National Management Measures to Protect and Restore Wetlands and Riparian Areas for the Abatement of Nonpoint Source Pollution

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Nonpoint Source Control Branch
Office of Wetlands, Oceans and Watersheds
Office of Water
U.S. Environmental Protection Agency

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Disclaimer

This document provides guidance to States, Territories, authorized Tribes, and the public regarding management measures that may be used to reduce nonpoint source pollution through the protection and restoration of wetlands and riparian areas. At times, this document refers to statutory and regulatory provisions, which contain legally binding requirements. This document does not substitute for those provisions or regulations, nor is it a regulation itself. Thus, it does not impose legally-binding requirements on EPA, States, Territories, authorized Tribes, or the public and may not apply to a particular situation based upon the circumstances. EPA, State, Territory, and authorized Tribe decision makers retain the discretion to adopt approaches to control nonpoint source pollution by protecting and restoring wetlands and riparian activities on a case-by-case basis that differ from this guidance where appropriate. EPA may change this guidance in the future.

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1 Introduction

The nation's aquatic resources are among its most valuable assets. Although environmental protection programs in the United States have successfully improved water quality during the past 30 years, many challenges remain. Significant strides have been made in reducing the impacts of discrete pollutant sources, but aquatic ecosystems remain impaired, primarily because of complex pollution problems caused by nonpoint source (NPS) pollution.

Wetlands and riparian areas play a significant role in managing the adverse water quality impacts associated with NPS pollution.

The most recent national water quality inventory (2000) shows that nearly 39 percent of assessed rivers and streams, 45 percent of lakes, reservoirs, and ponds, and 51 percent of estuaries in the United States remain too polluted for fishing, swimming, and other uses (USEPA, 2002). Habitat alterations, such as hydromodification, dredging, streambank destabilization, and the loss or degradation of wetlands, contribute to the impacts on quality. Many pollutants are delivered to these surface waters and to ground water from diffuse sources, such as urban runoff, agricultural runoff, and atmospheric deposition of contaminants.The leading causes of impairment are nutrients, pathogens, siltation, oxygen-depleting substances, metals, and suspended solids (USEPA, 2000a).

Wetlands and riparian areas play a significant role in protecting water quality and reducing adverse water quality impacts associated with NPS pollution, and they help decrease the need for costly stormwater and flood protection facilities. Thus, wetlands and riparian areas are an important component of a combination of management practices that can be used to reduce NPS pollution. In addition, in their natural condition they provide habitat for feeding, nesting, cover, and breeding to many species of birds, fishes, amphibians, reptiles, and mammals.

Although wetlands have long been recognized for their water quality improvement functions, unrestricted use of natural wetlands as receptacles for point and nonpoint source pollution, such as urban stormwater and other sources of runoff, could have an adverse effect on wetlands and wetland biota. As stated by Robb (1992):

> *Wetlands have an important role in the landscape through their ability to improve water quality by filtering, transforming, and accumulating pollutants and thereby protecting adjacent rivers, lakes, and streams. This "buffering" function, however, also encourages overuse, and this overuse can compromise these and other wetland functions, such as wildlife habitat and aesthetic and recreational values.*

According to Fields (1992), wetlands should be preserved for their pollutant abatement abilities while maintaining overall wetland health.

> *Foremost, wetlands should be protected because of the many values and functions they provide. But, in addition, protection and restoration of wetlands are also acceptable management measures for preventing the impacts to water*

> *quality that result when wetlands are destroyed or degraded... The benefit of improved water quality will be realized if wetlands and riparian areas are maintained (or restored) in the landscape to perform their natural functions. When this approach is used, additional BMPs [best management practices], such as buffer zones, must be utilized to ensure that there is no adverse impact to wildlife using the wetlands and that the integrity of the wetlands will be maintained over time.*

1.1 What Are The Purpose and Scope of This Guidance?

This guidance document describes practices to reduce NPS pollution of surface waters and ground water through the protection and restoration of wetlands and riparian areas, as well as the implementation of vegetated treatment systems. The guidance provides background information about NPS pollution, including where it comes from and how it enters the nation's waters; discusses the broad concept of assessing and addressing water quality problems on a watershed level; and presents recent technical information about how certain types of NPS pollution can be reduced effectively through the implementation of these management measures. This document is not intended to be used as a design guide for restoring or constructing wetlands, nor should it replace input from experts during the planning or implementation phases of wetland or riparian area creation or restoration.

Although the scope of this guidance is broad and includes many diverse wetland and riparian area NPS topics, a number of issues are not covered. Such issues include treatment wetlands for abandoned mine drainage and wastewater treatment wetlands. Application of constructed wetlands as an alternative to conventional engineering methods for the treatment of mine drainage and wastewater is gaining recognition as a reliable and economical method for improving water quality. Information on this technology is growing at exponential rates. Readers interested in these topics are referred to USEPA (1999), USEPA (2000d), Kadlec and Knight (1996), Moshiri (1993), or a local Natural Resources Conservation Service (NRCS) office for information on the planning, design, construction, and operation of treatment wetlands for water quality improvement.

This guidance is designed to provide current information to state program managers on controlling NPS pollution to wetlands, riparian areas, and vegetated treatment systems.

This document provides guidance to states, territories, authorized tribes, and the public regarding management measures that may be used to protect and restore the NPS pollution abatement functions of wetlands and riparian areas. This document refers in some instances to statutory and regulatory provisions that contain legally binding requirements. This document does not substitute for those provisions or regulations, nor is it a regulation itself. Thus, it does not impose legally binding requirements on the United States Environmental Protection Agency (EPA), states, territories, authorized tribes, or the public and might not apply to a particular situation based upon the circumstances. The decision makers of EPA, states, territories, and authorized tribes retain the discretion to adopt approaches on a case-by-case basis that differ from this guidance where appropriate. EPA may change this guidance in the future.

This guidance is consistent with the *Guidance Specifying Management Measures for Sources of Nonpoint Source Pollution in Coastal Waters* (USEPA, 1993c), published under section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990 (CZARA). The management measures are the same, but this document modifies, expands, and supplements the technical information contained in the coastal management measures guidance to ensure that it reflects particular circumstances relevant to differing inland conditions and provides up-to-date technical information.

This guidance does ***not*** *replace the 1993* Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters.

This guidance contrasts with the CZARA management measures guidance, which requires that state coastal nonpoint pollution control programs are in conformity with CZARA management measures. The guidance provided in this document, on the other hand, is intended merely to provide technical assistance to state program managers and others with general knowledge of wetland ecosystems who are seeking updated information on practices to address NPS pollution. This guidance accomplishes that objective by expanding and enhancing the descriptions and examples first presented in the CZARA guidance. This document does not set new or additional standards for either CZARA section 6217 Coastal Nonpoint Pollution Control Programs or Clean Water Act section 319 Nonpoint Source Management Programs.

1.2 What Is in This Document?

This document contains six chapters and six appendices, which are described below.

Chapter 1: Introduction

Chapter 1 provides a brief introduction to NPS pollution and the national effort to control it. It also provides background information on the 1993 *Guidance Specifying Management Measures for Sources of Nonpoint Source Pollution in Coastal Waters*, a predecessor to this document.

Chapter 2: Overview

Chapter 2 introduces wetlands, riparian areas, and vegetated treatment systems. It explains what they are, how they function, and what their importance is in terms of NPS pollution.

Chapter 3: Management Measures

Chapter 3 briefly defines what management measures are and how they work to prevent NPS pollution. It also describes management practices.

Chapter 4: Protection of Wetlands and Riparian Areas

Chapter 4 contains information on the management measure for the protection of wetlands and riparian areas and its four practices. It also has a list of resources for further information.

Chapter 5: Restoration of Wetlands and Riparian Areas

Chapter 5 explains what restoration is and discusses the management measure for restoration of wetlands and riparian areas. Three practices to implement the management measure are discussed.

Chapter 6: Vegetated Treatment Systems

Chapter 6 describes the management measure and three practices related to vegetated treatment systems.

Resources

A list of resources for further information on topics discussed in this document is provided.

Glossary

The glossary defines important terminology used throughout this document.

References

The references used in this document are provided in one combined section.

Appendix A: Examples of Federal, Nonprofit, and Private Financial and Technical Assistance Programs

Appendix A contains information on federal incentive programs to protect and restore wetlands. It also contains information on incentive programs from non-profit and private organizations. For each agency and organization, contacts are provided for further information.

Appendix B: U.S. Environmental Protection Agency Contacts

Appendix B provides wetland contacts, NPS regional contacts, and Clean Water State Revolving Fund contacts.

Appendix C: U.S. Army Corps of Engineers Wetland Contacts

Appendix C provides information on Division Regulatory Offices and District Regulatory Offices for the U.S. Army Corps of Engineers.

Appendix D: U.S. Fish and Wildlife Service Regional Wetland Contacts

Appendix D lists regional wetland contacts.

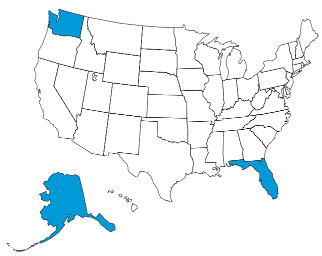
Appendix E: U.S. State and Territory Agency Wetland Contacts

Appendix E provides wetland contact names for each state and trust territory.

Appendix F: Case Studies Organized by State, Territory, and Tribe

Appendix F is directly related to the tables provided in the chapters. It provides more detailed information on implementation activities, case studies, and resource documents. In Chapters 4 through 6, appropriate implementation practices are described for each management measure. Within the discussion of each implementation practice is a table entitled "Map Box." The map box contains a list of appropriate activities that can be used to implement that practice. Each implementation activity is followed by a list of titles and locations, e.g., "Local Wetland Management Plans (AK)." (See Table 1-1.) These titles indicate a specific case study representative of that implementation activity. By using the location indicator, in this case AK for Alaska, the reader knows to turn to Appendix F, find the section on Alaska, and look for the case study entitled "Local Wetland Management Plans." It is there that the reader can find more information about the case study, including the source of information. At the top of each map box, an outline of the United States indicates that there are case studies for this practice from those states that are shaded.

Table 1-1. Example of Map Boxes throughout Document Referencing Case Studies (Appendix F)



Practice: Consider wetlands and riparian areas and their NPS control potential on a watershed or landscape scale.

This table provides some examples from different locations in the United States of the kinds of activities that can help implement this practice. For more information about the examples, refer to Appendix F at the back of the document.

Implementation Activities	Example Projects
Use a landscape approach to evaluate wetland water quality functions.	Local Wetland Management Plans (AK), Wetland Protection (FL)
Use watershed analysis as a tool to ensure functional performance.	Synoptic Assessment Approach (WA)

1.3 What Is Nonpoint Source Pollution?

NPS water pollution comes from diffuse or scattered sources in the environment, rather than from a defined outlet such as a pipe. Generally, NPS pollution results from precipitation, atmospheric deposition, land runoff, infiltration, drainage, seepage, or hydrologic modification. As runoff from rainfall or snowmelt moves, it picks up and transports natural pollutants and pollutants resulting from human activity, ultimately depositing them into rivers, lakes, wetlands, and coastal waters or, through percolation, into the ground water. In a legal sense, the term *nonpoint source* is defined to mean any source of water pollution that does not meet the legal definition of *point source* in section 502(14) of the Clean Water Act, as amended by the Water Quality Act of 1987.

> *The term* **point source** *means any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft from which pollutants are or may be discharged. This term does not include agricultural stormwater discharges and return flows from irrigated agriculture.*

Although diffuse runoff is usually treated as NPS pollution, runoff that enters and is discharged from conveyances such as those described above, as well as runoff from construction activities, is treated as a point source discharge and therefore is subject to the permit requirements of the Clean Water Act. In contrast, nonpoint sources are not subject to federal permit requirements. Point sources typically enter receiving surface water bodies at some identifiable site(s) and carry pollutants whose generation is controlled by some internal process or activity, rather than by the weather. Point source discharges such as municipal and industrial wastewaters, runoff or leachate from solid waste disposal sites and concentrated animal feeding operations, storm sewer outfalls from large urban centers, and Phase I and Phase II construction stormwater runoff are regulated and permitted under the Clean Water Act.

Although it is imperative that water program managers understand and manage in accordance with legal definitions and requirements, the nonlegal community often characterizes nonpoint sources in the following ways:

- NPS discharges enter surface waters or ground water in a diffuse manner at intermittent intervals related mostly to meteorological events.
- Pollutant generation arises over an extensive land area, and pollutants move overland before they reach surface waters or infiltrate into the ground water.
- The extent of NPS pollution is related to uncontrollable climatic events and to geographic and geologic conditions, and it varies greatly from place to place and from year to year.
- Nonpoint sources are often more difficult or expensive to monitor, as compared to point sources.
- Abatement of NPS pollution is focused on land and runoff management practices, rather than on effluent treatment.

Hydrologic modification, an additional form of nonpoint source pollution, can cause adverse effects on the biological and physical integrity of surface waters and ground water. This can include increases in NPS pollutants, such as suspended solids, toxic substances, organic matter, heat, excess salts, and pathogens.

1.4 What National Efforts Are Under Way to Control Nonpoint Source Pollution?

1.4.1 Nonpoint Source Program (Clean Water Act Section 319)

Section 319 requires states to assess NPS pollution and implement management programs.

During the first 15 years of the national program to abate and control water pollution (1972-1987), EPA and its partners focused most of their water pollution control activities on traditional point sources like discharges through pipes from sewage treatment plants and industrial facilities. These point sources have been regulated by EPA and the states through the National Pollutant Discharge Elimination System (NPDES) permit program established by section 402 of the 1972 Federal Water Pollution Control Act (Clean Water Act).

As a result of the activities mentioned previously, the nation has greatly reduced pollutant loads from point source discharges and has made considerable progress in restoring and maintaining water quality. However, the gains in controlling point sources have not solved all of the nation's water quality problems. Recent studies and surveys conducted by EPA and by state and tribal water quality agencies indicate that the majority of the remaining water quality impairments in our nation's rivers, streams, lakes, estuaries, coastal waters, and wetlands result from NPS pollution and other nontraditional sources, such as urban stormwater discharges and combined sewer overflows.

In 1987, in view of the progress achieved in controlling point sources and the growing national awareness of the increasingly dominant influence of NPS pollution on water quality, Congress amended the Clean Water Act to focus greater national efforts on nonpoint sources. Under this amended version, referred to as the Water Quality Act of 1987, Congress revised section 101, Declaration of Goals and Policy, to add the following fundamental principle:

> *It is the national policy that programs for the control of NPS pollution be developed and implemented in an expeditious manner so as to enable the goals of this Act to be met through the control of both point and nonpoint sources of pollution.*

Section 319 authorizes EPA to provide grants to assist state and tribal NPS pollution control programs.

More importantly, Congress enacted section 319 of the Clean Water Act, which established a national program to control nonpoint sources of water pollution. Under section 319, states and tribes assess NPS pollution problems and causes within the state and implement management programs to control the NPS pollution. Section 319 authorizes EPA to issue grants to states to assist them in implementing management programs or portions of management programs that have been approved by EPA. Other federal water management agencies such as the U.S. Departments of Agriculture and Interior, the Bureau of Reclamation and the U.S. Army Corps of Engineers (USACE) are also involved in nonpoint source pollution control activities; therefore, federal agencies may need to coordinate with state and tribal programs to the extent that agency mission activities intersect with these programs.

1.4.2 Section 404 Discharge of Dredged and Fill Material

Under section 404 of the Clean Water Act, persons planning to discharge dredged or fill material to wetlands or other waters of the United States must obtain authorization for the discharge from the USACE, or a state approved to administer the section 404 program. Such authorization can be through issuance of an individual permit, or may be subject to a general permit, which apply to certain categories of activities having minimal adverse environmental effects. Implementation of section 404 is shared between the USACE and EPA. The USACE is responsible for reviewing permit applications and deciding whether to issue or deny permits. EPA, in consultation with the USACE, develops the section 404(b)(1) guidelines, which are the environmental criteria that the USACE applies when deciding whether to issue permits, and EPA also has authority under section 404(c) to "veto" USACE issuance of a permit in certain cases. EPA also has responsibility for determining what is a "water of the United States" protected by Clean Water Act programs, including Section 404. More information about the 404 program is provided at <*http://www.epa.gov/owow/wetlands*>.

1.4.3 National Estuary Program

EPA also administers the National Estuary Program under section 320 of the Clean Water Act. This program focuses on both point and nonpoint sources of pollution in designated geographically targeted, high-priority estuarine waters. Through this program, EPA assists state, regional, and local governments in developing comprehensive conservation and management plans that recommend priority corrective actions to restore estuarine water quality, fish populations, and other designated uses of the waters.

1.4.4 Pesticides Program

Another program administered by EPA that controls some forms of NPS pollution is the pesticides program under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Among its provisions, the program authorizes EPA to control pesticides that might threaten ground water and surface waters. FIFRA provides for the registration of pesticides and enforceable label requirements, which may include maximum rates of application, restrictions on use practices, and classification of pesticides as "restricted use" pesticides (which restricts use to certified applicators trained to handle toxic chemicals).

1.4.5 Farm Bill Conservation Provisions

Many Farm Bill programs provide funds for land treatment. Please contact your state or local U.S. Department of Agriculture (USDA) office for details.

Technical and financial assistance for landowners seeking to preserve soil and other natural resources is authorized by the federal government under provisions of the Food Security Act (Farm Bill). Appendix A lists several USDA programs with provisions included in the 1996 and 2002 Farm Bills that relate directly to installation and maintenance of BMPs. Some of these programs include:

- Conservation Reserve Program (CRP)
- Wetlands Reserve Program (WRP)
- Environmental Quality Incentives Program (EQIP)
- Wildlife Habitat Incentives Program (WHIP)
- Conservation of Private Grazing Land
- Swampbuster Program
- Conservation of Highly Erodible Lands
- Forest Land Enhancement Program (FLEP)
- Grassland Reserve Program (GRP)
- Resource Conservation and Development Program (RC&D)

1.4.6 Coastal Nonpoint Pollution Control Program

In November 1990 Congress enacted the CZARA. These amendments were intended to address the impact of NPS pollution on coastal waters.

Congress enacted section 6217 of CZARA, providing that each state with an approved Coastal Zone Management Program must develop and submit to EPA and the National Oceanic and Atmospheric Administration (NOAA) for approval a Coastal Nonpoint Pollution Control Program. The purpose of the program is "to develop and implement management measures for NPS pollution to restore and protect coastal waters, working in close conjunction with other state and local authorities."

The intent of the legislation was for state coastal zone and water quality agencies to have balanced roles, analogous to the sharing of responsibility between NOAA and EPA at the federal level.

Section 6217(g) of CZARA required EPA to publish, in consultation with NOAA, the U.S. Fish and Wildlife Service (USFWS), and other federal agencies, "guidance for specifying management measures for sources of nonpoint pollution in coastal waters." *Management measures* are defined in section 6217(g)(5) as:

> *Economically achievable measures for the control of the addition of pollutants from existing and new categories and classes of nonpoint sources of pollution, which reflect the greatest degree of pollutant reduction achievable through the application of the best available nonpoint source control practices, technologies, processes, siting criteria, operating methods, or other alternatives.*

In 1993 EPA published *Guidance Specifying Management Measures for Sources of Nonpoint Source Pollution in Coastal Waters* (USEPA, 1993c). In the 1993 document, management measures for urban areas; agricultural sources; forestry; marinas and recreational boating; hydromodification (channelization and channel modification, dams, and streambank and shoreline erosion); and wetlands, riparian areas, and vegetated treatment systems were defined and described. The management measures included in this document for controlling NPS pollution in wetlands, riparian areas, and vegetated treated systems are based on those outlined in the 1993 CZARA guidance.

2 Overview of Wetlands, Riparian Areas, and Vegetated Treatment Systems

Understanding the role of wetlands, riparian areas, and vegetated treatment systems in abating NPS pollution requires an understanding of several terms. Because federal, state, and local laws, ordinances, and policy documents define these terms in a number of different ways, this chapter provides an overview of how the terms might be interpreted and defines the terms as they are used in this document.

2.1 Wetlands and Riparian Areas

For purposes of this guidance, ***wetlands*** are defined as

> *those areas that are inundated or saturated by surface water 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.*

Wetlands are defined as those areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil conditions.

As waters of the United States, wetlands are afforded protection under the Clean Water Act. Although the focus of this document is on the function of wetlands in reducing NPS pollution, it is important to keep in mind that wetlands are ecological systems that perform a range of functions (e.g., hydrologic, flood control, and aquatic habitat functions) in addition to pollutant removal. Therefore, adverse impacts on existing wetlands should be avoided to the maximum extent possible.

Definitions of wetlands are also contained in federal, state, and local laws, ordinances, and policy documents. Because those definitions do not always use scientific concepts, they might differ between states or even between localities within a state.

For purposes of this guidance, ***riparian areas*** are defined as

> *A vegetated ecosystem along a water body through which energy, materials, and water pass. Riparian areas characteristically have a high water table and are subject to periodic flooding and influence from the adjacent water body. These systems encompass wetlands, uplands, or some combination of these two landforms. They will not in all cases have all the characteristics necessary for them to be also classified as wetlands.*

Riparian areas are defined as vegetated ecosystems along a water body through which energy, materials, and water pass.

Like the definitions for wetlands, the definitions for riparian areas can vary. For example, a definition of riparian areas might be based on geographic region (arid or humid climates) or on distance from a stream channel rather than on site characteristics.

Figure 2-1 illustrates the general relationship between wetlands, uplands, riparian areas, and a stream channel. Identifying the exact boundaries of wetlands or riparian areas is less critical than identifying ecological systems of concern. For instance, even those riparian areas that fall outside wetland boundaries provide many of the same important water quality functions that wetlands provide. In many cases, the area of concern might include an upland buffer adjacent to sensitive wetlands or riparian areas that protects them from excessive NPS impacts or pretreats inflowing surface waters.

The functions of wetlands and riparian areas include water quality improvement; stream shading; flood attenuation; shoreline stabilization; ground water exchange; and habitat for aquatic, semiaquatic, terrestrial, migratory, and rare species. Wetlands and riparian areas typically occur as natural buffers between uplands and adjacent water bodies. Loss of these systems allows for a more direct contribution of NPS pollutants to receiving waters. The pollutant removal functions associated with wetlands and riparian area vegetation and soils combine the physical process of filtering and the biological processes of nutrient uptake and denitrification (Lowrance et al., 1983; Peterjohn and Correll, 1984). Riparian forests, for example, have been found to contribute to the quality of aquatic habitat by providing cover, bank stability, and a source of organic carbon for microbial processes like denitrification (James et al., 1990; Pinay and Decamps, 1988). Riparian systems, particularly in western regions, have been shown to stabilize the recharge of shallow aquifers in a manner that supports streamflows of longer natural duration (Platts and Jenson, 1990). Riparian forests have also been found to be effective at reducing in-stream pollution during flood flows (Karr and Gorman, 1975; Kleiss et al., 1989).

Wetlands and riparian areas can play a critical role in reducing NPS pollution by intercepting surface runoff, subsurface flow, and certain ground water flows.

