard Wildlife. Urban Wildlife Series No. 3. Jefferson City, Missouri

National Parks Service. 1996. Floods, Floodplains and Floks. Rivers, Trails and Conservation Assistance Program

North Dakota Water Users Association. 1990. North Dakota Wetlands Management Handbook. Bismarck, North Dakota

Northern Vermont Resource Conservation and Development Council. 1979. Landowners Guide to Streambank Management

State of Wisconsin. 1995. Basic Guide to Wisconsin’s Wetlands and Their Boundaries. Department of Administration, Wisconsin Coastal Management Program, Madison, Wisconsin

State of Wisconsin. 1976. Wisconsin Wetlands. Pub. No. G 2818. Madison, Wisconsin

State Wetlands Plan. 1995. Dealing With Wetlands In Minnesota: Questions & Concerns From Around the State About Issues For a State Wetlands Conservation Plan. Project Reprot #1. Minnesota Department of Natural Resources, St. Paul, Minnesota

Tip of the Mitt Watershed Council. 1992. Michigan Wetlands Yours to Protect: A Citizen's Guide to Local Involvement in Wetland Protection. Second Edition. Conway, Michigan

U.S. Army Corps of Engineers. 1995. Floodplain Managment Assessment of the Upper Mississippi River and Lower Missouri Rivers and Tributaries. St. Paul, Minnesota

U.S. Army Corps of Engineers. 1993. Flood Proofing - How to Evaluate Your Options

U.S. Department of the Interior. 1993. Riparian Area Management: Process for Assessing Proper Functioning Condition. Bureau of Land Managment, Denver, Colorado. Tech. Ref. 1737-9

U.S. Department of the Interior. 1991. A Casebook in Managing Rivers for Multiple Uses. National Park Service, Washington, D.C.

University of Minnesota. 1994. Recovery and Resettlement A First Look at Post-Flood Recovery Planning Issues in the Upper Mississippi River Valley. Design Center for American Urban Landscape, College of Architecture and Landscape Architecture. Minneapolis, Minnesota

Wolf, R. Raccoon River Watershed Project. West Des Moines, Iowa

Education

Briuer, E. 1994. The Young Scientist's Introduction to Wetlands. U.S. Army Corps of Engineers, Vicksburg, Mississippi

Environmental Conern, Inc. and The Watercourse. 1995. WOW! The Wonders of Wetlands. St. Michaels, Maryland and Bozeman, Montana

Creation and Restoration Guidance

Apogee Research, Inc. 1994. National Wetland Mitigation Banking Study: An Examination of Wetlands Programs: Opportunities for Compensatory Mitigation. Bethesda, Maryland

Coastal America. 1996. Coastal Restoratin and Protection: Lessons Learned. Coastal America Technology Transfer Report. Silver Spring, Maryland

Coastal American. 1993. Building Alliances To Restore Coastal Environments. Washington, D.C.

Dennison, M. S. 1997. Wetland Mitigation: Mitigation Banking and Other Strategies For Development and Compliance. Government Institutes, Rockville, Maryland

Kusler, J.A. and M.E. Kentula. (Eds.). 1990. Wetland Creation and Restoration The Status of the Science. Islanld Press, Washington, D.C.

Marsh, L., D. R. Porter, and D. A. Salvesen. (Eds.). 1996. Mitigation Banking Theory and Practice. Island Press, Washington, D.C.

U.S. Environmental Protection Agency. 1995. Review of Federal Agency/Nonprofit Organization Partnerships For Stream Restoration. Washington, D.C.

U.S. Environmental Protection Agency. 1992. Restoring and Creating Wetlands: A Planning Guide for the Central States Region: Iowa, Kansas, Missouri, and Nebraska. Region 7, Wetlands Protection Section, Kansas City, Kansas

Watershed Planning/Management Guidance

Ministry of Natural Resources. 1993. Integrating Water Management Objectives Into Municipal Planning Documents. Ontario, Canada

Ministry of Natural Resources. 1993. Water Management On A Watershed Basis: Implementing an Ecosystem Approach. Ontario, Canada

Ministry of Natural Resources. 1993. Subwatershed Planning. Ontario, Canada

Napa County Resource Conservation District. 1994. Napa River Watershed Owner's Manual: A Framework for Integrated Resource Management. Napa, California

River Federation. 1994. Institutional Frameworks For Watershed Management Programs: Profiles and Analysis of Selected Programs. Silver Spring, Maryland. Order No. 2W-6317-NASA.

River Network. 1995. The Watershed Innovators Workshop. Portland, Oregon

U.S. Advisory Commission on Intergovernmental Relations. 1996. Watershed and Regionally-Based Wetlands Planning and Management Institutions For The Future. Discussion Draft. Washington, D.C.