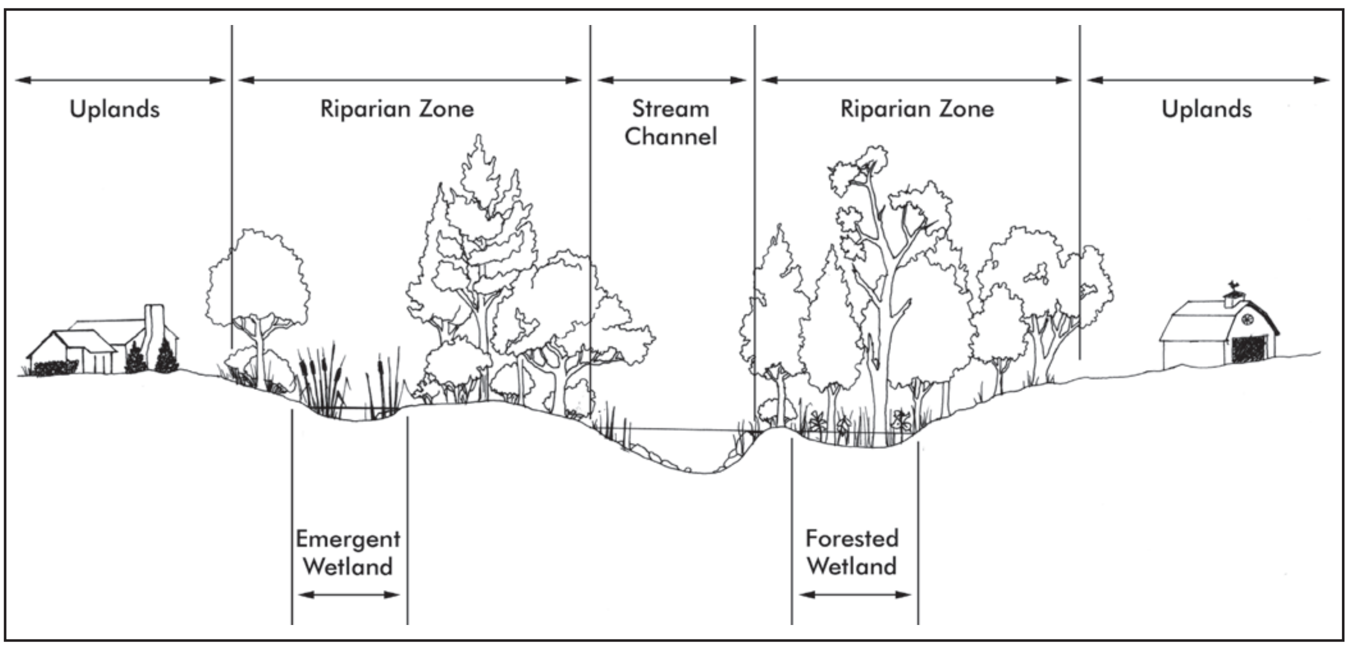


Figure 2-1. Relationship Between Wetlands, Uplands, Riparian Areas, and the Stream Channel

Their role in water quality improvement includes processing, removing, transforming, and storing such pollutants as sediment, nitrogen, phosphorus, and certain heavy metals (Washington State Department of Ecology, 1996). Research also shows that riparian areas function to control the release of herbicides into surface waters. Thus, wetlands and riparian areas buffer receiving waters from the effects of pollutants or they prevent the entry of pollutants into receiving waters. It is important to consider that degradation of wetlands and riparian areas can inhibit their ability to treat NPS pollution. Degraded wetlands and riparian areas can also become sources of NPS pollution.

The role of wetlands and riparian areas in water quality improvement includes processing, removing, transforming, and storing such pollutants as sediment, nitrogen, phosphorus, and certain heavy metals.

In highly developed urban areas, wetlands and riparian areas can be virtually destroyed by construction, filling, channelization, or other significant alterations. In agricultural areas, wetlands and riparian areas can be affected by overuse of the area for grazing or removal of native vegetation and replacement with annual crops or perennial cover. In addition, significant hydrologic alterations might have occurred to expedite drainage of farmland. Other significant impacts might occur as a result of various activities such as highway construction, surface mining, deposition of dredged material, and excavation of ports and marinas. All these activities have the potential to degrade or destroy the water quality improvement functions of wetlands and riparian areas and might exacerbate NPS pollution problems.

A wetland's position in the landscape affects its water quality functions. Some cases have been studied sufficiently to predict how an individual wetland will affect water quality on a landscape scale (Whigham et al., 1988). For example, relationships have been demonstrated between the extent of individual wetlands and lowered suspended solids, fecal coliform, and nutrients in streams (Detenbeck et al., 1993; Johnson et al., 1990). Also, wetlands that border first-order streams were found by Whigham and others (1988) to be efficient at removing nitrate from ground water and sediment from surface waters. When located downstream from first-order streams, wetlands and riparian areas were found to be less effective than those located upstream at removing sediment and nutrient from the stream itself because of a smaller percentage of stream water coming into contact with the wetlands (Whigham et al., 1988). It has also been estimated that the portion of a wetland or riparian area immediately below the source of NPS pollution might be the most efficient at removing pollutants (Cooper et al., 1987; Lowrance et al., 1983; Phillips, 1989).

Although wetlands and riparian areas reduce NPS pollution, they do so within a definite range of operational conditions and cannot be viewed as a treatment mechanism for unlimited amounts of NPS pollution. When hydrologic changes or NPS pollutants exceed the natural assimilative capacity of wetlands and riparian areas, these systems become stressed and can be degraded or destroyed. A degraded wetland has less ability to remove NPS pollutants and to attenuate stormwater peak flows (Bedford and Preston, 1988; Richardson and Davis, 1987; Richardson, 1988). In addition, a degraded wetland can deliver increased amounts of sediment, nutrients, and other pollutants to the adjoining water body, thereby acting as a source of NPS pollution instead of a treatment (Brinson, 1988; Richardson, 1988). Therefore, wetlands and riparian areas should be protected to the maximum extent possible from changes that would degrade their existing pollution abatement functions. This protection can be accomplished by applying NPS management measures appropriate to the source of pollutants (e.g., activities associated with agriculture, urban development, forestry, hydromodification, and marinas and recreational boating). Finally, degraded wetlands and riparian areas should be restored, where possible, to serve an NPS pollution abatement function.

2.2 Vegetated Treatment Systems

For purposes of this guidance, vegetated treatment systems are defined to include vegetated filter strips or constructed wetlands. Vegetated treatment systems can also be a combination of vegetated filter strips and constructed wetlands. Both of these systems have been defined in scientific literature and have been studied individually to determine their effectiveness in NPS pollutant removal.

Vegetated filter strips are defined as created areas of vegetation designed to remove sediment and other pollutants from surface water runoff by filtration, deposition, infiltration, adsorption, absorption, decomposition, and volatilization.

In this guidance, *vegetated filter strips* (VFS) are defined as (Dillaha et al., 1989a and USEPA, 1996a)

> *created areas of vegetation designed to remove sediment and other pollutants from surface water runoff by filtration, deposition, infiltration, adsorption, absorption, decomposition, and volatilization. Vegetated filter strips are densely vegetated sections of land designed to convey runoff in the form of sheet flow across grassed or forested surfaces.* A *vegetated filter strip is an area that maintains soil aeration as opposed to a wetland, which at times exhibits anaerobic soil conditions.*

In this guidance, *constructed wetlands* are defined as (USEPA, 1998a)

> *wetlands that use natural processes involving wetland vegetation, soils, and their associated microbial assemblages to assist, at least partially, in treating an effluent or other source water. These systems are engineered and constructed in uplands, outside 'waters of the United States,' unless the water source can serve a significant restoration function to a degraded system.*

In areas where naturally occurring wetlands or riparian areas do not exist or cannot be restored to original sites, vegetated treatment systems can be designed and constructed to perform some of the same functions. When such engineered systems are installed for a specific NPS pollution abatement purpose, however, they might not offer the same range of functions that naturally occurring wetlands or riparian areas offer. Vegetated treatment systems have been installed in a wide range of settings, including cropland, pastureland, forests, cities, and urbanizing areas, where the systems can perform a complementary function of sediment control and surface water runoff management. Vegetated treatment systems should be considered to have wide-ranging applicability to various NPS categories.

When properly installed and maintained, VFS have been shown to effectively prevent the entry of sediment, sediment-bound pollutants, and nutrients into water bodies. VFS reduce NPS pollutants primarily by filtering water passing over or through the strips. Properly designed and maintained VFS can substantially reduce the delivery of sediment and some nutrients to waters from nonpoint sources. With proper planning and maintenance, VFS can be a beneficial part of a network of NPS pollution control measures for a particular site. Efficiencies of VFS and riparian areas in removing sediments and nutrients from water passing over and through the systems are discussed later in this document. VFS are often coupled with practices that reduce nutrient inputs, minimize soil erosion, or collect runoff. Where wildlife needs are factored into the design, VFS or buffers in urban areas can add to the species diversity of the urban environment by providing wildlife nesting and feeding sites, in addition to serving as a pollution control measure. However, VFS might require maintenance such as grass mowing or removal of accumulated sediment. These and other maintenance activities might preclude some of their value for wildlife, for example, by disturbing or destroying nesting sites.

Constructed wetlands are defined as wetlands that use natural processes involving wetland vegetation, soils, and their associated microbial assemblages to assist, at least partially, in treating an effluent or other source water.

Constructed wetlands are designed to mimic the pollutant-removal functions of natural wetlands and might lack aquatic habitat functions and species diversity. It is important to note that aquatic plants and benthic organisms used in constructed wetlands serve primarily to remove pollutants. Constructed wetlands may or may not be designed to provide flood storage, ground water exchange, or other functions associated with natural wetlands. In fact, if there is a potential for exposing wildlife to contamination or other detrimental impacts, constructed wetlands should be designed to discourage use by wildlife. If constructed wetlands are planned and designed correctly, however, they can be designed to provide significant wildlife habitat, water reuse, and public use opportunities.

Pollutant removal in constructed wetlands is accomplished by several mechanisms, including sediment trapping, plant uptake, bacterial decomposition, and adsorption. Properly designed and constructed wetlands filter and settle suspended solids. Wetland vegetation used in constructed wetlands converts some pollutants (nitrogen, phosphorus, and metals) into plant biomass (Watson et al., 1988). Nitrification, denitrification, and organic decomposition are bacterial processes that occur in constructed wetlands. Some pollutants, such as phosphorus and most metals, physically attach or adsorb to soil and sediment particles; therefore, constructed wetlands, used as a management practice, could be an important component in managing NPS pollution from a variety of sources. They are not intended to replace or destroy natural wetland areas, but rather to remove NPS pollution before it enters a stream, natural wetland, or other water body.

Vegetated buffers are defined as strips of vegetation separating a water body from a land use that could act as a NPS pollution source.

The term *vegetated buffer* is currently used in many contexts, and there is no agreement on any single concept of what constitutes a buffer, what activities are acceptable in a buffer zone, or what is an appropriate buffer width. In one usage, the term vegetated buffer refers to natural riparian areas that are set aside or restored to filter pollutants from runoff and to maintain the ecological integrity of the water body and the land adjacent to it (Nieswand et al., 1989). In another usage, the term refers to constructed strips of vegetation used in various settings to remove pollutants in runoff from a developed site (Nieswand et al., 1989). USEPA (1996a) referred to vegetated buffers as barriers of natural or established perennial vegetation managed to reduce the impact of development or pollution on the water quality of adjacent areas. Vegetated buffers reduce the velocity of surface runoff and provide an area for infiltration of runoff into the soil. Finally, the term vegetated buffer can be used to describe a transition zone between an urbanized area and a naturally occurring riparian forest (Faber et al., 1989). In all these contexts, buffers can provide value to wildlife, as well as aesthetic value.

A vegetated buffer usually has a rough surface and typically contains a heterogeneous mix of ground cover, including herbaceous and woody species of vegetation (Stewardship Incentive Program, 1991; Swift, 1986). This mix of vegetation allows the buffer to function like a filter for pollutants. A VFS can also be constructed to remove pollutants in runoff from a developed site, but a filter strip differs from a vegetated buffer in that a filter strip typically has a smooth surface with a vegetated cover made up of a homogeneous species of vegetation (Dillaha et al., 1989a).

To avoid confusion, this guidance focuses specifically on the use of VFS (not the more general vegetated buffer) that are used as vegetated treatment systems in abating NPS pollution.

3 Management Measures

When discussing specific categories of NPS pollution, such as agriculture, forestry, urban areas, marinas and recreational boating, and hydromodification, "management measures" represent effective systems of practices available to prevent or reduce NPS pollution. Implementing the management measures in this document will help to reduce pollution coming from a broad variety of nonpoint sources by promoting the protection and restoration of wetlands and riparian areas and the use of vegetated treatment systems. The following management measures have been developed to protect the multiple functions wetland and riparian ecosystems provide and to ensure their continued capacity for NPS pollution abatement. They are described in greater detail in chapters 4, 5, and 6. It is important to note, however, that while wetlands have the potential to prevent or reduce NPS pollution, unrestricted use of wetlands as receptacles for NPS pollution could have an adverse effect on the wetlands and wetland biota.

- *Management Measure for Protection of Wetlands and Riparian Areas:* Protect from adverse effects wetlands and riparian areas that are serving a significant NPS abatement function and maintain this function while protecting the other existing functions of these wetlands and riparian areas as measured by characteristics such as vegetative composition and cover, hydrology of surface water and ground water, geochemistry of the substrate, and species composition.
- *Management Measure for Restoration of Wetlands and Riparian Areas:* Promote the restoration of the preexisting functions in damaged and destroyed wetlands and riparian systems, especially in areas where the systems will serve a significant NPS pollution abatement function.
- *Management Measure for Vegetated Treatment Systems:* Promote the use of engineered vegetated treatment systems such as constructed wetlands or vegetated filter strips where these systems will serve a significant NPS pollution abatement function.

Management measures have been developed for the control of NPS pollution through the protection and restoration of wetlands and riparian areas and the use of vegetated treatment systems.

3.1 How Management Measures Work to Prevent Nonpoint Source Pollution

Implementation of the management measures will help to control the delivery of NPS pollutants to receiving water resources by

- Minimizing pollutants available (source reduction);
- Reducing the flow rate of runoff to allow for deposition of the pollutant or infiltration of runoff; or
- Remediating or intercepting the pollutant through chemical or biological transformation.

Management measures generally focus on the control of a particular type of pollutant or pollutant category from specific land uses. The intent of the three management measures is to ensure that the NPS benefits of protecting and restoring wetlands and riparian areas, and of constructing vegetated treatment systems, will be considered in all water pollution control activities in a watershed. These management measures form an essential element of any state NPS pollution program.

Implementation of the first management measure is intended to protect the full range of functions for wetlands and riparian areas that serve an NPS abatement function. This protection will preserve their value as an NPS pollution control and help to ensure that they do not become a significant nonpoint pollutant source as a result of degradation.

The second management measure promotes the comprehensive restoration of degraded wetlands and riparian systems with NPS pollution control potential for reasons similar to those for the first measure—the increase in pollutant loadings that can result from degradation of wetlands and riparian areas and the substantial evidence in the literature on the effectiveness of wetlands and riparian areas for NPS pollution abatement. In addition, restoration might benefit wildlife and aquatic organisms. This measure recommends evaluation of degraded wetlands and riparian systems, as well as restoration if the systems will serve an NPS pollution abatement function (e.g., by cost-effectively treating NPS pollution or by attenuating peak flows).

The third management measure promotes the use of vegetated treatment systems because of their wide-scale ability to treat a variety of NPS pollutants. This measure will also apply, as appropriate, to the other sources of NPS pollution addressed in the CZARA Guidance (USEPA, 1993c).

3.2 Management Practices

In addition to specifying management measures, chapters 4 through 6 also list and describe management practices. EPA has found the practices listed in this document to be representative of the types of practices that can be applied successfully to achieve the management measures. EPA recognizes that there is often site-specific, regional, and national variability in the selection of appropriate practices, as well as in the design constraints and pollution control effectiveness of practices. The practices presented for each management measure are not all-inclusive. State, tribal, or local agencies may wish to apply other technically and environmentally sound practices to achieve the goals of the management measures.

4 Management Measure for Protection of Wetlands and Riparian Areas

This chapter presents supporting information, including management practices, specific implementation examples, and costs and benefits, for the following management measure:

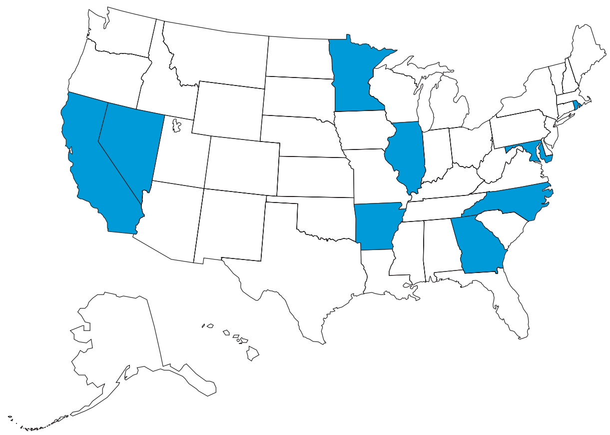
Management Measure
Protect from adverse effects wetlands and riparian areas that are serving a significant NPS abatement function and maintain this function while protecting the other existing functions of these wetlands and riparian areas as measured by characteristics such as vegetative composition and cover, hydrology of surface water and ground water, geochemistry of the substrate, and species composition.

The purpose of this management measure is to maintain the water quality benefits of wetlands and riparian areas and to ensure that such areas do not become a source of NPS pollution as a result of degradation. The term *NPS abatement function* refers to the ability of a wetland or riparian area to remove NPS pollutants from runoff passing through the wetland or riparian area. Two examples of NPS pollution abatement functions performed by wetlands and riparian areas are (1) acting as a sink for phosphorus and (2) converting nitrate to nitrogen gas through denitrification. Wetlands and riparian areas have been shown to have useful functions for removing other NPS pollutants, including total suspended solids (TSS), sulfates, calcium, magnesium, and sediments. Table 4-1 shows results of several studies of the NPS pollution abatement functions of wetlands and riparian areas. The ability of wetlands and riparian areas to perform pollution filtration functions is determined by species composition, geochemistry, and hydrogeomorphic characteristics. Any changes to these characteristics can affect filtering capacities. Evaluation of these data can give an indication of the range of pollutant removals expected; however, ranges vary due to variations in sampling techniques, parameters measured, and the nature of the sampling event (storm event versus long-term monitoring.)

The NPS pollution abatement functions performed by wetlands and riparian areas are most effective as parts of an integrated land management system that combines nutrient, sediment, and soil erosion control.

Reduction of NPS Pollutants in Coastal Plain Wetlands and Riparian Areas
A study performed in the southeastern United States coastal plain dramatically illustrates the role that wetlands and riparian areas play in abating NPS pollutants. It examined the water quality role played by mixed hardwood forests along stream channels adjacent to agricultural lands. These streamside forests were shown to be effective in retaining nitrogen, phosphorus, calcium, and magnesium. The study authors projected that total conversion of the riparian forest to a mix of crops typically grown on uplands would result in a 20-fold increase in nitrate-nitrogen loadings to the streams. This projected increase resulted from use of fertilizers (e.g., nitrates) to promote crop development and from the loss of nitrate removal functions previously performed by the riparian forest.
Source: Lowrance et al., 1983.

Table 4-1. Effectiveness of Natural Wetlands and Riparian Areas for NPS Pollutant Removal



Measurements taken throughout the United States show the NPS pollutant abatement functions of wetlands and riparian areas. Results of studies in various states (see map at left) are shown in the table below. The effectiveness of natural wetlands and riparian areas for removing NPS pollutants depends on many factors, which are discussed in this chapter. Natural wetlands and riparian areas should be routinely monitored to measure their environmental health and protect all of the physical, chemical, and biological functions they provide. See section 4.1.2 for more details. Additional information about each study cited in the table is provided in Appendix F at the back of the document.

Study	Solids	NO_3	N	P	SO_4	Ca	Mg	Example Projects
Pollutant reduction by floodplain deposition in bottomland hardwood forest	50%[1]	80%		50%				Cache River (AR)
Nitrate retention in a third-order stream		14%						Little Lost Man Creek (CA)
Nutrient removal in a mixed hardwood, riparian forest		67%		25%		42%	22%	Tifton (GA)
Sediment and phosphorus retention in a riparian wetland	3%			0.4%				Heron Pond (IL)
Nitrate and sulphate reduction in a riparian forested wetland		86%			25%			Rhode River 1 (MD)
Removal of nutrients in a riparian deciduous hardwood forest		>80%		>80%				Rhode River 2 (MD)
Phosphorus and nitrate export and removal in a forested riparian area		79%		80%				Rhode River Subwatershed (MD)
Retention of sediment and nutrient loads from storm water runoff by an urban wetland	97%[2] 76%[3]		47%	48%				Fish Lake (MN)
Nitrate reduction by a forested riparian buffer strip		93%						Beaver Dam Creek Watershed (NC)
Removal of phosphate in a riparian forest				50%				Cypress Creek 1 (NC)
Sediment trapping efficiency in riparian areas	84-90%[4]							Cypress Creek 2 (NC)
Nitrate removal by wetland and riparian areas in watershed headwaters		99%						Lake Tahoe (NV)
Seasonal groundwater nitrate removal by wetlands		80%						Kingston 1 (RI)
Nitrate retention by riparian forest with upland wetland transition zones and red maple wetlands		59%						Kingston 2 (RI)

Note: NO_3, nitrates; N, organic nitrogen; P, phosphorus; SO_4, sulfate; Ca, calcium; Mg, magnesium.

[1] Total suspended solids.

[2] Nonvolatile solids.

[3] Volatile solids.

[4] Sediment.

Factors Affecting Removal Efficiencies

The properties of a particular wetland or riparian area and of the surrounding watershed play a significant role in the ability of the wetland or riparian area to retain its existing wetland functions (such as food and habitat for animals, flood storage, and ground water recharge) and serve an NPS pollution abatement function. Several factors determine the pollutant-removal efficiency of a specific wetland or riparian area, including the following:

- Frequency and duration of flooding
- Types of soil
- Slope of landscape
- Types of vegetation
- Balance of nitrogen and carbon
- Ratio of edge to area for the wetland or riparian area

The composition of water and characteristics of the surrounding watershed affect the balance of wetland or riparian function and pollutant removal efficiency. Some of these characteristics are the land use practices in the watershed, the number and types of surrounding wetlands and riparian areas, and the climatic conditions in the area.

Multiple Benefits

EPA is encouraging the preservation and protection of wetlands and riparian areas because these natural systems have been shown to provide many other benefits in addition to NPS pollution reduction. The basis of protection involves avoiding and minimizing impacts on wetlands and riparian areas that control NPS pollution by maintaining the existing functions of these areas, including vegetative composition and cover, flow characteristics of surface water and ground water, hydrology and geochemical characteristics of substrate, and species composition (Azous, 1991; Hammer, 1992; Mitsch and Gosselink, 1986; Reinelt and Horner, 1990; Richter et al., 1991; Stockdale, 1991).

Wetlands and riparian areas also perform important functions such as providing a source of food, nesting material, habitat, and nursery areas for a variety of terrestrial and aquatic wildlife (Atcheson et al., 1979). Many animals whose development histories include an aquatic phase (amphibians, some reptiles, and invertebrates) need habitat provided by wetlands (Mitsch and Gosselink, 1993). Other important functions of wetlands and riparian areas include floodwater storage, erosion control, ground water recharge, and maintenance of biological diversity. Protection of wetlands and riparian areas should allow for both NPS control and other corollary benefits of these natural aquatic systems.

The preservation and protection of wetlands and riparian areas is encouraged because these natural systems provide many benefits, in addition to providing the potential for NPS pollution reduction.

Degradation Increases Pollution

Wetlands perform many water quality functions; however, when severely degraded, they can be a source of NPS pollution (Brinson 1988; Richardson, 1988). For example, the drainage of tidal wetlands underlain by a layer of organic peat can cause the soil to rapidly decompose and release sulfuric acid, which can significantly reduce pH (increase acidity) in surrounding waters. Removal of wetland or riparian area vegetation along the shorelines of streams, bays, or estuaries makes these areas more vulnerable to erosion because of increased water level fluctuation associated with storm events, concentrated runoff, and wave action. Activities such as channelization, which modify the hydrology of floodplain wetlands, can alter the ability of these areas to retain sediment when they are flooded and result instead in erosion and a net export of sediment from the wetland (Reinelt and Horner, 1990).

Permits to Protect Wetlands

A permit program administered by the USACE, EPA, and approved states under section 404 of the Clean Water Act regulates the discharge of dredged or fill material into waters of the United States, including wetlands. The management measure and section 404 program complement each other, but the two differ in focus.

The management measure focuses on protecting wetlands that help to abate NPS problems, as well as on maintaining the functions of these wetlands. This protection can include preventing impacts resulting from upland development and upstream channel modifications that erode wetlands, change salinity, kill existing vegetation, and upset sediment and nutrient balances. The section 404 program focuses on protecting wetlands from physical destruction and other pollutant problems that could result from discharges of dredged or fill material. Table 4-2 shows many of the federal programs that affect wetlands in the United States.

In *Solid Waste Agency of Northern Cook County v. Army Corps of Engineers,* no. 99-1178 (January 9, 2001) ("SWANCC"), the United State Supreme Court in a 5-4 decision, limited the ability of the USACE and EPA to assert Clean Water Act jurisdiction over isolated intrastate non-navigable waters. The Supreme Court held that USACE exceeded its statutory authority by asserting Clean Water Act jurisdiction over such waters based soley on the fact they are or could be used as habitat for migratory birds or endangered species ("Migratory bird rule"). Under this ruling, isolated wetlands and other waters may remain protected under the Act, but only if other bases for jurisdiciton are identified. In additon, isolated waters or wetlands may still be subject to regulation by state agencies.

Although the SWANCC decision limits federal Clean Water Act jurisdiction over isolated, intrastate, non-navigable waters and wetlands, the Federal government remains committed to protecting all of the nation's waters. EPA and the USACE will continue to monitor implementation of the Clean Water Act Section 404 regulatory program to ensure its effectiveness. As of December 2003, the Federal government was implementing 30 programs to protect and restore millions of acres of our Nation's wetlands. These include programs such as the Food Security Act's "Swampbuster" requirements and the Wetlands Reserve Program, both under the authority of USDA. EPA programs include its "Five-Star Restoration" grant program, the EPA wetlands grants programs and the National Estuary Program. Other federal programs include: the Fish and Wildlife Service's "Partners in Wildlife" program, the National Marine Fisheries Service's Coastal Wetlands Restoration Program and the Migratory Bird Conservation Commission, composed of the Secretaries of Interior and Agriculture, the Administrator of EPA, and Members of Congress (USEPA, 2003).

Table 4-2. Federal Programs and Acts That Affect Wetlands in the United States

Program or Act	Agency	Effect of Program
Clean Water Act	EPA, Corps, FWS, NOAA	Section 404 establishes permit program for discharge of dredged or fill material into all waters of the US, including wetlands. Section 402 similarly requires permits for discharges of other pollutants.
Coastal Barriers Resources Act (P.L. 96-348) (1982)	NOAA	Designates various undeveloped coastal barrier islands for inclusion in the Coastal Barrier Resources System. Designated areas are ineligible for federal financial assistance that may aid development.
Coastal Wetland Planning, Protection, and Restoration Act (P.L. 101-646) (1990)	USACE, FWS, EPA, NMFS, NRCS	Provides for interagency wetlands restoration and conservation planning and acquisition in Louisiana, other coastal states, and the trust territories.
Coastal Zone Management Act (P.L. 92-583) (1972)	NOAA	Provides federal funding for wetlands programs in most coastal states, including the preparation of Coastal Zone Management Plans.
Emergency Wetlands Resources Act of 1986 (P.L. 99-645)	FWS	Pays debts incurred by FWS for wetlands acquisition and provides additional revenue sources.
Endangered Species Act of 1973 (P.L. 93-205)	FWS	Provides for the designation and protection of wildlife, fish, and plant species that are in danger of extinction.
Estuary Protection Act (P.L. 90-454) (1968)	DOI	Authorized the study and inventory of estuaries and the Great Lakes, and provided for management of designated estuaries between DOI and the states.
Estuary Restoration Act of 2000 (P.L. 106-457) (2000)	USEAP, NOAA, USACE, FWS, USDA	Promotes the restoration of estuary habitat, develops a national estuary habitat restoration strategy, provides federal assistance and promotes efficient financing of such projects, and enhances monitoring and research capabilities.
E.O. 11990, Protection of Wetlands (1977)	AFA	Requires federal agencies to minimize impacts of federal activities on wetlands.
E.O. 11988, Protection of Floodplains (1977)	AFA	Requires federal agencies to minimize impacts of federal activities on floodplains.
Federal Aid in Wildlife Coordination Act of 1956	DOI	Authorizes the development and distribution of fish and wildlife information and the development of policies and procedures relating to fish and wildlife.
Food, Agriculture, Conservation, and Trade Act of 1990 (P.L. 101-624)	NRCS	Water Resources Development Act of Wetland Reserve Program purchases perpetual nondevelopment easements on farmed wetlands. Subsidizes restoration of croplands to wetlands.
Food Security Act of 1985 (Swampbuster) (P.L. 99-198)	FSA, FWS	"Swampbuster" program suspends agricultural subsidies for farmers who convert wetlands to agriculture. Conservation Easements program allows FmHA FSA to eliminate some farm debts in exchange for long-term easements that protect wetlands and other areas.
Migratory Bird Hunting and Conservation Stamps (1934) (Ch. 71, 48 Stat. 452)	FWS	Acquires wetland easements using revenues from fees paid by hunters for duck stamps.
National Environmental Policy Act of 1969 (P.L. 91-190)	AFA	Requires the preparation of an environmental impact statement for all major federal actions significantly affecting the environment.
North American Waterfowl Management Plan (1986)	FWS	Establishes a plan for managing waterfowl resources by various methods, such as acquiring wetlands.
North American Wetlands Conservation Act (1989) (P.L. 101-233)	FWS	Encourages public/private partnerships by providing matching grants to organizations for protecting, restoring, or enhancing wetlands.
Rivers and Harbors Act of 1938 (52 Stat. 802)	USACE	Provides that "due regard" be given to wildlife conservation in planning federal water projects.
U.S. Tax Code Tax Reform Act of 1986 (P.L. 99-514)	IRS	Provides deductions for donors of wetlands and to some nonprofit organizations.
Water Bank Act (1970) (P.L. 91-559)	FSA	Leases wetlands and adjacent uplands from farmers for waterfowl habitat for 10-year periods.
Water Resources Development Act of 2000 (P.L. 106-541)	USACE	States that future mitigation plans for federal water projects should include "in kind" mitigation for bottomland hardwood forests.
Wetlands Loan Act (1961) (P.L. 87-383	FWS	Provides interest-free loans for wetland acquisition and easements.
Wild and Scenic Rivers Act (P.L. 90-542) (1968)	DOI, USDA	Protects designated river segments from alterations without a permit.

Note: AFA, all federal agencies; ASCS, Agricultural Stabilization and Conservation Service; DOI, Department of the Interior; EPA, Environmental Protection Agency; FSA, Farm Service Agency; FmHA, Farmer's Home Administration; FWS, Fish and Wildlife Service; IRS, Internal Revenue Service; NMFS, National Marine Fisheries Service; NOAA, National Oceanic and Atmospheric Administration; USACE, U.S. Army Corps of Engineers; USDA, U.S. Department of Agriculture; P.L., Public Law; E.O., Executive Order.

4.1 Management Practices for Protecting Wetlands and Riparian Areas

The management measure for protecting wetlands and riparian areas generally will be implemented by applying one or more practices appropriate to a specific source, location, and climate. Wetland evaluation, assessment of functions and values, programmatic approaches to wetland protection, and preliminary treatment practices can be applied to implement the management measure for protecting wetlands and riparian areas. The following pages and Table 4-3 provide details about each practice.

Wetlands and riparian areas should be considered as part of a continuum of filters along rivers, streams, and coastal waters that together serve an important NPS abatement function.

4.1.1 Wetland Evaluation

Practice
Evaluate and document the NPS control potential of wetlands and riparian areas on a watershed or landscape scale.

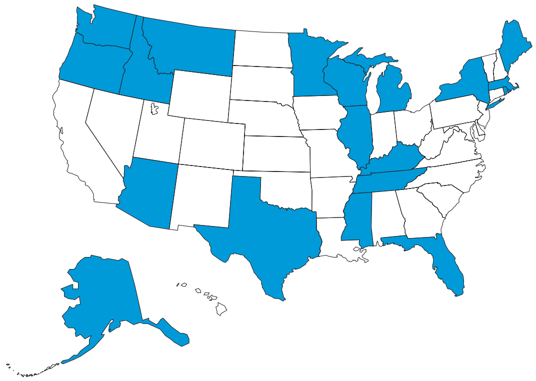
Wetlands and riparian areas should be considered part of a continuum of filters along rivers, streams, lakes, and coastal waters that together serve an important NPS abatement function. Examples of evaluating wetlands and riparian areas on a watershed or landscape scale were outlined by Whigham and others (1988). They found that a landscape approach can be used to make reasonable decisions about how any particular wetland might affect water quality parameters. Wetlands in the upper parts of the drainage systems tend to have a greater impact on water quality than those in lower reaches.

Wetlands and riparian areas are particularly sensitive to landscape disturbance, including fragmentation and changes in land cover. Wetlands and riparian areas covering large areas provide for more sustainable NPS control within a watershed (Mitsch, 1992). Hanson and others (1990) used a model to determine the effect of riparian forest fragmentation on forest dynamics. They concluded that increased fragmentation would lead to lower species diversity and an increased prevalence of species that are adapted to isolated conditions. Naiman and others (1988) discussed the importance of wetlands and riparian areas as boundary ecosystems, providing a boundary between terrestrial and aquatic ecosystems. EPA BASINS (Better Assessment Science Integrating Point and Nonpoint Sources) software may also be useful for wetlands evaluations by providing integrated databases and assessment tools to analyze environmental information, and provide a framework for examining management alternatives.

Geographic Differences

The characteristics of wetlands and riparian areas are largely controlled by climate, landscape characteristics, vegetation, and soils. Regional variations in these controls can greatly affect how a wetland or riparian area functions within a watershed. Therefore, it is important to consider geographic variations when evaluating the potential NPS pollution control functions of wetlands and riparian areas. For instance, wetlands in arid or semiarid areas are typically associated

Table 4-3. Potential of Wetlands and Riparian Areas for NPS Pollution Control.



Practice: Evaluate and document the NPS pollution control potential of wetlands and riparian areas on a watershed or landscape scale.

This table provides some examples from different locations in the United States of the kinds of activities that can help implement this practice. For more information about the examples, refer to Appendix F at the back of the document.

Implementation Activities	Example Projects
Use a landscape approach to evaluate wetland water quality functions.	Local Wetland Management Plans (AK), Wetland Protection (FL), Wetland Assessment (IL), Grand Traverse Bay Watershed Initiative (MI), Wetland Protection (RI), Rivers and Wetlands Program (TN), Synoptic Assessment Approach (WA)
Use watershed analysis as a tool to ensure functional performance.	Wetland Protection (FL), Synoptic Assessment Approach (WA)
Use tools such as the synoptic approach to construct broad scale assessments.	Wetland Assessment (IL), Pearl River Basin (MS), Synoptic Assessment Approach (WA)
Recognize geographic differences when considering wetland or riparian area functions within a watershed.	Reference Reach Monitoring Program (KY), Wetland Conservation Plan (MN), Wetland Conservation Plan (TX), Synoptic Assessment Approach (WA)
Develop wetland conservation plans that consider wetlands and riparian areas on a watershed or landscape scale.	Wetland Conservation Plan (ME), Grand Traverse Bay Watershed Initiative (MI), Watershed Initiative Program (MI), Wetland Protection (NY), Wetland Conservation Plans (OR), Rivers and Wetlands Program (TN), Wetland Conservation Plan (TX), Synoptic Assessment Approach (WA), Wetlands Conservation Plan/Outreach (Bad River Band), Watershed Demonstration Project (Flathead Reservation), Watershed Protection (Umatilla), Wetland Conservation Program (Nez Perce), Wetlands Conservation Project (Hopi)
Consider water quality functions of wetlands and riparian areas during the planning process.	Wetland Protection (MA), Wetland Conservation Plans (OR)

with perennial springs and headwaters streams; that is, they are able to exist because they are near enough to the headwaters that the probability of erosive scour from flood flows is minimal. The upstream pumping of ground water can disrupt the hydrology of cienagas and playas, two of the more common arid/semi-arid wetland types, where water is not abundant. These types of wetlands play an important role in NPS pollution control because of their location within the watershed or landscape. In addition, the characteristics of a watershed wield a strong influence on rivers, flooding patterns, and riparian wetlands. Western and eastern riparian wetlands in small watersheds tend to flood for a few months during spring thaw, whereas eastern bottomland forests (such as those along the Mississippi River) flood for several months. During these flood periods the wetlands capture and filter the NPS pollutants carried in the floodwaters. Changes in the volume and flood period can affect the NPS pollution control potential of these wetlands. For additional geographic differences in wetlands, refer to Table 4-4.

Table 4-4. Descriptions of Specific Wetland Types

Pocosin Wetlands	Pocosin wetlands occur along the Atlantic seaboard's lower coastal plain, from southern Virginia to northern Florida. Pocosin wetlands are found in ridge and swale topography, as well as in flat areas of the lower coastal plain, in depressions of the Carolina Bays, in areas of springs and seeps in the upper coastal plain, and in the floodplains of streams. The substrates of pocosins are not very permeable so groundwater beneath the wetland, which has a high mineral content, does not come into contact with the low-mineral-content water and soil of the pocosin. Water movement occurs as seepage at the pocosin's margins that flows to streams, or as direct flow to salt marshes in estuarine areas.
Cienegas	Cienega is a term that usually applies to a mid-elevation wetland characterized by permanently saturated, highly organic, reducing soils. Cienegas are perpetuated by permanent, scarcely fluctuating sources of water and are rarely subject to harsh winter conditions. They occur at mid-elevations of semidesert grasslands and are usually associated with perennial springs and headwater streams.
Playa Lakes	The term playas generally refers to areas occupied by temporary shallow lakes that have internal drainage, usually in arid to semiarid regions of the southern Great Plains. They are not part of an integrated surface drainage system, but are related to geologic fracture areas. Playa floors are plate-like with relatively constant water depth throughout much of the basin. Very few playas are directly associated with groundwater, and playas usually fill only from precipitation and irrigation runoff. Most playas are dry during one or more periods of each year, usually late winter, early spring, and late summer. There is no surface water outflow; playas lose their water by evaporation, seepage, and irrigation use.
Riverine or Riparian Wetland Areas of the Southwest	Riverine or riparian wetlands exist along the margins of rivers, behind natural levees, in oxbows and floodplains. Riverine wetlands in arid climates are limited shoreward by desert and riverward by water depth and scouring. These wetlands are transitory. They develop rapidly only to be removed by channel-straightening floods, or they proceed toward an upland community after drying. In the American Southwest, riverine marshes are located primarily in broad alluvial valleys.
Prairie Potholes	The prairie pothole region of the northern United States consists of North Dakota, western Minnesota, northeastern South Dakota, and upper central Iowa. A pothole is defined as a surface depression occurring in glacial sediments, containing water from precipitation, surface runoff, and groundwater. Potholes have an average depth of about 2 to 5 feet and can range in size from a few hundred square yards up to several thousand square miles. These wetlands are not usually associated with any regional network of stream channels, but they are related to local and regional groundwater systems. The hydroperiods in potholes range from temporarily to permanently flooded, and these differences cause the development of diverse vegetation zones such as wet meadow, shallow marsh, and deep marsh. Prairie potholes lose water through evaporation, transpiration, and seepage to groundwater.
Bogs and Fens	Bogs have acidic, fibrous, spongy, nutrient-poor organic soil, and their organic plant material consists mostly of sphagnum moss. Because of their location at or above the local groundwater table, bogs acquire most of their water from precipitation. Fens represent a transitional stage between marshes and bogs. Fens obtain water not only directly from precipitation, but also by surface runoff and groundwater seepage. Acidic water with a very low mineral content is typical of bogs; fens are characterized by the reverse. Mineralized fen water originates from groundwater, whereas precipitation produces the high-acidity, low-mineral water content of a bog.
Bottomland Hardwoods	Bottomland hardwoods are forested wetlands in the river valley floodplains of Missouri, the southern Atlantic Coastal Plain, and the Gulf states of Alabama, Mississippi, and Louisiana. They occupy the broad floodplains, seldom exceeding a width of 5 miles. Seasonal hydrology in these wetlands affects surface water and groundwater movement. In drier seasons, floodwaters and lateral groundwater movement serve as the dominant inputs. Other input sources include overbank flooding from the main channel, flooding from small tributary streams, lateral overland flow from valley sides, lateral groundwater flow from valley-side rock formations, and movements of groundwater parallel to the main river channel. Recharge can also occur in the form of bank storage. As water levels rise, water moves laterally from the channel to the adjacent floodplain.
Cypress Dome Wetlands	Cypress dome wetlands occur in southern Georgia and Florida. The term cypress dome is defined as a hardwood forested wetland occurring in seasonally or permanently wet saucer-shaped depressions. These wetlands are small, usually not exceeding 25 acres, and are dominated by pond cypress trees. The trees assume a characteristic dome-shaped profile, with the smaller trees toward the edges and the larger trees in the middle due to the occurrence of wildfire, which often burns only the outer, smaller trees. Cypress domes occur in flat areas where the water table is close to the surface; this surface water is connected to shallow aquifers. Primary hydrologic inputs to cypress dome wetlands are rainfall and surface water inflow. Water is lost through evapotranspiration and seepage to groundwater systems.
Permafrost/ Tundra Wetlands	Permafrost/Tundra wetlands occur in the interior of Alaska and are the western extension of the wetland complexes of northern Canada. Permafrost is the most important characteristic that distinguishes the hydrology of these wetlands. Wetlands produced by permafrost include seasonal thaw ponds, shallow emergent wetlands, partially drained lake basins, and wetlands in wet and dry tundra. The term muskeg means peatland, and it constitutes the organic content of these wetlands. Precipitation is the main water input because of impermeable conditions created by permafrost. Very little water is lost or received to or from stream and groundwater flow.
Vernal Pools	Vernal pools are naturally occurring depressional wetlands that are covered by shallow water for variable periods from winter to spring but may be completely dry for most of the summer and fall. These wetlands range in size from small puddles to shallow lakes. Although generally isolated, they are sometimes connected to each other by small drainages known as vernal swales. Beneath vernal pools lies either bedrock or a hard clay layer in the soil that helps keep water in the pool. The pools collect water during winter and spring rains, changing in volume in response to varying weather patterns. During a single season, pools may fill and dry several times. In years of drought, some pools might not fill at all.

Source: USEPA 1996a

Ecosystem Management

Several federal agencies, states, tribes, and many local communities are beginning to outline the role of wetlands and riparian areas in terms of ecosystem management. The underlying tenet of this management strategy is that biodiversity and ecological processes form the core of functioning landscapes (Henjum et al., 1994). If examples of each type of representative ecosystem in a region can be maintained, including wetlands and riparian areas, the species that live in these ecosystems will also be afforded an opportunity to persist (Noss and Cooperrider, 1994). To achieve this, areas of relatively intact, functioning ecosystems that represent biological diversity should be given serious consideration as sites where wetlands and riparian area protection and restoration efforts are focused (Doppelt et al., 1993).

Watershed Analysis

Planning for NPS pollution control in an ecosystem context will require use of new approaches in environmental assessment. Watershed analysis is one such tool that can be used to ensure the functional performance of wetlands and riparian area protection and conservation practices and to evaluate the success of such practices. Watershed analysis is structured around a series of questions whose answers provide a model of ecosystem processes, disturbance history, and risk (Montgomery et al., 1995). The analysis can be conducted at various spatial scales, and used to evaluate the relative contribution of wetlands and riparian areas to maintaining regional or basinwide water quality conditions.

Watershed Approach in Arkansas

The Arkansas Wetland Strategy does not replace other natural resource plans; it recognizes them and puts wetlands in context with other resource plans, such as NPS pollution management, floodplain management, habitat protection, ground water protection, and other water quality programs, for decision making at the watershed level. It also provides an ecosystem context by linking with regional wetland plans and priorities. Stakeholders (including wetland scientists, policy makers, landowners, and regulators) concluded that case-by-case wetland permitting does not result in a balanced conservation strategy. Case-by-case permitting tends to be inconsistent and confusing to landowners and usually does not result in “no net loss.” The Arkansas Wetland Strategy promotes voluntary, incentive-based, locally lead conservation planning through the implementation of the strategy objectives.
Source: Multi-Agency Wetland Planning Team, 2001.

Synoptic Approach

A similar method for conducting broad-scale assessment is the Synoptic Approach developed by EPA (Leibowitz et al., 1992). The approach involves compiling, organizing, and depicting environmental information in a manner that ranks watersheds according to the relative significance and risks associated with wetlands (or other ecosystems). States can use the synoptic approach and related assessment methodologies to refine water quality protection strategies (e.g., geographic prioritization), including plans for NPS control (Daggett, 1994). In Louisiana and Washington State, EPA has conducted studies that use the synoptic approach to assess wetland water quality functions on a landscape scale (Abbruzzese et al., 1990a, 1990b). The synoptic approach considers the environ-

Watershed Approach

A watershed is an area of land that drains to a single stream or other water resources. Watersheds are defined solely by drainage areas and may include multiple landowners or cross political boundaries. The watershed approach is a coordinating framework for environmental management that focuses public and private sector efforts to address the highest priority problems within hydrologically defined geographic areas (e.g., watersheds), taking into consideration both ground and surface water flow.

EPA supports watershed approaches that aim to prevent pollution, achieve and sustain environmental improvements, and meet other goals important to the community. Although watershed approaches may vary in terms of specific objectives, priorities, elements, timing, and resources, all should be based on the following guiding principles:

- *Partnerships*. Those people most affected by management decisions are involved throughout and shape key decisions. This ensures that environmental objectives are well integrated with those for economic stability and other social and cultural goals. Partnerships also ensure that the people who depend on the natural resources within the watersheds are well informed and participate in planning and implementation activities.
- *Geographic focus*. Activities are directed within specific geographic areas, typically the areas that drain to surface water bodies or that recharge or overlay ground waters or a combination of both. Cooperation between multiple landowners and political jurisdictions is essential.
- *Sound management techniques based on strong science and data.* Collectively, watershed stakeholders employ sound scientific data, tools, and techniques in an interactive decision-making process. This process should include:
  - Assessment and characterization of the natural resources and the communities that depend on them.
  - Goal setting and identification of environmental objectives based on the condition or vulnerability of resources and the needs of the aquatic ecosystem and the people in the community.
  - Identification of priority problems.
  - Development of specific management options and action plans.
  - Implementation.
  - Evaluation of effectiveness and revision of plans, as needed.