U.S. Environmental Protection Agency. 1995. Watershed Protection: A Project Focus. Washington, D.C.

U.S. Environmental Protection Agency. 1995. Watershed Protection: A Statewide Approach. Washington, D.C.

U.S Environmental Protection Agency. 1995. Waterhsed Tools Directory. Washington, D.C.

U.S. Environmental Protection Agency. 1994. NPDES Watershed Strategy. Washington, D.C..

U.S. Environmental Protection Agency. 1994. Section 319 Success Stories. Office of Wetlands, Oceans and Watersheds, Washington, D.C.

United States General Accounting Office. 1995. Agriculture and the Environment: Information and Characteristics of Selected Watershed Projects. Washington, D.C.

Water Quality; Stormwater

City of Eugene. 1993. Comprehensive Stormwater Management Plan. Draft. Eugene, Oregon

Horner, R. R., J. Skupien, E. H. Livingston, and H. E. Shaver. 1994. Fundamentals of Urban Runoff Management: Technical and Institutional Issues. Terrene Institute, Washington, D.C.

Mann, J.E. 1993. Citizens Water Quality Handbook. Northern Virginia Soil and Water Conservation District. Fairfax, Virginia

Schueler, T. 1995. Site Planning for Urban Stream Protection. Center for Waterhsed Protection, Silver Spring, Maryland

Terrene Institute. 1993. Clean Water in Your Watershed: A Citizens Guide to Watershed Protection. Washington, D.C.

U.S. Department of Agriculture. 1992. Clean Water...A Community Commitment to Protecting New York's Watersheds. Soil Conservation Service

U.S. Environmental Protection Agency. 1997. Drinking Water Infrastructure Needs Survey. Washington, D.C.

U.S. Environmental Protection Agency. 1990. National Water Quality Inventory. Washington, D.C. pp. 187 + Appendix.

U.S. Environmental Protection Agency. 1990. Water Quality Standards for Wetlands. Office of Water Regulations and Standards, Washington, D.C.

U.S. Environmental Protection Agency. 1988. America's Wetlands Our Vital Link Between Land and Water. Public Information Center (PM-211B), Washington, D.C.

U.S. Environmental Protection Agency. Protecting Natural Wetlands: A Guide to Stormwater Best Management Practices. Office of Water, Washington, D.C.

<u>State and Local Guidebooks</u>

Crane, S., J. Goldman-Carter, H. Sherk, and M. Senatore. 1995. Wetlands Conservation: Tools for State and Local Action. World Wildlife Fund, Washington, D.C.

Goldman-Carter, J. 1989. A Citizens' Guide to Protecting Wetlands. The National Wildlife Federation, Washington, D.C.

Frome, M.L. and E. Shenkman (Eds.). 1990. Wetlands Protection: A Handbook for Local Officials. Report No. 7. Department of Environmental Resources, Commonwealth of Pennsylvania, Harrisburg, Pennsylvania

Henderson, T.R., W. Smith, and D.G. Burke. 1983. Non-Tidal Wetlands Protection: A Handbook for Maryland Local Governments. Maryland Department of Natural Resources

Kusler, J. and T. Opheim. 1996. Our National Wetland Heritage: A Protection Guide. Second Edition. Environmental Law Institute, Washington, D.C.

Kusler, J.A., W.J. Mitsch, and J.S. Larson. 1994. Wetlands *in* Scientific American. January vol. 270, no. 1, pp. 50-56.

National Audubon Society. 1990. Saving Wetlands: A Citizens' Guide for Action in Florida

Rubey Frost, J. and K. Stenberg. 1992. Designing Wetlands Preservation Programs for Local Governmental: A Summary. Washington State Department of Ecology, Olympia, Washington. Pub. No. 92-19

U.S. Department of Transportation. Wetlands and Highways: A Natural Approach. Federal Highway Administration. Pub. No. FHWA-PD-94-004HEP-40/11-93(30M)E

U.S. Environmental Protection Agency. 1997. Protecting Wetlands: Tools for Local Governments in the Chesapeake Bay Region. Chesapeake Bay Program Office, Annapolis, Maryland

U.S. Environmental Protection Agency. 1996. Chesapeake Bay Communities-Making the Connection. Chesapeake Bay Program Office, Annapolis, Maryland

U. S. Environmental Protection Agency. 1994. Innovations In Coastal Protection: Searching For Uncommon Solutions To Common Problems. Washington, D.C.

U.S. Environmental Protection Agency. 1993. Building Near Wetlands: The Dry Facts. Pub. #EPA-902-F-93-001. New York, New York

U.S. Environmental Protection Agency. 1992. Audubon's America A Cooperative Landscape Conservation Project. Washington, D.C.