When stakeholders work together, actions are based on shared information and a common understanding of the roles, priorities, and responsibilities of all involved parties. The nature of the watershed approach encourages partners to set goals and targets and to make maximum progress based on available information, while continuing analysis and verification in areas where information is incomplete.

Watershed projects should have a strong monitoring and evaluation component. Monitoring is essential to determining the effectiveness of management options chosen by stakeholders. Because many watershed protection activities require long-term commitments from stakeholders, they need to know whether their efforts are achieving real improvements in wetland or riparian area functions.

Operating and coordinating programs on a watershed basis makes good sense for environmental, financial, social, and administrative reasons. For example, by jointly reviewing the results of assessment efforts for NPS pollution control, fish and wildlife habitat protection, and other resource protection programs, managers can better understand the cumulative impacts of various human activities and determine the most critical problems in each watershed. Using this information to set priorities for action allows public and private managers from all levels to allocate limited financial and human resources to address the most critical needs.

The final result of the watershed approach is a plan that is a clear description of resource problems, goals to be obtained, monitoring to be conducted, and identification of sources for technical, educational and funding assistance. The successful plan provides a basis for seeking support and for maximizing the benefits of that support.

Source: USEPA, 1996b.

mental effects of cumulative wetland losses. In addition, this approach involves assembling a framework that ranks watersheds according to the relative importance of wetland functions and losses. States are also encouraged to refine their water quality standards applicable to wetlands by assigning wetland-specific designated uses to classes of wetlands (USEPA, 1990).

A number of factors in a watershed should be considered in the development of a wetland conservation plan. Factors such as position in the landscape, present or past land use, and existing modification of the natural hydrology help to define the goals and objectives of a conservation plan and identify problems and opportunities for protection and management.

4.1.2 Assessment of Functions and Values

Practice

Identify existing functions of those wetlands and riparian areas with significant NPS control potential when implementing NPS management practices. Do not alter wetlands or riparian areas to improve their water quality function at the expense of their other functions.

Although wetlands are recognized for their flood control and water quality improvement functions, use of natural wetlands to reduce pollutants in stormwater and other forms of runoff can have dramatically adverse effects on wetland systems. EPA's Office of Wetlands has several Fact Sheets available (for example, Wetland Monitoring and Assessment: A Technical Framework, USEPA, 2002 and Wetland Monitoring and Assessment, USEPA, 2001) that provide information on protecting and monitoring wetlands. See the EPA Office of Wetlands' website, http://www.epa.gov/owow/wetlands/facts/contents.html for a complete list of wetlands fact sheets and other technical information. Several states have laws that restrict direct conveyance of stormwater into natural wetlands. For example, the Washington State Department of Ecology established regulations restricting the placement of stormwater management ponds in wetlands. Stormwater discharges to wetlands must be treated and controlled to meet state water quality and ground water quality standards. The hydroperiod and flows of existing site conditions must also be maintained to protect characteristic uses of the wetland (Washington State Department of Ecology, 1992).

In general, the following practices should be avoided:

- Location of surface water runoff ponds or sediment retention basins in wetland systems.
- Extensive dredging and plant harvesting as part of nutrient or metals management in natural wetlands.

Some harvesting within wetlands might be necessary to control the invasion of exotic plants. Extensive harvesting of plants in a wetland for surface water runoff or nutrient management, however, could be very disruptive to the existing plant and animal communities.

A study conducted on two similar wetlands in New Jersey demonstrated an increase in erosion associated with the harvesting of vegetation. Vegetation was cut in one of the wetlands and left undisturbed in the other. Banks eroded more than 6 feet in the harvested wetlands while the uncut site exhibited minimal erosion (USEPA, 1995b).

Assessment

The assessment of wetland and riparian areas can provide data needed to identify degradation of functions within the systems and potential sources of the degradation. Several states assess wetlands that are relatively free from impacts to define baseline conditions and establish standards to protect wetlands.

Several assessment approaches can be applied to characterize existing functions of wetlands and riparian areas. The Hydrogeomorphic Approach to the Functional Assessment of Wetlands (HGM) was developed by the USACE Waterways Experiment Station (USACE Waterways Experiment Station, 1995). HGM establishes procedures for classifying regional wetland types and developing models for assessing the functions of each. HGM is based on the recognition of common hydrologic and geomorphic characteristics of different types of wetland ecosystems and the use of reference systems as the basis of scaling functional attributes of wetlands. With the establishment of reference wetlands, in which functions have already been evaluated, a site being evaluated can be compared to the reference group of the same class. The HGM method represents a rapid assessment approach that can be used to characterize existing functions in wetlands, potential impacts to wetland functions as the result of an activity, and changes in wetland function over time.

Examples of the use of functional assessment tools for various wetland or riparian area applications are provided in Table 4-5 and Appendix F.

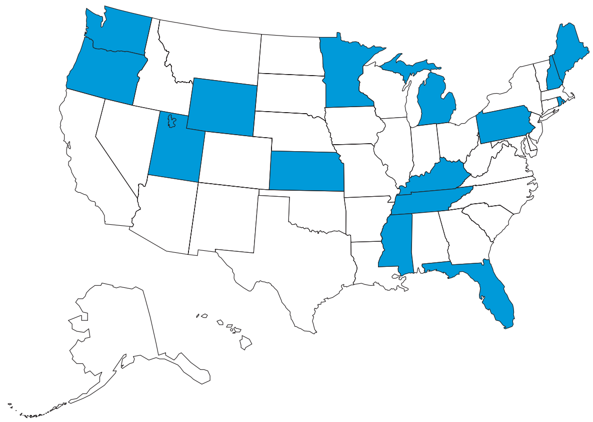
Monitoring

Water quality and biological monitoring may be necessary to characterize general conditions and to document changes over time. Monitoring of conditions in wetland or riparian areas, particularly where such areas are providing NPS pollution reduction functions, is important to ensure that healthy habitat conditions are maintained. Water quality monitoring is useful for determining the physical characteristics and chemical composition of a water body at a particular time. A sustained record of water quality sampling makes it possible to determine trends in pollutant loadings. BMPs to protect habitat functions can be implemented where adverse impacts are identified.

A state may need to address any one or a combination of factors in particular circumstances to meet the mandates of the Clean Water Act articulated in section 101(a): "to restore and maintain the chemical, physical, and biological integrity of the nation's waters."

One of the most direct and effective ways of evaluating the ecological health or integrity of a wetland is to directly measure the condition of the wetland's biological community. Bioassessment methods can be used to directly measure the long-term biological integrity of wetlands and quickly screen them for signs of impairment. Several states, including Florida, Indiana, Maine, Massachusetts, Minnesota, Montanan, North Dakota, Ohio, and Pennsylvania, are developing biological assessment methods to evaluate the health of their wetlands. Wetland bioassessments can be useful in defining management approaches to maintain

Table 4-5. Assessment of Functions and Values for Protection of Wetlands or Riparian Areas



Practice: Identify existing functions of those wetlands and riparian areas with significant NPS pollution control potential when implementing NPS pollution management practices. Do not alter wetlands or riparian areas to improve their water quality function at the expense of their other functions.

This table provides some examples from different locations in the United States of the kinds of activities that can help implement this practice. For more information about the examples, refer to Appendix F at the back of the document.

Implementation Activities	Example Projects
Identify and evaluate existing NPS functions of wetland and riparian areas.	Wetland Conservation Plans (OR), Wetland Protection (RI), Wetland Protection (Guam), Wetlands Protection Plan (Rincon)
Apply assessment tools to characterize existing functions in wetlands.	Wetland Protection (FL), Water Quality Assessment (KS), Meadows Golf Club (MI), Reference Wetlands Project (MN), Pearl River Basin (MS), Rivers and Wetlands Program (TN), Matheson Preserve (UT), Synoptic Assessment Approach (WA), Green River (WY), Wetlands Protection Plan (Rincon), Wetlands Project (Santa Clara Pueblo)
Use assessment tools to evaluate potential impacts resulting from activities within the watershed.	Reference Wetlands Project (MN), Pearl River Basin (MS), Rivers and Wetlands Program (TN), Synoptic Assessment Approach (WA), GIS Assessment (Virgin Islands)
Monitor wetlands throughout watersheds to characterize general conditions and changes over time.	Water Quality Assessment (KS), Reference Reach Monitoring Program (KY), Reference Wetlands Project (MN), Wetland Conservation Plan (ME), Wetland Water Quality Standards (NH), Wetland Restoration/Creation Site Registry (PA), Rivers and Wetlands Program (TN), Matheson Preserve (UT), Wetland Water Quality Standards (Miccosukee), Wetlands Protection Plan (Rincon), Wetlands Project (Santa Clara Pueblo)
Characterize unaltered wetlands to define baseline conditions and establish wetland protection standards.	Water Quality Assessment (KS), Watershed Initiative Program (MI), Reference Wetlands Project (MN)

and restore wetland condition and in evaluating the performance of protection and restoration activities.

The involvement of volunteers in wetland assessment and monitoring programs is a realistic, cost-effective and beneficial way to obtain important information that might otherwise be unavailable because of a lack of resources at government agencies. Initiatives like Riverwatch, Adopt a Stream, and the Izaak Walton League's Save Our Streams program have been highly successful in maintaining groups of interested volunteers and yielding data useful to scientists, planners, and concerned citizens. A growing number of organizations are training citizens to monitor wetlands.

In addition to providing useful information, these programs have the benefit of educating citizens about wetland functions and empowering citizens to become more active stewards of wetland resources in their communities. Informed citizens can play a key role in encouraging land and water stewardship in all sectors of society, from industry to private homeowners and from housing developers to municipal sewage treatment managers and local planning boards.

4.1.3 Programmatic Approaches

Practice
Use permitting, licensing, certification, and nonregulatory approaches to protect wetland functions.

There are many possible programs, both regulatory and nonregulatory, to protect wetland functions (Table 4-6). Appendix A and Appendix F also provide information on federal, state, nonprofit, and private programs involved in the protection and restoration of wetlands and riparian areas on private lands. From a regulatory standpoint, many states have already implemented requirements for increases in flow rates into wetlands and restricted the placement of detention/retention and other basins in high ground water areas. The use of permitting, licensing, and certification is a practice that is constantly being used, modified, and updated.

Acquisition

Obtain easements or full fee acquisition rights for wetlands and riparian areas along streams, bays, and estuaries. Numerous federal programs, such as the USDA WRP, the EPA Clean Water State Revolving Fund (SRF), and the Fish and Wildlife Service North American Waterfowl Management Plan can provide assistance for acquiring easements or full title. Acquisition of water rights to ensure maintenance of minimum in-stream flows is another means to protect wetlands or riparian areas. Water rights acquisition can be a critical issue in the arid West. See Table 4-6 and Appendix F for examples of acquisition and easement programs.

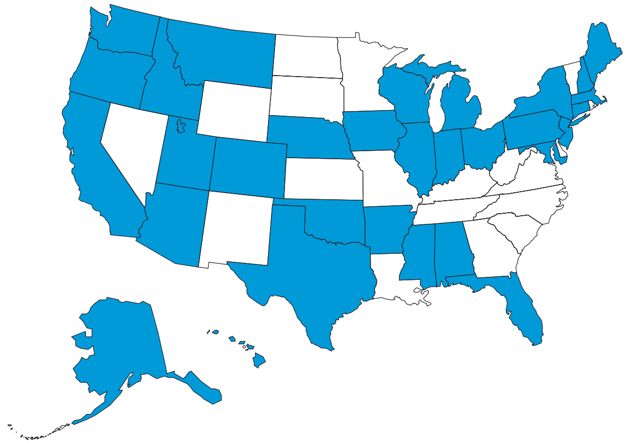
Several states have developed landowner guides for wetland protection and management. Table 4-7 provides examples of states that have developed guides. Additional information on protection and management guides is provided in Appendix F.

Provide a mechanism for private landowners and agencies in mixed-ownership watersheds to develop, by consensus, goals, management plans, and appropriate practices and to obtain assistance from federal and state agencies.

Zoning and Protective Ordinances

Restrict activities that have a negative impact on wetlands and riparian areas through implementation of special area zoning and transferable development rights. Identify impediments to wetland protection such as excessive street standards and setback requirements that limit site-planning options and sometimes force development into wetlands.

Table 4-6. Programmatic Approaches to Protecting Wetlands and Riparian Areas

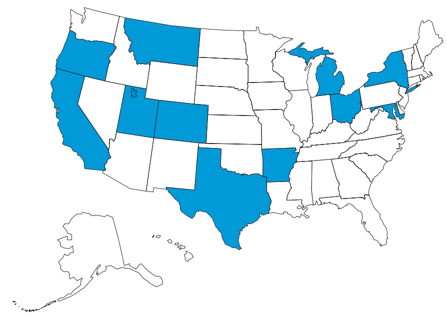


Practice: Conduct permitting, licensing, certification, and nonregulatory NPS pollution abatement activities in a manner that protects wetland functions.

This table provides some examples from different locations in the United States of the kinds of activities that can help implement this practice. For more information about the examples, refer to Appendix F at the back of the document.

Implementation Activities	Example Projects
	Wetland Protection (FL), Wetland Protection (MA), Nontidal Wetlands Protection Act (MD), Wetland Protection (MI),
Protect sensitive lands along watercourses from encroachment.	Freshwater Protection Act Rules (NJ), Conservation Easement Purchase (OH), Wetlands Conservation Plan (OR), Wetland Protection (RI), Comprehensive Plan Policy (VA), Mangrove Protection (Puerto Rico)
Require ecological transition areas or buffers adjacent to wetlands.	Wetland Protection (CT), Wetland Protection (MA), Forest Buffer Legislation (MD), Freshwater Protection Act Rules (NJ), Wetland Protection (NY), Wetland Protection (RI), Coastal Management Program (American Samoa)
Develop regulatory programs to counteract encroachment resulting from zoning requirements.	Wetlands Regulatory Program (WA)
Develop tools for determining proper buffer widths.	Buffer Zone Guidelines (FL), Agricultural Experiment Station (NJ) Wetland Water Quality Standards (NH), State Water Quality Standards (WI), Wetland Water Quality Standards (Miccosukee), Wetlands Protection Program (Narragansett), Wetlands Program (Pueblo of Laguana)
Develop wetland water quality standards.	Landowner's Guide (AR), Wetland Conservation Guide (CA), Landowning Colorado Style (CO), Wetlands Assistance Guide (MD), Watershed Initiative Program (MI), Ohio Wetlands (OH), Protecting Darby Creek (OH), Wetlands Conservation Guide (OR), Wetlands Assistance Guide (TX), Wetlands Conservation Plan (TX), Wetland Habitat Alliance of Texas (TX)
Provide a mechanism for private landowners to obtain wetlands assistance.	Huichica Creek Vineyard (CA), Hamakau Wetlands (HI), Tiburon Golf Course (NE), Rivers and Wetlands Program (TN), Wetland Conservation Grant (TN), Wetland Conservation Plan (TX), Matheson Preserve (UT), Riparian Restoration Demonstration (VA), Riparian Task Force (WV), Wetland Conservation Plan/Outreach (Bad River Band), Watershed Demonstration Project (Flathead Reservation), Wetlands Conservation Project (Hopi), Wetlands Outreach (MITC), Wetlands Protection Program (Narragansett), Wetlands Outreach (Red Lake Band), Watershed Protection (Umatilla), Wetland Community Park (Umatilla)
Provide outreach and education support for wetland and riparian area protection and restoration.	Gulf Oak Ridge (AL), Ramsey Canyon (AZ), Tahoe Conservancy (CA), Wetland Restoration Program (IA), Teton River Basin (ID), Southern Lake Michigan (IN), Wetland Protection (MA), Pine Butte Swamp (MT), Wetland Acquisition (MI), Coastal Preserves (MS), Green Acres Program (NJ), Conservation Easement Purchase (OH), West Eugene Wetlands Project (OR), Hackberry Flat (OK), Wetland Restoration/Creation Site Registry (PA), Wetland Conservation Grant (TN), Wetland Restoration Site Registry (TX), Winona Wetlands Purchase (WA)
Develop wetland management plans that specify practices for protection.	Local Wetland Management Plans (AK), Wetland Conservation Strategy (IL), Nontidal Wetland Protection Act (MD), Wetland Conservation Plans (OR), Wetland Conservation Plan (ME), Wetland Protection (MA), Watershed Initiative Program (MI), Pine Butte Swamp (MT), Wetlands Conservation Plan (TX), Coastal Management Program (American Samoa), Wetlands Conservation Plan/Outreach (Bad River Band), Watershed Demonstration Project (Flathead Reservation), Wetlands Conservation Project (Hopi), Wetlands Protection Program (Narragansett), Wetland Conservation Program (Nez Perce), Wetlands Protection Program (Pueblo of Acoma), Wetlands Program (Pueblo of Laguana), Wetlands Conservation Plan (Sisseton-Wahpeton Dakota Nation), Watershed Protection (Umatilla), Wetlands Conservation Plan (Warm Springs)

Table 4-7. Examples of State Guides for Wetland Protection and Management



Explanation of Definition	Characterization of Functions	Characterization of Loss	State Regulatory Programs	Federal Regulatory Programs	State Nonregulatory Programs	Federal Nonregulatory Programs	Landowner Options	State Sources for Assistance	Federal Sources for Assistance	Contacts	Case Studies	Example Guide
✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		Landowner's Guide (AR)
✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	Wetland Conservation Guide (CA)
				✓			✓			✓		Landowning Colorado Style (CO)
✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Wetlands Assistance Guide (MD)
✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Living With Michigan's Wetlands (MI)
	✓		✓	✓			✓					Stream Managment Guide (MT)
	✓		✓	✓			✓	✓	✓	✓		Wetland Regulation Guidebook (NY)
✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	Ohio Wetlands (OH)
✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Wetlands Conservation Guide (OR)
✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Wetlands Assistance Guide (TX)
✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		A Wetlands Workbook (UT)

Winona Wetlands Purchase

The city of Port Townsend, Washington, was able to meet both stormwater management objectives and a wetlands preservation goal by obtaining funding from Washington's SRF to purchase an area known as the Winona Wetlands. This wetland acts as a critical stormwater basin for the area and provides valuable wildlife habitat. Potential development of the area not only threatened the wetlands but also would result in stormwater management problems. By purchasing the wetlands, the city was able to protect a natural stormwater management system as well as a wildlife refuge. The city purchased 6.5 acres in Phase I and is currently planning to borrow additional SRF funds for a Phase II purchase of 9 acres. This $400,000 project is part of the National Estuary Program (Clean Water Act section 320) for the Puget Sound Estuary. A portion of the city's stormwater utility fee paid by households is being used to repay the Washington SRF.
Source: USEPA. 1998c.

Chesapeake Bay Program

The Chesapeake Bay Program has developed a compilation of tools to assist local governments in the protection of wetlands, including planning, zoning, and tax incentive approaches that have been useful for protecting wetlands in the Chesapeake Bay region.
Source: USEPA, 1997b.

Water Quality Standards

Several states and tribes have realized the importance of developing and implementing water quality standards that protect the full range of wetland functions.

A significant percentage of wetlands are waters of the United States, as defined in the Clean Water Act. Consider natural water quality functions when specifying designated uses for wetlands, and include biological and hydrologic narrative criteria to protect the full range of wetland functions. Table 4-6 and Appendix F provide examples of cases where water quality standards that specifically address wetland functions have been, or are being, developed. Also refer to EPA's *Water Quality Standards for Wetlands: National Guidance* for more information (USEPA, 1990).

For more information on State Revolving Funds, contact your Clean Water State Revolving Fund Program or contact:

The Clean Water State Revolving Fund Branch
U.S. EPA
1200 Pennsylvania Ave., NW
(Mailcode 4204)
Washington, DC 20460
(202) 260-7359
http://www.epa.gov/OWM

Regulation and Enforcement

Establish, maintain, and strengthen regulatory and enforcement programs. Where allowed by law, include conditions in permits and licenses issued under Clean Water Act sections 401, 402, and 404; state regulations; or other regulations to protect wetlands.

As an example of a linkage to protect NPS pollutant abatement and other benefits of wetlands, a state could determine under Clean Water Act section 401 that a proposed discharge or other activity in a wetland is inconsistent with state water quality standards. A state might need to address any one of a combination of factors in particular circumstances to meet the mandates of the Clean Water Act articulated in section 101(a) "to restore and maintain the chemical, physical, and biological integrity of the nation's waters." Protection of water quality includes protection of multiple elements that together make up aquatic systems, including the aquatic life, wildlife, wetlands and other aquatic habitat, vegetation, and hydrology required to maintain the aquatic system. An activity within a wetland could be determined to be consistent with water quality standards if existing use requirements are met and if the activity does not cause or contribute to significant degradation of the aquatic environment as defined in the guidelines developed under section 404(b)(1) of the Clean Water Act (USEPA, 1991).

Restoration

Programs such as USDA's CRP and WRP provide opportunities to set aside and restore wetlands and riparian areas. Also, incentives that encourage private restoration of fish and wildlife productivity are often more cost-effective than federal, state or local acquisition.

Education and Training

Education and outreach are essential tools for promoting an understanding of the importance of wetland and riparian areas in maintaining water quality and in developing support for the protection of these habitats and the valuable functions that they perform.

- Educate farmers, urban dwellers, and federal agencies on the role of wetlands and riparian areas in protecting water quality and on BMPs for restoring stream edges.

Where wetlands are the final discharge point for runoff, BMPs can be used to control the runoff before it reaches the wetland and to ensure the maintenance of existing pollution abatement functions.

- Teach courses in simple restoration techniques for landowners.
- Use local and regional wetlands guides. Many states have developed wetlands guides to assist landowners in protecting wetland and riparian areas according to their different needs (see Table 4-7). Appendix A and Appendix F provide additional examples of federal, state, tribal, nonprofit, and private programs that provide financial and technical assistance to landowners for wetland or riparian area protection or restoration.
- Provide a mechanism for private landowners and agencies in mixed-ownership watersheds to develop, by consensus, goals, management plans, and appropriate practices and to obtain assistance from federal and state agencies. EPA's National Estuary Program and the USFWS Bay/Estuary Program are excellent examples of approaches that establish a framework for multiagency program linkage and present opportunities to link implementation efforts aimed at protection or restoration of wetlands and riparian areas.

A number of state and federal agencies carry out programs with compatible NPS pollution reduction goals. For example, Maryland's Nontidal Wetlands Protection Act encourages development of comprehensive watershed plans for addressing wetland protection, mitigation, and restoration issues in conjunction with water supply issues. In addition, the USACE and EPA administer the Clean Water Act section 404 program; USDA implements the Swampbuster, CRP, and WRP; EPA, USACE, and states work together to perform advanced identification of wetlands for special consideration (Clean Water Act section 404); and states administer both the Coastal Zone Management (CZM) program, which provides opportunity or consistency determinations, and the Clean Water Act section 401 certification program, which allows for consideration of wetland protection and water quality objectives.

4.1.4 Preliminary Treatment Practices

The characteristics of runoff are directly affected by land use. Agricultural runoff tends to be high in nitrogen, phosphorus, bacteria, and suspended sediments. Typical pollutants found in urban runoff include sediment, oxygen-demanding substances, nutrients, heavy metals, pesticides, hydrocarbons, increased temperature, and trash and debris.

Practice
Use appropriate preliminary treatment practices such as vegetated treatment systems or detention or retention basins to prevent adverse impacts on wetland functions that affect NPS pollution abatement.

Land Uses

Land use directly affects the characteristics of runoff. For example, the constituents of runoff from farmland are likely to be different from those in urban runoff. Agricultural runoff tends to be high in nitrogen, phosphorus, bacteria, and suspended sediments; typical pollutants found in urban runoff include sediment, oxygen-demanding substances, nutrients, heavy metals, pesticides, hydrocarbons, increased temperature, and trash and debris (USEPA, 1996a).

The principal consideration in the design of a BMP is whether it will provide the level of protection necessary to ensure that the wetland will retain its natural health and functions.

Different wetland types vary in their ability to handle changes caused by stormwater flows and pollutant levels. Where runoff is directly channeled to wetlands, treatment practices, or BMPs, should be implemented to maintain the natural functions of the wetland. This may require the use of BMPs designed for water quality improvement, maintenance of natural hydrologic conditions, or both, that consider site-specific conditions, including regional variations in geography and climate. The principal consideration in the design of a BMP is whether it will provide the level of protection necessary to ensure that the wetland will retain its natural health and functions. BMPs should be selected after carefully considering the combination of variables that influence a wetland and the characteristics of the runoff entering the wetland, as well as the capabilities and applicability of the BMPs being considered (USEPA, 1996a). Several states, including Delaware and Florida, have or are currently developing programs and guidelines for protecting wetlands through the use of BMPs.

Design of Pretreatment Practices

Properly designed and placed BMPs can effectively protect the functions of natural wetlands from NPS pollution. Natural wetlands, because of their position in the landscape, often directly receive stormwater runoff. Large flow volumes, high velocities, increased sedimentation, and long-term pollutant loads delivered in runoff can alter or destroy stable wetland ecosystems and their ability to perform NPS pollution abatement functions. Both structural and nonstructural BMPs can be used to provide preliminary treatment of runoff that might impact a receiving wetland.

Often, designing a combination of BMPs is the best approach to protecting existing wetland resources. BMPs in series (sometimes referred to as a "treatment train") incorporate several stormwater treatment mechanisms in sequence to enhance the treatment of runoff. By combining BMPs in series rather than using a single method of treatment for runoff, the efficiency and reliability of pollutant removal can be improved. Examples of serial BMPs that can be used to provide preliminary treatment of runoff headed for wetlands include (1) multiple pond systems, (2) grassed swales combined with detention ponds, and (3) grassed swales leading to vegetated filter strips, followed by infiltration trenches.

It is important in the design of BMPs in series to consider the hydrologic characteristics of the existing wetland. The series of BMPs should be designed to ensure that the amount of runoff to the wetland is not decreased or otherwise changed to a degree that negatively affects the function of the wetland. For example, where properly designed BMPs are not used, wetlands can be impacted by the accumulation of sediments resulting from decreased flow velocities as runoff enters the wetland. Increased stormwater volumes and velocities associated with development in a watershed may also result in the scouring of wetland substrates if BMPs are not in place to slow and reduce flows. In addition to the hydrologic characteristics of the wetland, the characteristics of the NPS runoff, as well as individual BMP capabilities, design requirements, and cost, are important variables when considering the use of serial BMPs.

Many states and territories have developed manuals that provide information on the proper design of BMPs for stormwater and erosion and sediment control (ESC). *Protecting Natural Wetlands: A Guide to Stormwater Best Management Practices* (USEPA, 1996a) provides insight into the application of BMPs to protect wetlands from the adverse effects of NPS runoff and provides sources for additional information. Additional information on the application of BMPs for wetland protection can also be found in the Management Measure for Vegetated Treatment Systems.

Additional information on BMPs for use with wetlands can be found in Protecting Natural Wetlands: A Guide to Stormwater Best Management Practices *(USEPA, 1996a).*

Programmatic Approaches

Programmatic BMPs can also be used to help ensure that preliminary treatment of runoff is conducted before the runoff enters wetlands. Requiring implementation of ESC practices at construction sites is an example of a good programmatic approach for reducing sediment and other pollutant loads to wetlands. ESC programs should provide a good source of design guidelines and make sure that effective sediment control practices are being implemented, based on good design criteria, monitoring of completed installations, good maintenance procedures, and monitoring follow-up to ensure that maintenance is being performed. Examples of states and territories that have developed ESC programs are Virginia, Delaware, North Carolina, and Guam.

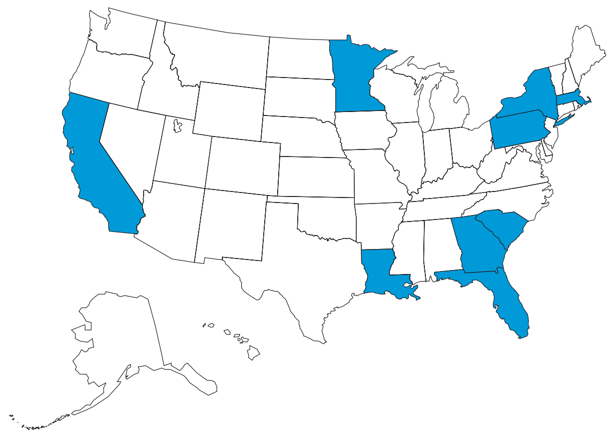
For more information on the technical implementation and effectiveness of treatment systems, refer to the Management Measure for Vegetated Treatment Systems and Appendix F.

The Fish and Wildlife Service has a long history of wetlands acquisition, protection, and enhancement. The first national wildlife refuge, Pelican Island, was established in 1903 and was created for its namesake, the brown pelican, a wetland-dependent species. The passage of the Migratory Bird Treaty Act in 1918 and the Migratory Bird Conservation Act of 1929 greatly expanded the Service's role in protecting wetlands and species and their habitats. In 1996 the Service managed 472 national wildlife refuges covering approximately 90 million acres. It is estimated that wetlands constitute more than 35 percent of this total refuge area. Proceeds from the sale of the Federal Migratory Bird Hunting and Conservation Stamp, popularly known as the Duck Stamp, have provided more than $250 million for the acquisition of wetlands habitats for inclusion into the refuge system.
Source: USGS, 1996.

4.2 Cost and Benefits of Practices

Costs to implement this management measure, as well as economic benefits derived from implementing this management measure, are associated with planning, mapping, geographic information systems (GIS), protection programs, and pretreatment. This section describes the economic benefits of protecting wetlands and riparian areas that serve NPS abatement functions. This information is intended to demonstrate the cost savings accrued by implementing the management measure as compared to the costs of not implementing it. Because of the wide diversity of regions throughout the United States, no single cost or economic benefit can be used across the board. Instead, the information below and in Table 4-8 provides examples of such costs and benefits in specific areas of the country. The majority of the costs of protecting wetlands and riparian

Table 4-8. Costs and Economic Benefits Associated with Protecting Wetlands



Examples from throughout the United States show the expected cost of many types of wetland and riparian protection projects, as well as their value to the respective communities. For many of these projects, the cost to install structural or conventional technologies to replace the functions of wetlands have been shown to be much greater than the cost of the protection measure. When available, the dates for project/wetland costs are provided. Results of studies in various states (see map at left) are shown in the table below. Additional information about each study cited in the table is provided in Appendix F.

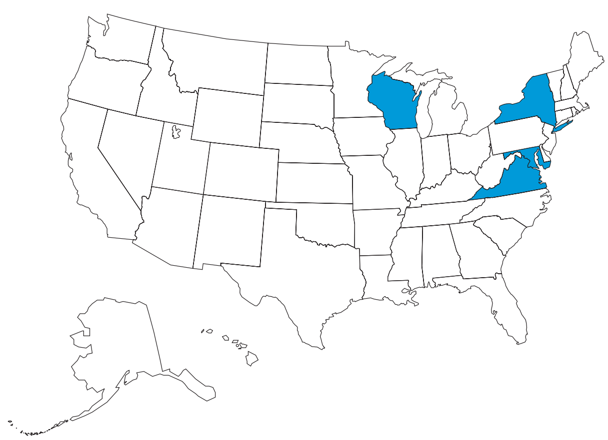
Study	Cost of Conventional Project	Cost of Wetland	Estimated Benefit of Wetlands	Example Projects
Dredging costs presumed due to wetland loss	$2.8 million in dredging costs (1999)		Reduced sedimentation in shipping channel	Redwood City (CA)
Kissimmee Prairie, Florida, Basin		$33,837,767 (1998)	The acquisition of Kissimmee Prairie State Preserve provided tax incentives to the landowner and has provided an excellent public/private partnership for watershed protection	Kissimmee Prairie Watershed (FL)
Valuation of estuarine wetlands for wastewater treatment	$368 to $2,204/acre for wastewater treatment (1994)		$82/acre to $157/acre; $4,626/acre (industrial wastewater) (1994)	Barataria-Terrebonne Estuary (LA)
Valuation of coastal wetlands (fisheries, recreation, trapping, storm protection)			$2,429/acre to $8,977/acre (1989)	Coastal Wetlands (LA)
Construction of a dam versus preserving wetlands	$100 million (dam construction) (1984)	$10 million (wetland purchases) (1984)	$90 million (one-time structural costs avoided) and $3.2 million in reduced flood damage in 1987	Natural Storage in the Charles River Valley (MA)
Cost to replace water storage capability of a wetland	$300/acre-foot		$1.5 million/year for the estimated 5,000 acres of wetlands lost each year	Minnesota Department of Natural Resources (MN)
Savings of constructed wetlands vs. conventional method	$50 million (ongoing since 1960's)			Staten Island Bluebelt Project (NY)
Wastewater costs due to wetland loss	$1.5 million (no date)		$1.5 million sewer system installation	East Goshen (PA)
Replacement of swamp with a water treatment facility for pollution prevention	$5 million		$5 million for installation of water treatment facility	Congaree Swamp (SC)

areas shown in Table 4-8 are the result of the purchase of wetlands or cost avoidance (e.g., cost of retaining wetlands rather than constructing water or waste treatment facilities).

In addition to direct costs (e.g., planning, mapping, protection progress, and pretreatment) associated with protecting natural wetlands that serve NPS pollution abatement functions, there are other planning and outreach costs with corresponding benefits. These planning and outreach costs are associated with activities such as modeling studies for stormwater flow and water quality protection, educational programs for stakeholders, and development of comprehensive land use plans that include NPS pollutant controls and wetlands protection. Table 4-9 provides specific examples of planning and outreach costs and associated benefits.

Estimating the costs to control NPS pollution nationwide is a difficult task. Critical information, such as identification of waters contaminated with NPS pollution and the contribution of each of those sources, is not readily available at the local level, much less at a national level. Reported in a 1999 publication, EPA estimated the annual costs of controlling three major sources (agriculture, silviculture, and animal feeding operations) of NPS pollution to be $9.4 billion, an amount that represents one of the few systematic attempts at estimating such costs nationwide (GAO, 1999). Part of this cost is attributed to protecting and restoring wetlands and riparian areas.

Table 4-9. Planning and Outreach Costs and Benefits



Additional costs are associated with the planning of wetlands protection, as well as with public outreach and education. Some examples of such costs are identified below. When available, the dates for project costs are provided. More information on these examples is provided in Appendix F.

Study	Cost of Project	Estimated Benefit	Example Projects
GIS Flood Management and Water Quality Models, Prince George's County	$450,000	Exceptional cost and time savings have resulted from use of the Geo-STORM application, and the methods are more consistent than previous studies.	GIS (MD)
Monroe County Wetlands Education for schools and public officials	$20,000 plus $9,000 in-kind services (1999)	There is a high demand for the wetland field trip workshop. "More land use decision-makers and residents are receptive to the placement of constructed wetlands in their communities."	Wetland Education Program (NY)
Development of wetland protection and conservation ordinance	$50,000 to $100,000		Grand Portage Reservation (Tribal)
Henrico County's Environmental Program: Protection of Water Resources–regulatory strategies (a watershed-based storm water management program that is protective of wetlands)		Conflicts between developers and homebuilders are reduced because of plan reviews and approvals relating to U.S. wetlands and waters. Accidental impacts to wetlands or streams are avoided.	Henrico County's Environmental Program (VA)
Duck, Apple, and Ashwaubenon Creeks (DAA) Priority Watershed Project–comprehensive planning and implementation of NPS control measures; establishment of water quality goals and objectives	$21,800,000 (DAA Nonpoint Source Control Plan) (1999)	Water quality and quantity will be improved, and the economy and the quality of life in northeastern Wisconsin will benefit directly from those improvements.	Wisconsin Department of Natural Resources, Oneida Indian Reservation (WI)

There are a number of federal and state programs available to help both public and private groups preserve and protect wetlands and riparian areas. Some of these programs are summarized in Appendix F.

The benefits of preserving wetlands and riparian areas in terms of reducing NPS pollution are well recognized. Representative studies of the kind that document benefits are summarized in Table 4-1. Wetlands have important filtering capabilities for intercepting surface-water runoff from higher dry land before the runoff reaches open water. In performing this filtering function, wetlands save communities a great deal of money. For example, a 1990 study showed that without the Congaree Bottomland Hardwood Swamp in South Carolina, the area would need a $5 million wastewater treatment plant (USEPA, 1996b). The value of a wetland to a community can be estimated based on the wetland's ability to abate NPS pollution. For example, wetlands near cities have been estimated to be worth about $98,000 per acre (1997) for their ability to clean water, recycle nutrients, recharge aquifers, control floods, and support fish and wildlife (Abramovitz, 1997).

The Minnesota Department of Natural Resources places a value of $665 per acre per year (in 1996 dollars) on the ability of wetlands to remove nutrients and sediments from the environment. In an economic assessment of wetland mitigation in northwest Minnesota, Sip et al. (1998) used a value of $175 per acre per year as a proxy for the value of water quality protection.

It is estimated that riparian forest buffers can remove 21 pounds of nitrogen per acre each year for $0.30 per pound and about 4 pounds of phosphorus per acre each year for $1.65 per pound. The Interstate Commission for the Potomac River Basin estimates that urban retrofit of BMPs to remove 20 percent of current nutrient runoff will cost approximately $200 per acre, or $643 million for the entire Chesapeake Bay basin. In the same study, estimated costs of reducing runoff from highly erodible agricultural land are $130 per acre, or $68 million for the basin.

Many other economic benefits of wetlands have also been described by a number of studies and reports. A wealth of natural products are harvested from wetlands, including fish and shellfish, blueberries, cranberries, timber, and wild rice, as well as medicines that are derived from wetland soils and plants. Many of the nation's fishing and shellfishing industries harvest wetland-dependent species; the catch is valued at $15 billion per year. The coastal marshes of Louisiana alone produced 1.2 billion pounds of commercial fish and shellfish in 1991, a harvest worth $244 million. Wetlands also have recreational, historical, scientific, and cultural value. More than half of all U.S. adults (98 million) hunt, fish, birdwatch or photograph wildlife. They spend a total of $59.5 billion annually (USEPA, 1996b).

Current state and local requirements for ESC increase the cost of development. BMPs for ESC cost between $1,500 and $1,700 per acre (year 2000 dollars), based on averaging 1, 3, and 5 acre sites and assuming moderate slope (7 percent) and moderate soil erodibility. Administrative requirements associated with ESC, which include notice of intent (NOI), municipal notification, stormwater pollution prevention plans (SWPPP), record retention, and notice of termination (NOT), cost about $930 per site (year 2000 dollars) (SAIC, 1999). Forest conservation and riparian buffers sharply reduce ESC costs. Forest conservation would keep soil on-site, resulting in less time and labor regrading, stabilizing and relandscaping the site.

5 Management Measure for Restoration of Wetlands and Riparian Areas

This chapter presents supporting information, including management practices, specific implementation examples, and costs and benefits, for the following management measure:

Management Measure
Promote the restoration of the preexisting functions in damaged and destroyed wetlands and riparian systems, especially in areas where the systems will serve a significant NPS pollution abatement function.

Healthy wetland and riparian areas can effectively reduce pollutants such as sediment, nitrogen, and phosphorus in stormwater. Wetlands and riparian areas also help to lessen flows from storm events and protect downstream areas from impacts such as channel scour, streambank erosion, and fluctuations in temperature and chemical characteristics. When wetlands or riparian areas are degraded or destroyed, the valuable functions they perform are lost. States and tribes can apply this management measure to restore the full range of wetlands and riparian functions in areas where the systems have been degraded or destroyed.

What Is Restoration?

Restoration is defined as the return of an ecosystem to a close approximation of the conditions present prior to disturbance. In restoration, ecological damage to the resource is repaired; both the structure and the functions of the ecosystem are recreated. The goal of restoration is to emulate a natural, functioning, self-regulating system that is integrated with the ecological landscape in which it occurs (USEPA, 1995a). Restored wetlands and riparian areas, like undisturbed ones, remove NPS pollutants from waters that flow through them. Acting as a sink for phosphorus and converting nitrate to nitrogen gas through denitrification are two examples of the important NPS pollution abatement functions performed by wetlands and riparian areas.

Restoration is an integral part of a broad, watershed-based approach for achieving federal, state, and local water resource goals (USEPA, 1995a). A restoration management measure should be used in conjunction with other measures addressing the adjacent land use activities and, in some cases, water activities as well. Restoration of wetlands and riparian areas is a holistic approach to water quality that addresses NPS problems while meeting the goals of the Clean Water Act to protect and restore the chemical, physical, and biological integrity of the nation's waters.

The fundamental goal of wetland or riparian restoration is to return the ecosystem to a condition that resembles the natural predisturbance state as closely as possible. The establishment and achievement of these goals involves consideration of the ecosystem's structure and function on both the local scale and the broader landscape or watershed scale. Proper planning is necessary to set ecological and NPS pollution goals and to ensure that design, implementation, and monitoring of the project are conducted in a timely and cost-efficient manner and that the goals of restoration are met. Monitoring is critical to measure progress toward achieving restoration goals and to verify that the restored site is performing as it should.

Full restoration of complex wetland and riparian functions may be difficult and expensive, depending on site conditions, the complexity of the system to be restored, the availability of native plants, and other factors. The Department of Energy conducted a study examining the economics of wetland creation, restoration, and enhancement (USDOE, 1995). In the 1995 USDOE report, costs varied widely, ranging from $5 per acre to more than $1.5 million per acre. Cost differences were attributed to target wetland type and to site-specific and project-specific factors that affected the preconstruction, construction, and postconstruction tasks necessary to meet the project goals. Specific practices for restoration must be tailored to the specific ecosystem type, site conditions, and economic parameters. In addition, wetlands restored to aid in reducing NPS pollution to water bodies must be protected from being degraded by NPS pollution impacts.

Restoration projects vary in size, complexity, and cost based on wetland type, sources of degradation, and local watershed conditions. Local experts knowledgeable about restoration and the local ecology should be involved in the planning process. While certain principles apply to all restoration projects, the design and implementation of restoration projects must be tailored to meet the particular circumstances of each project. For example, even though comprehensive monitoring of a restoration project is desirable, for smaller restoration projects, monitoring programs may need to be modified to address site-specific conditions and scaled proportionally to match the project size.

The following steps and activities should be considered in the planning and implementation of restoration projects.

Step 1. Conduct a Basic Site Characterization

Site characterization and data collection are important initial steps in any restoration effort. Data on the physical and chemical characteristics of the restoration site and conditions in the surrounding watershed should be collected and analyzed. Both present and historical site conditions should be characterized. Historical data can provide valuable information useful for developing potentially achievable project goals. It is important, at this stage, to compile available data on stressors that could affect restoration efforts such as NPS pollutant loadings, surrounding land use, and hydrologic alterations (hydromodification). Land ownership and regulatory requirements should also be identified.

Information compiled during the site characterization, including both site-specific and watershed-scale data, provides a baseline for developing the restoration design and for evaluating the progress and success of the project.

- *Characterize existing conditions.* Basic site characterization and data collection are important initial steps in planning restoration. Characterization should include information on soil types, watershed features (size, slope, water availability, water quality), existing vegetative cover types, adjacent land uses, projected future land uses, property boundaries, and fish and wildlife habitat.

  Take advantage of existing information about the site to be restored. Use of available documentation can save time, energy, and money. At least some background information is likely to be available. Examples of readily available sources of information include national wetland inventory maps, U.S. Geological Survey (USGS) topographic maps, NRCS soil surveys, state wetland maps, aerial photographs, and flood hazard boundary maps. Long-term residents, university libraries, and local private conservation organizations are also good sources of information. Many areas have been previously studied as part of watershed management plans, resource inventories, environmental impact statements, and the like.
- *Conduct watershed-scale analysis.* How a wetland or riparian area is situated in a watershed influences its function. It is important to understand what lands drain to a wetland or riparian area and how the ecosystem fits into the watershed. Conditions throughout a watershed can ultimately affect the success of restoration efforts.
- *Identify nature of impairment.* Initial identification of the causes of damage to a degraded wetland or riparian area is necessary to ensure that they are addressed and ameliorated during the restoration process. A thorough analysis of the cause or causes of alterations or impairments is fundamental to identifying management opportunities and constraints and to defining realistic and attainable restoration objectives.

Restoration projects provide excellent opportunities to educate the public on the roles of wetlands and riparian areas in protecting water quality.

Step 2. Identify Goals for Restoration

Before identifying and selecting restoration techniques, identify specific goals for restoration.

- *Identify pollution abatement functions along with other ecological benefits obtainable through restoration efforts.* Identify the environmental benefits that may be realized as a result of restoring preexisting wetland or riparian area functions. These benefits, such as NPS pollutant abatement, should form the basis for developing restoration goals. Goals are generalized statements about the expected outcome of the project. It is important that the goals are appropriate and obtainable based on project characteristics and constraints. Public involvement in the development of project goals is important. Involving the public not only improves the validity of restoration goals, but also generates interest and support and can be instrumental in finding necessary funding.
- *Develop specific objectives for hydrology, soils, and biota appropriate to the wetland type being restored.* Turn objectives into measurable target criteria that can be monitored to determine the progress of the project.

- *Begin partnership involvement and refine objectives.* Partners can include anyone who has an interest in the watershed. It is important to include all the key interest groups so that you can tap strengths, increase credibility, reduce duplication of efforts, and make optimal use of limited funds. Early consideration of restoration goals, objectives, and scope can assist participants in determining whose interests are affected. Active participants should include all parties necessary to develop and implement solutions to the problems being addressed, as well as those who could impede restoration efforts.
- *Plan to secure necessary permits.* Restoration conducted in, or in contact with, wetlands and other water bodies may be subject to federal, state, and local regulatory programs and requirements. Permit requirements should be determined at an early stage of the restoration process. Based on project goals and the proposed site, requirements established under federal, state, and local regulations may apply. Federal regulations that may apply include the National Environmental Policy Act; sections 401, 402, and 404 of the Clean Water Act; section 6 and 10 of the Endangered Species Act; and section 10 of the Rivers and Harbors Act of 1899. State water laws and permit requirements are important considerations for any restoration project.

Step 3. Identify and Select Restoration Techniques

Although addressing on-site conditions is critical to the chemical, physical, and biological restoration of a wetland or riparian area, the focus of management options should include stressors that originate outside the area as well. Management options considered should include techniques applied on-site and in the surrounding watershed that reduce pollutant loadings and allow the restored wetland or riparian area to reach a state of equilibrium in the landscape.