U.S. Environmental Protection Agency. 1988. Welcome to the Wetlands. Region 5, Chicago, Illinois

U.S. Environmental Protection Agency, Region 2. 1993. Wetlands Regulation Guidebook for New York State. Marine and Wetlands Protection Branch, New York, New York

Washington State Department of Ecology. 1990. Wetland Walks: A Guide to Washington's Public Access Wetlands. Wetland Section. Olympia, Washington. Pub. No. 89-30

Washington State Department of Ecology. 1986. Wetlands Acquisition & Preservation: A Guide for Landowners and Government Agencies. Shorelands & Coastal Zone Management Program, Wetlands Section

General Information and Guidance

Braddock, T. 1995. Wetlands: An Introduction to Ecology, the Law, and Permitting. Government Institutes, Inc., Rockville, Maryland

Brinson, M. M., F. R. Hauer, L. C. Lee, W. L. Nutter, R. D. Rheinhardt, R. D. Smith, and D. Whigham. 1995. A Guidebook for Application of Hydrogeomorphic Assessments to Riverine Wetlands. U.S. Army Corps of Engineers, Waterways Experiement Station, Washington, D.C. Technical Report WRP-DE-11

Brooks, R. P., D. A. Devlin, and J. Hassinger. 1993. Wetlands and Wildlife. The Pennsylvania State University, University Park, Pennsylvania

The Conservation Foundation. 1988. Protecting America's Wetlands: An Action Agenda. Washington, D.C.

Cooper, A. R., Sr. 1996. A Checklist Approach to Phase I Environmental Site Assessments. Government Institutes, Inc., Rockville, Maryland

Dahl, T.E. 1990. Wetlands Losses in the United States 1780's to 1980's. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C.

Dugan, P. J. (Ed.). 1990. Wetland Conservation: A Review of Current Issues and Required Action. IUCN, Gland, Switzerland

Erwin, K. L. 1996. A Bibliography of Wetland Creation and Restoration. The Association of State Wetland Managers, Inc., Berne, New York

Interagency Ecosystem management Task Force. 1995. The Ecosystem Approach: Healthy Ecosystems and Sustainable Economies. Voume II-Implementation Issues. National Technical Information Service, Springfield, Virginia. PB95-265591

Jensen, K.C. and C.O. Martin. 1994. Guidelines for Placement and Management of Wood Duck Nest Bozes in Wetland Habitats. USACOE, Vicksburg, Mississippi. WRP Tech. Note FW-SW-4.1.

Mitsch, W. J. and J. G. Gosselink. 1993. Wetlands Second Edition. Van Nostrand Reinhold, New York, New York

Morrish, W. R. and C. R. Brown. 1994. Planning To Stay. Milkweed Editions, Minneapolis, Minnesota

Platts, W. S., C. Armour, G. Booth, M. Bryant, J. L. Bufford, P. Cuplin, S. Jensen, G. W. Lienkaemper, G. W. Minshall, S. B. Monsen, R. L. Nelson, J. R. Sedell, and J. S. Tuhy. 1987. Methods for Evaluating Riparian Habitats With Applications to Management. U.S. Department of Agriculture, Forest Service, Intermountain Research Station. General Technical Reprot INT-221. Ogden, Utah

Smith, R. D., A. Ammann, C. Bartoldus, and M. M. Brinson. 1995. An Approach for Assessing Wetland Functions Using Hydrogeomorphic Classification, Reference Wetlands, and Functional Indices. U.S. Army Corps of Engineers, Waterways Experiment Station, Washington, D.C. Technical Report WRP-DE-9

South Carolina Water Resources Commission. 1993. Toward No Net Loss: A Methodology For Identifying Potential Wetland Mitigation Sites Using a Geographic Information System. Columbia, South Carolina

U.S. Army Corps of Engineers. Recognizing Wetlands. National Technical Information Service, Springfield, Virginia

U.S. Army Corps of Engineers. Regulatory Permit Program. Jacksonville, Florida

U.S. Department of Agriculture. 1994. Working With Wetlands. Soil Conservation Service, Washington, D.C. No. 672.

U.S. Environmental Protection Agency. 1995. Wetlands Fact Sheets. Office of Water, Office of Wetlands, Oceans and Watersheds (4502F), Washington, D.C. No. EPA843-F-95-001

U.S. Fish and Wildlife Service. 1989. National Wetlands Priority Conservation Plan. Washington, D.C.

U.S. Geological Survey. 1996. National Water Summary on Wetland Resources. Reston, Virginia. Water-Supply Paper 2425

Wilson, S. and T. Moritz. 1996. The Sierra Club Wetlands Reader: A Literary Companion. Sierra Club Books, San Francisco, California

World Wildlife Fund. 1992. Statewide Wetlands Strategies: A Guide to Protecting and Managing the Resource. Island Press, Washington, D.C.