- *Identify methods that allow nature to do the work (passive versus active restoration).* Consider the use of natural or bioengineering methods over typical structural engineering methods.
- *Identify viable BMPs applicable to obtaining restoration goals.* Properly designed and placed BMPs should be implemented to reduce potential impacts to restoration efforts associated with activities or conditions existing within or outside of the restoration site. See the Management Measures for the Protection of Wetlands and Riparian Areas and for Vegetated Treatment Systems for information on the technical implementation and effectiveness of BMPs. Also, identify BMPs to protect adjacent wetlands from impacts during the construction of the restoration project.
- *Evaluate costs and benefits.* Selecting and evaluating restoration efforts must take into account the costs of implementation, operation, and maintenance. A selected technique should be cost-effective and result in environmental benefits.
- *Consider available financial and technical assistance.* Identify programs to help achieve the implementation of restoration efforts. Nonregulatory or regulatory programs, technical assistance, financial

assistance, education, training, technology transfer, and demonstrated projects should be considered. More recently, nonprofit groups have emerged as sources of technical and financial assistance. See Appendix A for examples of programs and sources of technical assistance.

- *Select best combination of restoration options.* Once restoration options have been identified, select the ones that best meet the project goals, benefit the environment, and are within financial means. If more than one restoration strategy seems feasible, consider each alternative carefully before making a final selection. In particular, make sure the benefits and costs are understood fully when choosing an active restoration strategy. In many instances a passive or bioengineered approach might be preferable to or less expensive than an active or structural technique.
- *Assign priorities to restoration efforts.* Limitations of funding and human resources are often an issue for restoration projects. It is important to establish priorities so that time-sensitive projects and efforts providing the greatest returns can be implemented first.
- *Plan for monitoring.* In any restoration effort, monitoring is needed to evaluate progress toward achieving goals. Monitoring should be planned to track the progress of the project and identify potential problems to ensure that progress initially gained is not lost at a later time. Planning for monitoring should begin before the project is implemented and the site's characteristics are modified. The monitoring plan should include all three phases—design, installation, and evaluation.
- *Establish schedule.* Schedule for success. Seasonal variations and upstream BMP implementation schedules should be taken into account when scheduling restoration.
- *Finalize restoration design plan.* Develop a restoration design plan based on information collected and evaluated in the previous steps. The design plan will be used as the blueprint for implementation of the restoration project. Enough flexibility should be included in the plan to allow for modifications or corrections where needed.
- *Secure necessary permits.*
- *Consider using volunteers.*

Step 4. Implement Restoration

Before implementing restoration, the project designer, contractors, and other stakeholders should meet and agree on scheduling, the order of operation, and responsibilities. The potential for delays caused by bad weather or unforeseen construction obstacles should be considered when developing the project schedule. Allowing extra time to address unforeseen problems should improve the potential for successful restoration.

Riparian Restoration in Arid Lands
Riparian revegetation, which involves planting trees, shrubs, forbs, or grasses to replace species that have been lost, is one of several recovery strategies that have been used to address the decline of riparian ecosystems in the western United States. Other strategies include improving livestock management, installing streambank stabilization structures, and performing upland treatments. Legislation designed to protect riparian areas by establishing requirements to maintain in-stream flows has also been introduced as a means of restoring these arid region ecosystems.
Source: Briggs, 1996b.

- *Continue public participation.* Stakeholder involvement should begin early in the restoration process and should continue throughout. An effective and inclusive communication strategy ensures that all potential participants have an opportunity to become aware of the progress of restoration. As the process evolves, the goals and objectives may change. Changes in goals and objectives should be articulated to stakeholders.
- *Develop community support through publicity and the use of volunteers.*
- *Protect local resources from construction impacts.* Inspect the site during implementation. Have a coordinator on site to ensure plans are followed, to ensure BMPs are working, and to direct volunteers.
- *Be flexible.* Restoration projects are most successful where flexibility allows changes to be made or corrective measures to be implemented if the original design provides inadequate or site conditions change.

Step 5. Monitor for Success

Ensure that monitoring is designed so that progress is ongoing. All restoration projects should include post-project monitoring that evaluates the effectiveness of the restoration effort, and the evaluation technique should be based on the specific project goals and target criteria. Monitoring the results of the restoration effort allows recovery methods to be adjusted for greater effectiveness. In addition, lessons learned from successes and failures can be applied to future efforts.

- *Design data collection plan.* Typical monitoring activities include:
  – Water quality sampling (including upstream and downstream of project)
  – Measurement of water depths
  – Measurement of flow rates and flow patterns
  – Substrate characterization
  – Sediment flux
  – Vegetation characterization and success rates
  – Habitat evaluation
  – Development of a photographic record
- *Collect and evaluate data.* Progress can be measured in many ways and communicated through meetings, brochures, Internet sites, annual reports, news releases, and other ways. It is important to make sure that the appropriate measures of progress are selected and that information

> **Izaak Walton League of America's Save our Streams Program**
> Through workshops, publications, the Internet, and a toll-free hotline, the Izaak Walton League's Save Our Streams (SOS) program provides technical assistance on stream and wetland restoration and volunteer monitoring techniques to local watershed groups. Through its Watershed Literacy Assistance Center, SOS refers individual and groups to projects across the nation where similar issues have been tackled and solved. For more information, contact Save Our Streams at 1-(800) BUG-IWLA (284-4952) or *http://www.iwla.org*. Ask for a copy of SOS's excellent summary of watershed restoration resources.

on these indicators is shared with relevant stakeholders. Measurements of progress should be associated with achieving goals set for the restoration effort.

- *Set schedule for continued routine monitoring.* Continued monitoring should be conducted at set intervals that will enable potential problems to be identified early enough so that corrective measures can be successfully implemented. Routine monitoring should be performed at an appropriate time of year and should be repeated at appropriate intervals to determine whether the project is on track and objectives are being met. Inappropriate timing of monitoring visits can result in a high variability in data. Conduct routine assessment for several years following initial restoration.

Step 6. Long-Term Management

Restoration projects are most successful where long-term management and monitoring are provided. Restoration features or techniques that are consistent with natural forces often tend to require less active management. Where this is not possible, provisions for long term management might be expected. Continued monitoring typically differs from the initial monitoring program, which had the burden of proving that restoration techniques were working in the given setting. Monitoring and assessment should continue for several years and should include water levels throughout the year, establishment of wetland vegetation, patterns of plant succession, development of wetland soil profiles, and use by animal species. Monitoring and assessment should also include conditions in the upstream watershed. Changes in upstream hydrologic conditions resulting from hydromodification or land use changes could adversely affect the success of the restoration project. Identification of changes in the upstream watershed and assessment of their impacts on achieving restoration goals makes it possible to identify and implement design or management changes necessary to ensure the continued success of restoration. Long-term routine monitoring following the completion of initial restoration is designed to identify maintenance needs and to ensure progress toward project goals.

Volunteer monitoring should be considered for tracking the long-term success of the restoration. Volunteers benefit from learning about the characteristics and functions of wetlands and riparian areas. Also, using volunteers that are adequately trained with appropriate organization and support can represent a substantial reduction in the often high cost of long-term monitoring.

Minimal maintenance activities are often required to ensure success. Typical maintenance activities include maintaining buffer zones, preventing soil erosion

Key Resources for Promoting Successful Restoration

*A Citizen's Guide to Wetland Restoration: Approaches to Restoring Vegetation Communities and Wildlife Habitat Structure in Freshwater Wetland Sy*stems. 1994. U.S. Environmental Protection Agency, Region 10, Pacific Northwest.

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National Review of Corps Environmental Restoration Projects. 1995. CORPS. Evaluation of Environmental Investments Research Program. IWR Report 95-R-12.

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Our National Wetland Heritage: A Protection Guide. 1996. M.K. Briggs. University of Arizona Press, Tucson.

*Planning Aquatic Ecosystem Restoration Monitoring Pro*grams. 1996. Institute for Water Resources, USACE, Waterways Experiment Station, Vicksburg, MS. IWR Report 96-R-*23*.

Planning and Evaluating Restoration of Aquatic Habitats from an Ecological Perspective. 1996. D. Yozzo, J. Titre, and J. Sexton. Institute for Water Resources, USACE, Waterways Experiment Station, Vicksburg, MS. IWR Report 96-EL-4.

Principles for the Ecological Restoration of Aquatic Resources. 2000. U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA 841-F-00-003.

Protecting Coastal and Wetlands Resources. 1992. U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA 842-R-92-002.

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Restoration of Aquatic Ecosystems - Science, Technology, and Public Policy. 1992. National Research Council Committee on Restoration of Aquatic Ecosystems. National Academy Press, Washington, DC.

Restoring and Creating Wetlands: a Planning Guide for the Central States Region: Iowa, Kansas, Missouri, and Nebraska. 1992. U.S. Environmental Protection Agency, Region 7, Kansas City, KS.

Restoring Prairie Wetlands: An Ecological Approach. 1994. S. M. Galatowitsch and A.G. van der Valk. Iowa State University Press, Ames, IA.

Riparian Area Management: A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic Areas. 1998. Technical Reference 1737-15. U.S. Department of Interior, Bureau of Land Management, Denver, CO.

Riparian Area Management: A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lentic Areas. 1999. Technical Reference 1737-16. U.S. Department of Interior, Bureau of Land Management, Denver, CO.

Stream Corridor Restoration: Principles, Processes, and Practices. 1998. Federal Interagency Stream Restoration Working Group. U.S. Environmental Protection Agency, Washington, DC. EPA 841-R-98-900.

Top Ten Watershed Lessons Learned. 1998. U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA 840-F-97-001.

and sedimentation, inspecting and nurturing plantings and controlling exotic species.

Volunteer Monitoring
Across the country, private citizens are learning about water quality issues and helping protect our nation's water resources by becoming volunteer monitors. Volunteers benefit from learning more about their local water resources, identifying what conditions or activities might be contributing to pollution problems, and working with clubs, environmental groups, and state or local governments to address problem areas. Volunteer monitoring can also be a valuable tool for tracking the success of restoration projects and an effective way of reducing overall costs. EPA's Office of Water maintains an Internet site on the activities of volunteer groups in monitoring surface waters and selected natural resources.
Source: USEPA, 2000b.

5.1 Management Practices for Restoration of Wetlands and Riparian Areas

The management measure generally will be implemented by applying one or more management practices appropriate to the source, location, and climate. The three management practices described can be applied successfully to implement the management measure for restoring wetlands and riparian areas.

5.1.1 Restoration Project Location

Practice
Plan restoration adjacent to or as part of naturally occurring aquatic ecosystems.

Factor in ecological principles when selecting sites and designing restoration. Restoration goals for a particular project site should be based on an assessment of the condition of the surrounding landscape. The assessment will produce information that can be used to prioritize where specific management practices can achieve desired performance. The information can also be used to establish environmental benchmarks applicable to performance evaluations.

Planning to restore wetlands includes the following:

- Conduct synoptic assessment (Leibowitz et al., 1992) and/or watershed analysis (Montgomery et al., 1995) to establish restoration goals for a geographic area. For example, the opportunity for gaining NPS benefits from a wetland or riparian restoration project may tend to be greater in one area than in another.
- Consider the role of site restoration within a broader context, such as on a landscape scale.
- Characterize reference sites within priority watersheds to establish environmental benchmarks. The benchmarks are used to evaluate the performance of management practices.

Restoration goals for a particular project site should be based on an assessment of the condition of the surrounding landscape.

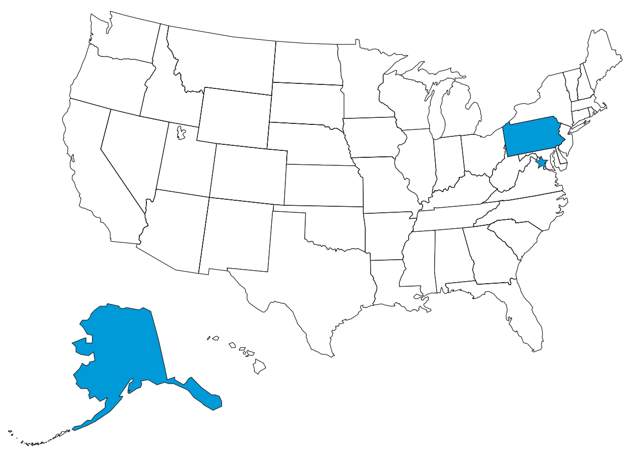
Watershed Restoration at Pike Run in Pennsylvania
A restoration project in Pennsylvania demonstrates the effectiveness of including habitat restoration techniques in a watershed treatment program. Restoring riparian areas and wetlands benefits landowners by providing direct economic gain through increased land values, and by providing excellent habitat for a variety of wildlife. Almost 22 miles of riparian restoration has been completed, a total of 40 wetland acres have been restored by fencing cattle out of degraded wetlands, and approximately 1,000 acres of native warm season grasses have been planted. The project included broad-based partnerships among the USFWS, EPA, NRCS, Ducks Unlimited, Pennsylvania Game Commission, Audubon Society, and many other public and private partnerships under the Partners For Wildlife and Clean Water Act section 319 NPS programs.
Source: USEPA and USDA, 1998.

- Depict a set of generally applicable practices for a specific geographic area watershed analysis. The practices are used to promote the development and understanding of a community-based strategy for controlling NPS pollution. For example, look for opportunities to include habitat restoration techniques such as maximizing connectedness, providing refuge for wildlife, and offering recreational amenities to the community. Set goals for the restoration project based on location and type of NPS pollution problem.
- Restoration sites near or connected to similar habitat have the best chance of succeeding. At these sites, it is easier to restore hydrology, soils might already have wetland characteristics, and native wetland species do not have far to travel to reach the site.
- Establish a citizen-based monitoring program that involves the community in NPS pollution control. Information gathered from the monitoring can be used to refine the future application of management practices.

American Rivers 1997 Urban Hometown River Award:
Earth Conservation Corps—Eagle and Salmon Corps
The Earth Conservation Corps works with disadvantaged young men and women to restore riparian habitats damaged by overuse, degradation, and pollution. In the process, members gain life and job skills that enable them to enter the workforce in the conservation field. Eagle Corps volunteers were chosen from local public housing communities in Washington, DC, in cooperation with the DC Housing Authority. Volunteers work to enhance the water quality of the Anacostia River and create viable bald eagle habitat by restoring natural areas along the river and sponsoring river cleanups to remove solid waste from tributaries. Salmon Corps members are predominantly from five Native American tribes in the Columbia and Snake river regions of the Pacific Northwest. Corps volunteers have enhanced salmon habitats in the five tribal areas by planting riparian vegetation, restoring stream channels, and building in-stream structures. They have erected pole fences to restrict livestock access to salmon habitat and removed trash and debris from spawning beds. For more information contact:
Earth Conservation Corps
Phone: (202) 554-1960, Fax: (202) 554-5060
<*http://www.earthconcorps.org*>
Source: American Rivers, 1998.

Examples of wetland and riparian area restoration are presented in Table 5-1 and Appendix F. Appendix A and Appendix F include examples of federal, state, and local programs to promote and implement restoration activities.

Table 5-1. Examples of Projects to Restore Wetlands and Riparian Areas



Examples of wetland and riparian area protection projects located throughout the United States.

Study	Type	Example Project
Riparian habitat restoration	Riparian Area	Eagle River Watershed Wonders (AK)
Intergovernmental partnership to restore Anacostia River and its tributaries	Wetland	Anacostia River Watershed (DC)
Restoration of Kenilworth Marsh	Wetland	Kenilworth Marsh Restoration (DC)
Restoration of emergent freshwater tidal wetlands	Wetland	Kingman Lake Restoration Project (DC)
Watershed treatment through the restoration of wetlands and riparian areas	Wetland and Riparian Areas	Pike Run (PA)

5.1.2 Hydrogeomorphic Regime

Practice

Provide a hydrogeomorphic regime similar to that of the type of wetland or riparian area being restored.

Restoration of hydrology is a critical factor to gain NPS pollution abatement benefits and to increase the probability of successful restoration.

Hydrologic and geomorphic conditions are responsible for maintaining many of the functional aspects of wetland ecosystems. These controls are important for such functions as the chemical characteristics of water, habitat maintenance, and water storage and transport. To ensure that restoration goals are achieved, preexisting, existing, and future hydrogeomorphic conditions must be fully understood, thoroughly considered, and carefully incorporated into a design plan for a wetland or riparian area restoration project. For restoration, local ground water interaction is a critical element to insure measures are consistent with the original supporting hydrologic conditions. An intact water table is also an important component for restoring lentic wetland areas, which are associated with still water systems.

The following are suggestions for implementing this practice:

- *Site history.* Know the past and projected uses of the site, including past wetland or riparian area functions.

- *Topography.* Map the surface topography, including slope and relief of the existing land surface.
- *Tide.* Determine the mean and maximum tidal range, if applicable.
- *Existing water control structures.* Identify the location of culverts, flow control structures, pumps, and outlets.
- *Hydrology.* Investigate the hydrologic conditions affecting the site: wave climate, currents, overland flows, ground water dynamics, average precipitation, and flood events. Review both minimum (drought) and maximum (extreme storms) in water budget evaluations.
- *Sediment budgets.* Understand the rates and paths of sediment inflow, outflow, and retention.
- *Soil.* Describe the existing soils, including their suitability for supporting wetland plants.
- *Plants.* Identify the existing and, if different, native vegetation.
- *Salinity.* Measure the existing or determine the planned salinity levels at the site, if applicable.

Information on native plant species is available from federal agencies (NRCS, USFWS, etc.), or various state or local agencies, such as the local Cooperative Extension Service office or state departments of agriculture or natural resources.

Table 4-4 provides examples of differences in hydrogeomorphic characteristics of several wetland types typically found in the United States. An understanding of these differences is essential in the development of a restoration plan. It is important to note that based on the current state-of-the-science, many of the wetland types described in Table 4-4 should be considered difficult to restore to a fully functional condition. Although it is important to protect all wetlands, emphasis should be placed on protecting those wetland types or wetlands located in areas that are known to be difficult to restore or have a low success rate for restoration.

5.1.3 Restoration of Soils and Plants

Practice
Restore native plant species and soil substrate through either natural succession or the introduction of plant and soil materials.

When consistent with preexisting conditions, plant a diversity of plant types or manage natural succession of diverse plant types rather than planting monocultures. Deeply rooted plants may work better than certain grasses for transforming nitrogen because the roots will reach the water moving below the surface of the soil. Vegetation has been recognized as a major tool to use in soil and water conservation to address water quality problems. For forested systems, a simple approach to successional restoration would be to plant one native tree species, one shrub species, and one ground-cover species and then allow natural succession to add a diversity of native species over time, where appropriate and warranted by target community composition and anticipated successional development. Table 5-2 contains information resources for wetland and riparian area plants.

In drier climates, depth to water table is a critical factor when planning the restoration of riparian areas. For many projects, use of an irrigation system for one or more growing seasons might be required to get the roots of plant material down to the water table (Carothers and Mills, 1990).

Table 5-2. Examples of Wetland and Riparian Area Plant Information Resources

Location	Reference Guide
CA	Mason, H.L. 1957. *A Flora of the Marshes of California*. University of California Press, Berkeley.
FL	• Dressler, R.L., D.W. Hall, K.D. Perkins, N.H. Williams. 1987. *Identification Manual for Wetland Plant Species of Florida*. University of Florida. • Tarver D.P., J.A. Rodgers, M.J. Mahler, and R.L. Lazor 1986. *Aquatic and Wetland Plants of Florida*. Florida DNR.
IL	Winterringer, G.S., and A.C. Lopinot. 1966. *Aquatic Plants of Illinois*. Illinois State Museum Popular Science Series Vol. VI.
IA	Beal, E.O., and P.H. Monson. 1954. Marsh and Aquatic Angiosperms of Iowa. Monocotyledons. Dicotyledons. State University of Iowa. *Studies in Natural History* Vol. 19(5), No. 429.
KY	Beal, E.O., and J.W. Thieret. 1986. *Aquatic and Wetland Plants of Kentucky*. Kentucky Nature Preserves Commission, Frankfort. Scientific and Technical Series No. 5.
LA	Chabreck, R.H., and R.E. Condrey. 1979. *Common Vascular Plants of the Louisiana Marsh*. Louisiana State University, Center for Wetland Resources.
MO	Whitley, J.R., B. Bassett, J.G. Dillard, and R.A. Haefner. 1990. *Water Plants for Missouri Ponds*. Missouri Department of Conservation.
MN	Fink, D.F. 1994. *A Guide to Aquatic Plants: Identification and Management*. Ecological Services Section, Minnesota DNR.
NJ	Fairbrothers, D.E., and E.T. Moul. 1965. *Aquatic Vegetation of New Jersey*. Extension Service, College of Agriculture, Rutgers University.
NC	Beal, E.O. 1977. *A Manual of Marsh and Aquatic Vascular Plants of North Carolina with Habitat Data*. NCSU Agricultural Experiment Station.
SC	Aulbach-Smith, C.A., S.J. de Kozlowski and L.A. Dyck. 1990. *Aquatic and Wetland Plants of South Carolina*. South Carolina Water Resources Commission.
AS, GU, HI, CNMI	Stemmermann, L. 1981. *A Guide to Pacific Wetland Plants*. U.S. Army Corps of Engineers, Honolulu District.
MN and WI	Eggers, S.D., and D. M. Reed. 1997. *Wetland Plants and Communities of Minnesota and Wisconsin*. Published by USACE. <http://www.npwrc.usgs.gov/resource/1998/mnplant/mnplant.htm>.
OR, WA	Guard, B.J. 1995. *Wetland Plants of Oregon & Washington*. Lone Pine Publishing, Redmond, WA.
TX, CO, KS, NM, OK	Haukos, D.A., and L.M. Smith. 1997. *Common Flora of the Playa Lakes*. Texas Tech University Press, Lubbock. 800/832-4042.
Atlantic Coast	• Eleuterius, L.N. 1990. *Tidal Marsh Plants*. Pelican Publishing Co., Gretna, LA. • Silberhorn, G. 1982. *Common Plants of the Mid-Atlantic Coast: A Field Guide*. Johns Hopkins University Press.
Eastern U.S.	Pierce, R.J. 1977. *Wetland Plants of the Eastern United States*. Army Corps of Engineers, North Atlantic Division, New York.
Midwestern U.S.	USDA. No date. *Midwestern Wetland Flora: Field Office Guide to Plant Species*. Soil Conservation Service, Midwest National Technical Center, Lincoln, NE. Home page of Northern Prairie Wildlife Research Center, Jamestown, ND. <http://www.npwrc.usgs.gov/resource/othrdata/plntguid/plntguid.htm>.
Northern Great Plains	Larson, G.E. 1993. *Aquatic and Wetland Vascular Plants of the Northern Great Plains*. General Technical Report RM-238, Fort Collins, CO. USDA, Forest Service, Rocky Mountain Forest and Range Experiment Station.
Northeastern U.S.	• Hellquist, C.B., and G.E. Crow. 1980. *Aquatic Vascular Plants of New England*. University of New Hampshire Agricultural Experiment Station. • Magee, D.W. 1981. *Freshwater Wetlands: A Guide to Common Indicator Plants of the Northeast*. University of Massachusetts Press. • Tiner, R.W. 1987. *A Field Guide to Coastal Wetland Plants of the Northeastern United States*. University of Massachusetts Press.
Northwestern U.S.	• Steward, A.N., L.J. Dennis, and H.M. Gilkey. 1963. *Aquatic Plants of the Pacific Northwest with Vegetative Keys*. Oregon State University. • Weinmann, F., M. Boule, K. Brunner, J. Malek, and V. Yoshino. 1984. *Wetland Plants of the Pacific Northwest*. USACE, Seattle District.
Southern U.S.	USDA. No date. *Southern Wetland Flora: Field Office Guide to Plant Species*. USDA. South National Technical Center, TX.
Southeastern U.S.	• Eyles, D.E., and J.L. Robertson. 1944. *A Guide and Key to the Aquatic Plants of the Southeastern United States*. Reprint 1963. U.S. Public Health Service, Washington, DC. • Godfrey, R.K., and J.W. Wooten. 1981. *Aquatic and Wetland Plants of Southeastern United States. Dicotyledons*. 1979. *Aquatic and Wetland Plants of Southeastern United States. Monocotyledons*. University of Georgia Press, Athens. • Tiner, R.W. 1993. *Field Guide to Coastal Wetland Plants of the Southeastern United States*. University of Massachusetts Press, Amherst.
Southwestern U.S.	Correll, D.S., and H.B. Correll. 1975. *Aquatic and Wetland Plants of Southwestern United States*. Stanford University Press, California. Vols. 1 and 2.
Western U.S.	USDA. No date. *Western Wetland Flora: Field Office Guide to Plant Species*. Soil Conservation Service, West National Technical Center, Portland, Oregon. Home page of Northern Prairie Wildlife Research Center, Jamestown, ND. <http://www.npwrc.usgs.gov/resource/othrdata/westflor/westflor.htm>.
General Coverage	• Fassett, N.C. 1940. *A Manual of Aquatic Plants*. Reprint 1972. University of Wisconsin Press, Madison. • Hotchkiss, N. 1972. *Common Marsh, Underwater and Floating-leaved Plants of the United States and Canada*. Dover Publications, NY. • Muenscher, W.C. 1944. *Aquatic Plants of the United States*. Comstock Publishing Associates, Cornell University Press, NY. • Tiner, R.W. 1988. *Field Guide to Nontidal Wetland Identification*. Maryland Department of Natural Resources and USFWS. • University of Florida. 1998. *Aquatic Plant Information Retrieval System*. Center for Aquatic and Invasive Plants, University of Florida, Gainesville. <http://aquat1.ifas.ufl.edu/welcome.html>.

The amount of soil organic matter in wetland soils plays a critical role in the function of a wetland, as well as its potential for restoration. In particular, the amount of soil organic matter in wetland soils plays a critical role in nutrient cycling and pollutant detoxification, provides substrate for essential microbes, and influences the development of wetland vegetation. Careful consideration should be given to whether the amount of organic matter at a project site can be increased through properly timed soil amendments and nutrient applications.

The Five Star Restoration Program is a wetlands restoration program established by the EPA. The agency created the program in an ongoing commitment to work with its partners to educate the public through community-based wetlands restoration projects in watersheds across the United States. The National Association of Counties, the National Fish and Wildlife Foundation, and the Wildlife Habitat Council partner with EPA in this effort.

Each year the Five Star Program receives hundreds of applications. The applications are reviewed by a panel of experts from the partnering organizations and ranked according to the environmental benefit to be derived, the educational and training for at-risk youth, and socioeconomic merits. EPA's Office of Wetlands, Oceans and Watersheds of the Office of Water provides major funding for these projects. The NOAA Fisheries' Community-based Restoration Program provides major funding for select grants of similar nature in the coastal areas. The average grant award is $10,000, with actual award amounts ranging from $5,000 to $20,000. Each project generally includes at least five participants; hence five star, from local governments, corporations and businesses, and representatives of federal and state government agencies.

The program brings together students, conservation corps, other youth organizations, citizen groups, corporations, landowners and government agencies to provide environmental education through projects that restore stream banks and wetlands. The program provides challenge grants, technical support, and opportunities for information exchange to enable community-based restoration projects.

Corporations such as Lockheed Martin, Ford Motor Company, Phillips Petroleum, and several private foundations have become project sponsors. Organizations become project sponsors by contributing as little as $5,000. On average, each dollar of sponsor funds is matched by four additional dollars in contributions provided by the local restoration partners in the form of funding, labor materials, equipment, or in-kind services.

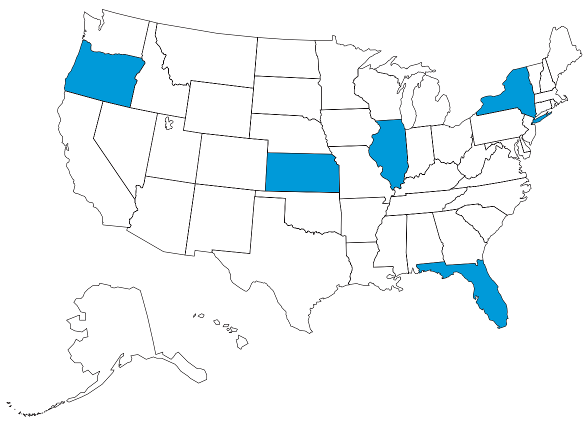
Source: U.S. Environmental Protection Agency. 2002. *Five Star Restoration Program*. *http://www.epa.gov/owow/wetlands/restore/5star/02factsheet.html*. Accessed on January 22, 2003.

Recent studies indicate that it might take decades for soil organic matter to accumulate in projects to levels comparable with those in similar, naturally occurring wetlands (USEPA, 1994c).

5.2 Cost and Benefits of Practices

This section describes the economic benefits of restoring wetlands and riparian areas that serve NPS functions. This information is intended to demonstrate the cost savings accrued by implementing the management measure as compared to the costs of not implementing it. Across the continental United States, the costs of wetland creation and restoration projects vary from $5 per acre to $1.5 million per acre. For those projects not involving the conversion of agricultural land, the average project costs reported in 1995 range from $20,000 to more than $75,000 per acre (U.S. DOE, 1995). Because of the wide diversity of regions throughout the United States, no single cost or economic benefit can be used across the board. Instead, the information provided below and in Table 5-3 reflects examples of such costs and benefits in specific areas of the country.

Table 5-3. Costs and Economic Benefits Associated with Restoring Wetlands and Riparian Areas



Examples of projects from the United States that show the expected cost of many types of wetland and riparian protection projects, as well as their value to the respective communities. For many of these projects, the cost to install structural or conventional methods to replace the functions of wetlands have been shown to be much greater than the actual cost of the wetland or riparian protection measure. When available, the dates for project/restoration costs are provided. Results of studies in various states (see map at left) are shown in the table below. Additional information and references about each study cited in the table as provided in Appendix F at the back of the document.

Study	Cost of Conventional Project	Cost of Restoration	Estimated Benefit to Community	Example Project
Habitat restoration and enhancement		$475,000 (spent from a total of $828,000 budgeted for restoration) (1999)	There is an increase in community awareness and appreciation of the environmental and economic benefits of coastal environment restoration	Emerson Point Park (FL)
Evaluation of wetland creation in former wetland habitat areas		$18,793 per acre (1996)	$3,714 per year per acre (recreational benefits)	East St. Louis (IL)
Storm water control projects that would have been implemented instead of the streamside greenways or other storm water controls	$120 million (1999)	$600,000 (1999)	Over $119 million in stormwater controls that will not have to be installed.	Johnson County Streamway Park System (KS)
Demonstration project to assist municipalities with planning issues at a watershed level		$10,450 (1999)	Fish and wildlife habitat has been restored, wetland habitat have been enhanced, and community awareness and involvement has increased.	Buffalo River and Cazenovia Creek Model (NY)
Riparian restoration to reduce dredging and water treatment costs	$1.6 million (1996)	$660,000 (1996)	$1 million per year	Tulatin River (OR)
Partnership to acquire and manage wetlands			Functions and values of the wetland system in the Willamette Valley will be restored and will benefit the larger ecological community.	West Eugene Wetlands Project (OR)

- In response to concerns from citizen groups about degrading streams, state and local governments in Maryland spent $20,000 to $50,000 per housing lot in some areas to repair damaged streams and restore riparian forests. This project was funded by the two counties in the Rock Creek watershed—Montgomery and Prince George’s—and by the Maryland

Department of the Environment. Total project costs were $2.2 million (NRDC, 1999).

- Vegetative seedings are a common way to stabilize or enhance shoreline. Prairie Restorations, Inc. (2000) estimates vegetative plantings cost from $2,600 to $9,150 per acre. Using a minimal mix of plant varieties, site preparation, materials, seeding, and first year maintenance cost an average of $2,950 per acre.

Federal wetland policies during the past decade have increasingly emphasized restoration of wetland areas. Much of this restoration occurs as part of efforts to mitigate the loss of wetlands at other sites.

Wetland Reconstruction
The City of Des Moines, Washington, is using SRF funds to purchase and reconstruct a badly degraded wetland area and to construct a sediment trap/pond facility. This project is allowing the city to meet two goals it constantly struggles to achieve: flood protection and wetland preservation and enhancement. Area stormwater will enter one of two sediment traps by way of the surrounding reconstructed wetlands. The wetlands serve the dual purpose of (1) providing flood protection by collecting stormwater runoff and (2) acting as a preliminary filter by removing suspended solids. The majority of sediment removal and any heavy metal removal will occur while the water is in the sediment traps. The water will then leave the traps through artificial inlets that lead to Barnes Creek, which eventually enters Puget Sound. This $222,500 project is part of the National Estuary Program (Clean Water Act section 320).
Source: USEPA, 1998c.

5.3 Mitigation Banking

Mitigation banking increasingly is recognized as a means of achieving environmentally and economically sound mitigation for unavoidable and minimized impacts.

Mitigation banking is defined as:

> *Wetland restoration, creation, enhancement, and, in exceptional circumstances, preservation undertaken expressly for the purpose of compensating for unavoidable wetland losses in advance of development actions, when such compensation cannot be achieved at the development site or would not be as environmentally beneficial. (60FR.58605, Nov. 28, 1995).*

Mitigation of proposed actions that would adversely affect wetlands has been a cornerstone of the Clean Water Act section 404 program in recent years. A 1990 memorandum of agreement signed by all the agencies with regulatory responsibilities (EPA and USACE) outlines a sequence of three steps that must be considered when evaluating an application for a section 404 permit. First, adverse impacts on wetlands should be avoided when possible; second, when they can not be avoided, impacts should be minimized; and third, where impacts still occur, compensatory mitigation is required. This “sequencing process” is designed to ensure that there is no net loss of wetland functions.

In light of the sequencing and compensatory mitigation requirements under the Clean Water Act section 404 permit program, the use of mitigation banking is gaining popularity.

Mitigation banking occurs in the context of the wetlands programs established under Clean Water Act section 404, the Rivers and Harbors Act section 10, and the Swampbuster Program under the Food Security Act. Consequently, mitigation banking is to provide for the replacement of the physical, chemical, and biological functions of wetlands that are lost as a result of authorized impacts.

The federal mitigation banking policy and its implementation are described in the *Federal Guidance for the Establishment, Use and Operation of Mitigation Banks* (60 FR 58605, Nov. 28, 1995). The federal guidance lists several advantages of mitigation banking over individual mitigation projects, including the following (*Federal Register*, Vol. 60, No. 228. November 28, 1995):

- It may be more advantageous for maintaining the integrity of the aquatic ecosystem to consolidate compensatory mitigation into a single large parcel or contiguous parcels when ecologically appropriate.
- A mitigation bank can bring together financial resources, planning, and scientific expertise not practicable to many project-specific compensatory mitigation proposals.
- Use of mitigation banks may reduce permit processing times and provide more cost-effective compensatory mitigation opportunities.
- Compensatory mitigation is typically implemented and functioning in advance of project impacts, thereby reducing temporal losses of wetland function and uncertainty over whether mitigation will be successful in offsetting wetland losses.
- Consolidation of compensatory mitigation within a mitigation bank increased the efficiency of limited agency resources in the review and compliance monitoring of mitigation projects, and thus improves the reliability of efforts to restore, create or enhance wetlands for mitigation purposes.
- The existence of mitigation banks can contribute toward attainment of the goal for no overall net loss of the nation's wetlands by providing opportunities to compensate for authorized impacts when mitigation might not otherwise be appropriate or practicable.

In December 2002, the USACE in consultation with the EPA, the USDA, the United States Department of Interior (DOI), Federal Highway Administration (FWHA), and NOAA reevaluated wetlands mitigation guidance and reissued a Regulatory Guidance Letter (RGL 02-2): *Compensatory Mitigation Projects for Aquatic Resource Impacts Under the Corps Regulatory Program Pursuant to Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899* (USCAE, 2002a). This guidance applies to all new compensatory mitigation proposals (which may be required to replace aquatic resource functions, including wetlands that are unavoidable lost or adversely affected by authorized activities) associated with USACE-issued permits. The guidance instructs the USACE Districts to use watershed and ecosystem approaches when determining compensatory mitigation approaches, consider the resource needs of the impacted watersheds, and consider the resource needs of neighboring watersheds. For more details see RGL 02-2 (USACE, 2002a) and the *National Wetlands Mitigation Action Plan* (USACE, 2002b).

Other issues to consider with mitigation banking include the following: (1) the hydrogeomorphic and ecological landscape and climate, (2) current and future watershed hydrology and wetland location, (3) restore or develop naturally variable hydrological conditions, (4) whenever possible, choose wetland restoration over creation, (5) avoid over-engineered structures in the wetland's design, (6) pay particular attention to appropriate planting elevation, depth, soil type, and seasonal timing, (7) provide appropriately heterogeneous topography, (8) pay attention to subsurface conditions, including soil and sediment geochemistry and physics, ground water quantity and quality, and in faunal communities, (9) consider complications associated with creation or restoration in seriously degraded or disturbed sites, and (10) conduct early monitoring as part of adaptive management (USACE, 2002a).

6 Management Measure for Vegetated Treatment Systems

This chapter presents supporting information, including management practices, specific implementation examples, and costs and benefits, for the following management measure:

Management Measure
Promote the use of engineered vegetated treatment systems such as constructed wetlands or vegetated filter strips where these systems will serve a significant NPS pollution abatement function.

This management measure is intended to be applied in cases where engineered systems of wetlands or vegetated treatment systems can treat NPS pollution. Vegetated treatment systems are located in upland regions and protect wetlands and aquatic resources from NPS pollution.

Vegetated treatment systems, by definition in this guidance, include vegetated filter strips (VFS) and constructed wetlands. Although these systems are distinctly different, both are designed to reduce NPS pollution. They need to be properly designed, correctly installed, and diligently maintained to function properly. The two types of vegetated treatment systems are discussed in more detail in separate sections below.

Whether constructed wetlands and VFS should be used individually or in series depends on several factors, including the quantity and quality of the inflowing runoff, the characteristics of the existing hydrology, and the physical limitations of the area surrounding the wetland or riparian area to be protected.

Vegetated Filter Strips

The purpose of VFS is to remove sediment and other pollutants from runoff and wastewater by filtration, deposition, infiltration, absorption, adsorption, decomposition, and volatilization, thereby reducing the amount of pollution entering surface waters (USDA, 1988). VFS are appropriate for use in areas adjacent to surface water systems that may receive runoff containing sediment, suspended solids, and/or nutrients. VFS can improve water quality by removing nutrients, sediment, suspended solids, and pesticides; however, they are most effective in removal of sediment and other suspended solids.

VFS can improve water quality by removing nutrients, sediment, suspended solids, and pesticides.

VFS are designed to be used under conditions in which runoff passes over the vegetation in a uniform sheet flow. Sheet flow is critical to the success of the filter strip. If runoff is allowed to concentrate or channelize, the VFS is easily inundated and will not function as designed.

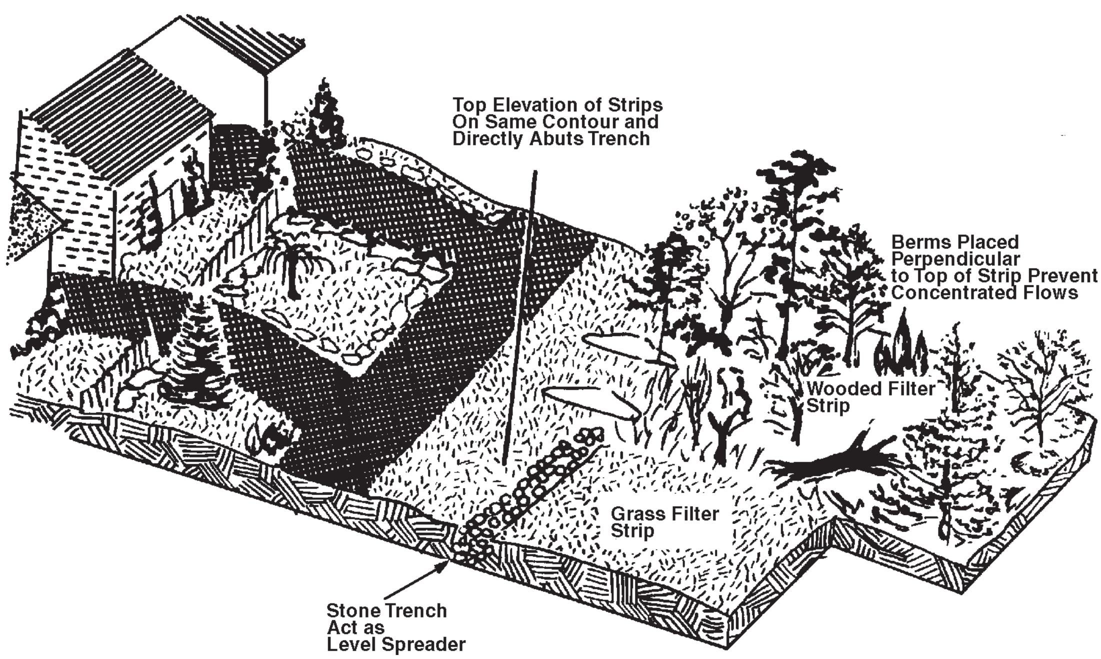
VFS need the following elements to work properly (Schueler, 1987; see Figure 6-1):

- A device such as a level spreader that ensures that runoff reaches the VFS as sheet flow. (Berms can be used for this purpose if they are placed at a perpendicular angle to the VFS area to prevent concentrated flows.)
- A dense vegetative cover of erosion-resistant plant species.
- A gentle slope of no more than 5 percent.
- A length at least as long as the adjacent contributing area.

In addition to serving as a pollution control measure, VFS can add positive improvements to the urban environment by increasing wildlife habitat and adding beauty to an area.

If these requirements are met, VFS have been shown to remove a high percentage of particulate pollutants. The effectiveness of VFS at removing soluble pollutants is highly variable (Schueler et al., 1992).

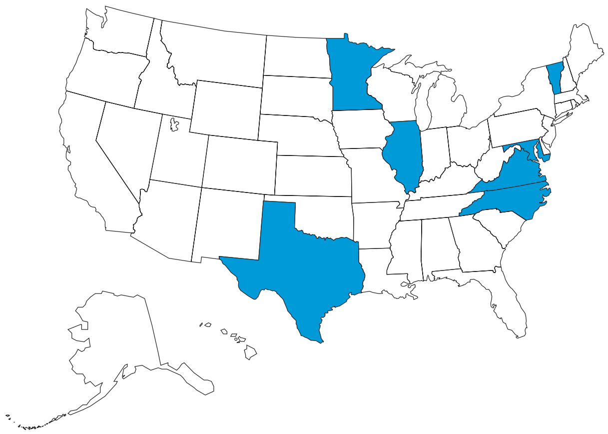
Several studies of VFS (Table 6-1) show that they improve water quality and can be an effective management practice for the control of NPS pollution from silvicultural, urban, construction, and agricultural sources of sediment, phosphorus, and bacterial contaminants. The research results reported in Table 6-1 show that VFS are most effective at sediment removal, with rates generally greater than 70 percent. The published results on the effectiveness of VFS in nutrient removal are more variable, but nitrogen and phosphorus removal rates are typically greater than 50 percent. It is important to note, however, that removal rates can be measured on an event basis and on a long-term basis. Comparisons of data may be complicated by variations in the type of event sampled, sampling techniques, and parameters measured.



Source: Schueler, 1987

Figure 6-1. Example of Vegetated Filter Strip

Table 6-1. Effectiveness of Vegetated Filter Strips for NPS Pollutant Removal



Measurements taken throughout the United States show NPS pollutant removal capabilities of VFS. The studies show variabilities in NPS pollutant removal capabilities for various VFS lengths and vegetative cover types. The effectiveness of VFS for removing pollutants depends on several design factors, which are described in this section. Proper operation and maintenance are also important for ensuring that the VFS continues to perform at its designed capacity. See section 6.1.1 for information about the design, operation, and maintenance of VFS. Results of studies in various states (see map at left) are shown in the table below. Additional information about each study cited in the table is provided in Appendix F.

Study		Vegetation	VFS Length (ft)	TSS	N	P	Study Title
Nutrient removal by forested and grassed vegetated filter strips		Cottonwood/silver maple Reed canary grass	53 128		90% 90%		Embarras River (IL)
Pollutant removal by vegetated filter strips under channelized and overland flow conditions		Mixed Fescue/alfalfa Foxtail	300 200 500-1500	73% 63% 78%	80/86%[1] 71/72%[1] 81/85%[1]	78%	University of Illinois (IL)
Removal of sediment and nutrients by vegetated filter strips		Bare plots	15	66%	0%	27%	Chesapeake Bay (MD)
Pollutant removal by vegetated filter strips		Corn Orchard grass Sorghum Oats Average	115-135	86% 66% 82% 75% 79%	84%	83%	Stevens County (MN)
Retention of sediment and nutrients by grassed filters and riparian buffers		Grass	13	50%			Coastal Plain/Piedmont (NC)
Pollutant removal from highway runoff by vegetated buffer strips	U.S. 183	Prairie buffalo grass	24-30	87%	50%	44%	Austin (TX)
	Walnut Creek	Mixed grasses	22-27	85%	23%	34%	
Removal of sediment and nutrients by vegetated filter strips		Orchard grass	15 30	81% 91%	64% 74%		Blacksburg (VA)
Nutrient removal by vegetated filter strips		Orchard grass	15 30	70% 84%	54% 3%	61% 79%	Prices Fork Research Farm (VA)
Pollutant removal from runoff by a vegetated filter strip		Fescue, ryegrass, bluegrass	85	95%	92%	89%	Charlotte (VT)

VFS, vegetated filter strip; TSS, total suspended solids; N, nitrogen; P, phosphorus.
[1]Total Kjeldahl nitrogen/ammonia nitrogen.

The following are nonpoint pollution sources for which VFS might provide some nutrient-removal capability:

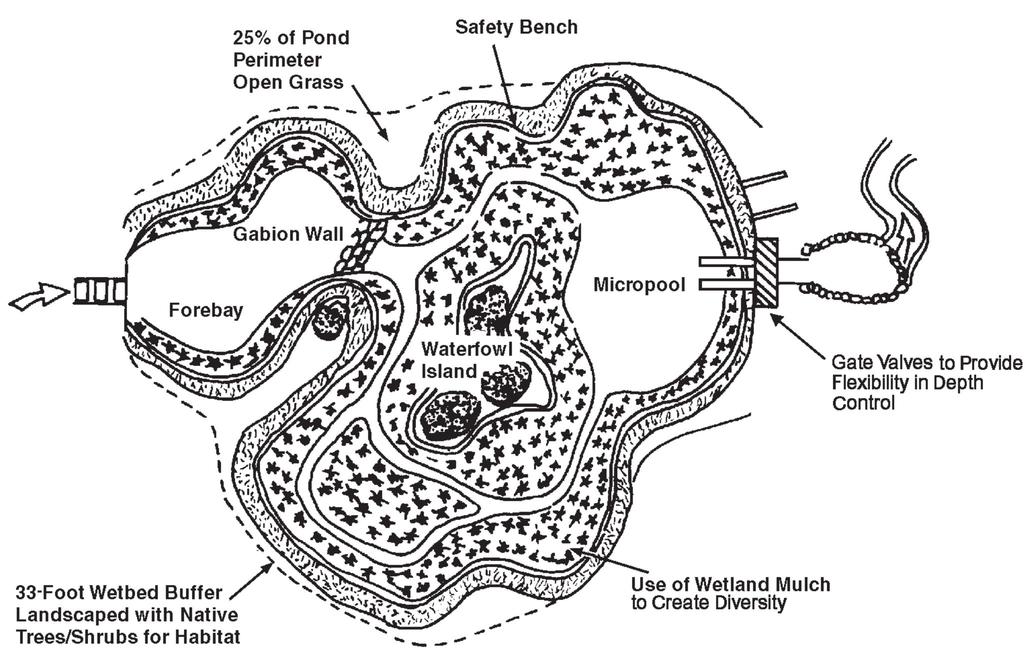
- *Cropland.* The primary function of VFS is to filter sediment from soil erosion and sediment-borne nutrients. However, VFS should not be relied on as the sole or primary means of preventing nutrient movement from cropland (Lanier, 1990).
- *Urban development.* VFS filter and remove sediment, organic material, and trace metals. According to the Metropolitan Washington Council of Governments, VFS have a low to moderate ability to remove dissolved

pollutants in urban runoff and have higher efficiency for removal of particulate pollutants than for removal of soluble pollutants (Schueler, 1987).

With proper planning and maintenance, VFS can be a beneficial part of a network of NPS pollution control measures for a particular site. They can help to reduce the polluting effects of agricultural runoff when coupled with either (1) farming practices that reduce nutrient inputs or minimize soil erosion or (2) detention ponds that collect runoff as it leaves a VFS. Properly planned VFS can add to urban settings by framing small streams, ponds, or lakes, or by delineating impervious areas.

Constructed Wetlands

Constructed wetlands are typically engineered systems that use natural processes involving wetland vegetation, soils, and their associated microbial assemblages to assist, at least partially, in treating an effluent or other source of water (Figure 6-2). These systems should be engineered and constructed in uplands, outside "waters of the United States," unless the water source can serve a significant restoration function for a degraded system. For example, agricultural runoff could potentially be directed toward a wetland that has been degraded due to water withdrawal in order to both treat the runoff and restore the hydrology of the wetland. In such cases, it is important that the runoff not contain contaminants that could pose a threat to people or wildlife. Properly designed and implemented constructed wetlands can be effective tools for improving water quality, while also providing a range of other benefits, such as wildlife habitat.



Source: Schueler, 1992

Figure 6-2. Example of Constructed Wetland

According to Hammer and others (1989), constructed wetlands typically have four principal components that can assist in pollutant removal:

- Substrates with various rates of hydraulic conductivity
- Plants adapted to water-saturated anaerobic substrate
- A water column (water flowing through or above the substrate)
- Aerobic and anaerobic microbial populations

Moshiri (1993), Kent (1994), Kadlec and Knight (1996), the Washington State Department of Ecology (1992), and USEPA (1996a) present design and maintenance criteria for constructed wetlands. Davis (1996) has developed a series of handbooks addressing general considerations for wetland construction and

Key Resources for Vegetated Treatment Systems

A Handbook of Constructed Wetlands. 1996. L. Davis. Volumes 1-5. Prepared for the USDA-Natural Resources Conservation Service and USEPA Region 3, in cooperation with the Pennsylvania Department of Environmental Resources. Available from Government Printing Office.

Buffer Zones: Their Processes and Potential in Water Protection. Proceedings of the International Conference on Buffer Zones, September 1996. N.E. Haycock, T.P. Burt, K.W.T. Goulding, and G. Pinay. Quest Environmental, Harpenden, Herts, UK.

Compensating for Wetland Losses Under the Clean Water Act. 2001. National Research Council. NRC, National Academy of Sciences, Washington, DC.

Constructed Wetlands for Water Quality Improvement. 1993. G.A. Moshiri, CRC Press, Inc. Boca Raton, FL.

Constructed Wetlands for Wastewater Treatment and Wildlife Habitat. 1993. U.S. Environmental Protection Agency, Office of Wastewater Management, Washington, DC. EPA832-R-93-005.

Constructed Wetlands for Wastewater Treatment: Municipal, Industrial, and Agricultural. 1988. D.A. Hammer, ed. Proceedings from the First International Conference on Constructed Wetlands for Wastewater Treatment, Chattanooga, Tennessee, June 13-17, 1988. Lewis Publishers, Inc., Chelsea, MI.

Created and Natural Wetlands for Controlling Nonpoint Source Pollution. 1993. CRC Press, Inc., Boca Raton, FL.

Creating Freshwater Wetlands. 1992. D. Hammer. Lewis Publishers, Inc. Chelsea, MI.

Design of Stormwater Wetland Systems: Guidelines for Creating Diverse and Effective Stormwater Wetlands in the Mid-Atlantic Region. 1992. T.R. Schueler, Metropolitan Washington Council of Governments, Washington, DC.

Evaluation and Management of Highway Runoff Water Quality. 1995. G. K. Young, S. Stein, P. Cole, T. Kammer, F. Graziano, and F. Bank. U.S. Department of Transportation, Federal Highway Administration. Publication No. FHWA-PD-96-032.

Natural Systems for Waste Management and Treatment, 2nd ed. 1995. S.C. Reed, R.W. Crites, and E.J. Middlebrooks. McGraw-Hill, Inc. New York, NY.

Relative Nutrient Requirements of Plants Suitable for Riparian Vegetated Buffer Strips. 1996. R.C. Steiner, Interstate Commission on the Potomac River.

Treatment Wetlands. 1996. R.H. Kadlec, and R.L. Knight. CRC Press, Inc. Boca Raton, FL.

Vegetated Stream Riparian Zones: Their Effects on Stream Nutrients, Sediments, and Toxic Substances. 1997. An annotated and indexed bibliography. D. Correll. Smithsonian Environmental Research Center, Edgewater, MD.

Wetlands. 1993. W.J. Mitsch and J.G. Gosselink. 2nd ed. Van Nostrand Reinhold, New York, NY.

Wetlands-Characteristics and Boundaries. 1995. National Research Council, Committee on Characterization of Wetlands, Washington, DC.

criteria for constructing wetlands for various treatment scenarios, including stormwater management.

Constructed wetlands have been considered for use in urban and agricultural settings where some sort of engineered system is suitable for NPS pollution reduction. A few studies have also been conducted to evaluate the effectiveness of artificial wetlands that were designed and constructed specifically to remove pollutants from surface water runoff (Table 6-2).

Table 6-2 summarizes the pollutant-removal effectiveness of constructed wetland systems built for treatment of surface water runoff. In general, constructed wetland systems designed for treatment of NPS pollution in surface water runoff were effective at removing suspended solids and pollutants that attach to solids and soil particles. The constructed wetland systems were not as effective at removing dissolved pollutants and those pollutants that dissolve under the conditions found in a wetland.

Like VFS, constructed wetlands offer an alternative to other structural NPS pollution control systems. In some cases, constructed wetland systems can provide limited ecological benefits in addition to their NPS control functions. In other cases, constructed wetlands offer few, if any, additional ecological benefits because of the type of vegetation planted in the constructed wetland or because of the quantity and type of pollutants received in runoff. Constructed wetlands that receive water containing large amounts of metals or pesticides should be fenced or otherwise designed to discourage use by wildlife. However, wildlife control requires vigilance. Fencing may not be practical for some species, or may be too expensive and not feasible for certain projects. Methods, such as owl decoys, noise makers, and other scare tactics may work for a while, but wildlife can become accustomed to these types of exclusion devices and eventually ignore them.

6.1 Management Practices for Vegetated Treatment Systems

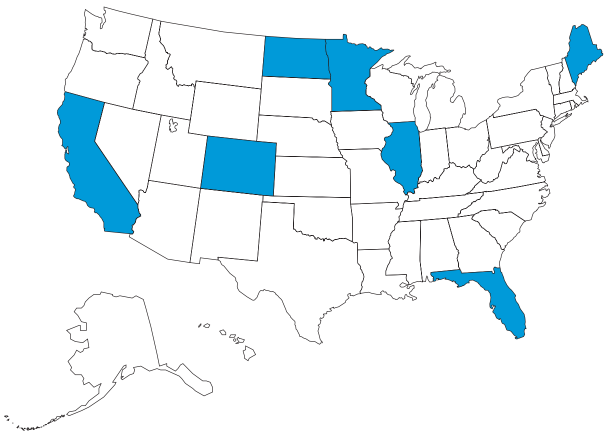
The management measure generally will be implemented by applying one or more management practices appropriate to the source, location, and climate. VFS and constructed wetlands can be applied successfully to implement the management measure for vegetated treatment systems. The following pages provide details about each practice.

6.1.1 Vegetated Filter Strips Factors to Consider

Practice
Construct VFS in upland areas adjacent to water bodies that may be subject to suspended solids and/or nutrient runoff.

A survey of the literature on the design, performance, and effectiveness of VFS shows that many factors must be considered on a site-specific basis before designing and constructing a VFS. The effectiveness of VFS varies with topography, drainage size, vegetative cover, implementation, and use with other man-

Table 6-2. Effectiveness of Constructed Wetlands for NPS Pollutant Removal



Measurements taken at several locations in the United States show the NPS pollutant removal capabilities of constructed wetland systems. The effectiveness of constructed wetlands for removing pollutants depends on several design factors, which are described in this section. Proper operation and maintenance are also important for ensuring that the constructed wetland continues to perform at its designed capacity. See section 6.1.2 for information about the design, operation, and maintenance of constructed wetlands. Results of studies in various states (see map at left) are shown in the table below. Additional information about each study cited in the table is provided in Appendix F.

Study	TSS	N (total)	NH_3	NO_3	NO_2	TKN	P (total)	P (ortho)	metals	Study Title
Pollutant removal from urban runoff by a subalpine constructed wetland	85%	85%-90%					47%[1] 20%[2]		84% (Fe)	Lake Tahoe, CA
Suspended solids and phosphorus removal from stormwater runoff by a wetland system	70%							52%	34%	Shop Creek Pond, CO
Phosphorus and nitrogen removal in a subtropical constructed wetland							72%			Kissimmee River, FL
Suspended solids and nutrient removal in a sediment filtration and constructed wetland system	94% 96%[3]	76%	37%	70%	75%		90%	78%		Lake Jackson, FL
Pollutant removal from urban runoff in a detention pond/wetland system	55%	36%					43%	21%	83% (Pb) 70% (Zn)	Orange County, FL
Pollutant removal from highway runoff by a constructed wetland system	55%-83%	36%					43%		55%-83% (Pb, Zn)	Orlando, FL
Pollutant removal from residential and golfcourse runoff by wetland impoundment	50%				71%		62%			Palm Beach Gardens, FL
Pollutant removal from urban stormwater runoff in a detention pond/wetland system	71%		44%	75%	75%		47%	56%		Tampa, FL
Pollutant removal from agricultural and urban runoff by constructed wetlands	86%-90%	61-92%					65%-78%			Des Plaines River, IL
Pollutant removal from agricultural runoff by a constructed wetland system	95%-97%						82%-91%			Long Lake, ME
Phosphorus and sediment removal from agricultural runoff by wetland treatment system	95%						92%			St. Agatha, ME
Phosphorus removal from urban and agricultural runoff by constructed wetlands							39%			Clear Lake, MN
Water quality improvements by a combined detention/wetland storm water treatment facility	96%	74%		63%		76%	78%		90% (Pb)	Lake McCarrons, MN
Pollutant removal from storm water by a constructed wetland							40%			Spring Creek, ND

TSS, total suspended solids; N, nitrogen; NH_3 ammonia; NO_3, nitrate; NO_2, nitrite; TKN, total kjeldahl nitrogen; P, phosphorus; Fe, iron; Pb, lead; Zn, zinc.

[1]Particulate phosphorus.

[2]Soluble phosphorus.

[3]Organic TSS.

agement practices. In addition, different VFS characteristics such as size and type of vegetation can result in different pollutant loading characteristics, as well as loading reductions. Table 6-1 and Table 6-3 give some removal rates for specific NPS pollutants based on VFS size and vegetation.

VFS have been successfully used in a variety of situations where some sort of BMP was needed to treat surface water runoff. Typical locations of VFS have included the following:

- Below cropland or other fields
- Above conservation practices such as terraces or diversions
- Between fields
- Alternating between wider bands of row crops
- Adjacent to wetlands, streams, ponds, or lakes
- Along roadways, parking lots, or other impervious areas
- In areas requiring filter strips as part of a waste management system
- On forested land

VFS function properly only in situations where they can accept overland sheet flow of runoff and should be designed accordingly. Contact time between runoff and the vegetation is a critical variable influencing VFS effectiveness. If existing site conditions include concentrated flows, BMPs other than VFS should be used. Pollutant-removal effectiveness increases as the ratio of VFS area to contributing area increases.

Schueler (1992), the Washington State Department of Ecology (1992), and USEPA (1996a) present design and maintenance criteria for VFS. Forested riparian buffer strips are a variation of standard VFS designs. A forested riparian buffer strip consists of an area of trees and/or shrubs located adjacent to and upslope from water bodies (USDA, 1995). When appropriately designed and managed, these buffer strips can contribute significantly to the maintenance of aquatic and riparian habitat. Additional discussion and design criteria for forested buffer strips are presented in USDA (1995) and Belt et al. (1992).

Several key local elements should be considered in the design of VFS: type of pollutant, slope, length, climate, plant species, detention time, monitoring, and maintenance.

Type of Pollutant

Sediment, nitrogen, phosphorus, and toxic substances are efficiently removed by VFS although removal rates are much lower for soluble nutrients and toxics (see Table 6-3). Monitoring should be conducted to determine the effectiveness of VFS in pollutant reduction and to determine if the VFS are meeting performance standards (water quality standards or prescribed VFS removal efficiency criteria).

Slope

VFS function best on slopes of less than 5 percent; slopes greater than 15 percent render them ineffective because surface runoff flow will not be sheet-like and uniform. In areas with steep slopes, terraces can be used to reduce the

Table 6-3. Nitrate-N Concentration Reduced by Forested Riparian Areas and VFS

Location	Length (m)	Ground-water	Surface Water	Author, Year (as cited in Martin, 1996)
Forested Sites				
Lake Tahoe	285[1]	99%[2]		Rhodes et al., 1985
Maryland	197	95%		Jordan et al., 1993
Georgia	180	83%		Lowrance et al., 1984
Maryland	164	90%	60%	Peterjohn and Correll, 1984
Rhode Island	82-197	>80%		Simmons et al., 1992
North Carolina	154	>99%		Jacobs and Gilliam, 1985b
Iowa	66	83%[3]		Schultz et al., 1995
Great Britain	66	99%		Haycock and Pinay, 1993
Iowa	66	96%		Licht and Schnoor, 1991
Maryland	62	93%	79%	Peterjohn and Correll, 1984
North Carolina	53	>99%		Jacobs and Gilliam, 1985b
North Carolina	49	96%		Hubbard and Sheridan, 1989
North Carolina	33	99%		Xu et al., 1992
New Zealand	16	98%		Schipper et al., 1989
Maryland	12		95%[4]	Doyle et al., 1977
VFS (Grass) Sites				
Great Britain	53	84%		Haycock and Pinay, 1993
Virginia	30		73%[4]	Dillaha et al., 1989
Virginia	15		54%[4]	Dillaha et al., 1989
Maryland	13		68%[4]	Doyle et al., 1977

[1] Estimated based on given area.
[2] Measured using mass balance.
[3] Measured in soil water.
[4] Total nitrogen reduction.

length and slope of overland flow. The effectiveness of VFS is strongly site-dependent. They are ineffective on hilly plots or in terrain that allows concentrated flows.

Length

The length of VFS is an important variable influencing their effectiveness because the contact time between runoff and vegetation in the VFS increases with increasing VFS length. Some sources recommend a minimum length of about 50 feet (Dillaha et al., 1989a; Nieswand et al., 1989; Schueler, 1987). USDA (1988) has prepared design criteria for VFS that take into consideration the nature of the source area for the runoff and the slope of the terrain. Another suggested design criterion in the literature is for the VFS to be at least as long as the runoff-contributing area. Unfortunately, there are no clear guidelines available in the literature for calculating VFS lengths for specific site conditions. Accordingly, this guidance does not prescribe a numeric value for the minimum length for an effective filter strip or a standard method to be used in the design criteria for computing the length of a VFS. Table 6-3 provides examples of nitrate-N reduction in surface waters and ground water by VFS of various lengths at several locations in the United States and Europe.

VFSMOD
VFSMOD is a field-scale, storm-based model designed to calculate the outflow, infiltration, and sediment-trapping efficiency of VFS. The model uses time-dependent hyetographs, space-distributed filter parameters (vegetation roughness or density, slope, and infiltration characteristics), and sediment characteristics to calculate VFS efficiency.
Source: Munoz-Carpena and Parsons, 1997.

Climate

Several regional differences are important to note when considering the use of VFS. Climate plays an important role in the effectiveness of these systems. The amount and duration of rainfall, the seasonal differences in precipitation patterns, and the type of vegetation suitable for local climatic conditions are examples of regional variables that can affect the performance of VFS. VFS should not be used in regions that have permafrost because infiltration is extremely limited, which greatly decreases the effectiveness of the BMP (USEPA, 1997b). Soil type and land use practices also vary with region and will affect characteristics of surface water runoff and thus of VFS performance. The sites where published research has been conducted on VFS effectiveness for pollutant removal are overwhelmingly located in the eastern United States. There is a demonstrated need for more studies located in different geographic areas in order to better categorize the effects of regional differences on the effectiveness of VFS.

Native Plants

The best vegetative species for VFS are those which will produce dense growths of grasses and legumes resistant to overland flow. Use native plants to avoid negatively affecting adjacent natural areas.

Detention

In the design process for a VFS, some consideration should be given to increasing the detention time of runoff as it passes over the VFS. One possibility is to design the VFS to include small rills that run parallel to the leading edge of the filter strip. These rills would trap water as runoff passes through the VFS. Another possibility is to plant crops upslope of the VFS in rows running parallel to the leading edge. Data from a study by Young and others (1980), in which corn was planted in rows parallel to the leading edge of the filter strip, show an increase in sediment trapping and nutrient removal.

Monitoring

The design, placement, and maintenance of VFS are all critical to their effectiveness, and concentrated flows should be prevented. Although intentional planting and naturalization of the vegetation will enhance the effectiveness of a larger filter strip, the strip should be inspected periodically to determine whether concentrated flows are bypassing or overwhelming the VFS, particularly around the perimeter. Regular inspection should be performed to determine whether sediment is accumulating within the VFS in quantities that would reduce its effectiveness (Magette et al., 1989). Monitoring should be conducted to determine the efficiency of VFS in pollutant reduction and to determine whether they are meeting performance standards.

Maintenance

For VFS that are relatively short in length, natural vegetative succession is not intended. It should be mowed two or three times a year, fertilized, and weeded in an attempt to achieve dense, hearty vegetation. The goal is to increase the density of the vegetation to obtain maximum filtration. For wooded filter strips, maintenance is minimal, and gradual succession from grass to meadow to second-growth forest will enhance, rather than detract from, the performance of longer filter strips. This process can be enhanced by intentional landscape planting to facilitate vegetative succession. Corrective action is still necessary around the edge of the strip, and trees might help to prevent concentrated flows from forming (USDOT, 1996). In cold regions where deicers are used regularly during winter months, requirements specific to the region are usually necessary. Use of salt-tolerant plant species could be necessary where parking lot or roadway runoff is directed to the VFS. Maintenance activities following spring snowmelt should include maintenance and replacement of any salt-damaged vegetation. In addition, mulching might be required in the spring to restore soil structure and moisture capacity because deicing salts can damage soil structure and reduce the organic content of the soil (USEPA, 1997b). Consider including one or more of the following items in a VFS maintenance program to make the performance of any VFS more efficient:

- Adding a stone trench to spread water effectively across the surface of the filter.
- Designing flow spreaders to pass debris and/or to facilitate maintenance access.
- Keeping the VFS carefully shaped to ensure sheet flow.
- Inspecting for damage following major storm events.
- Removing any accumulated sediment.
- Accounting for sediment and stream bed load for open wetland treatment systems.

All filter strips should be inspected on an annual basis and examined for gully erosion, vegetative density and health, concentrated flows, and damage from foot or vehicle traffic. Additional inspections should be conducted after high-volume runoff events. The flow spreader should be inspected to ensure that trash and debris have not collected in the spreader. Accumulated sediments should be removed to maintain sheet flow and preserve the original grade. Maintaining soil permeability is also crucial to ensure proper functioning of VFS. This might require periodic removal of thatch or mechanical aeration. Grass filter strips should be reseeded in dead or damaged areas where necessary, and dead vegetation in wooded filter strips should be removed (USDOT, 1996).

6.1.2 Constructed Wetlands

Constructed wetlands must be managed to avoid any negative impacts on wildlife and surrounding areas.

Practice
Construct properly engineered systems of wetlands for NPS pollution control. Manage these systems to avoid negative impacts on surrounding ecosystems or ground water.

Siting Constructed Wetlands

The Interagency Workgroup on Constructed Wetlands has issued a guidance document entitled *Guiding Principles for Constructed Treatment Wetlands: Providing Water Quality and Wildlife Habitat* (USEPA, 2000a). The workgroup consists of representatives from the Environmental Protection Agency, USACE, USFWS, NRCS, National Marine Fisheries Service, and Bureau of Reclamation. The workgroup suggests the following considerations for siting constructed wetlands.

1. *Waters of the United States and Floodplains.* Constructed wetlands should generally be constructed in upland areas and away from floodplains.
2. *Opportunities for Restoration of Degraded or Former Wetlands.* Constructed wetlands should be built in existing or former wetlands only if the water entering the project meets water quality standards; the project will have a net environmental benefit; and the project will help restore the historical condition of the wetland.
3. *Watershed Considerations.* Consider the role of the constructed wetland in the watershed. Some issues to evaluate are water quality impacts, surrounding and upstream land uses, location relative to flyways or wildlife corridors, and public acceptance and perceptions.
4. *Water-Depleted and Effluent-Dependent Ecosystems*. Constructed wetlands may provide valuable ecological benefits in regions where water resources are limited because of climatic conditions (for example arid areas) and human-induced impacts (for example urban areas).
5. *Other Site Selection Factors.* Numerous factors can affect whether a particular site is appropriate for the development of a constructed wetland. These factors include:

    - Substrate or soils
    - Hydrology/geomorphology
    - Vegetation
    - Presence of endangered species
    - Socioeconomic impacts/issues
    - Zoning considerations
    - Health and safety issues

The most important variable in constructed wetland design is hydrology. If proper hydrologic conditions are developed, the chemical and biological conditions will, to a degree, respond accordingly (Mitsch and Gosselink, 1993). The underlying soils in a wetland are key to establishing the proper hydrology. Soils vary in their ability to support vegetation, to prevent percolation of surface water into the ground water, and to provide active exchange sites for adsorption of constituents like phosphorus and metals.

Design Considerations

The planning and design of a constructed wetland must include considerations for the quality of the influent, the types of pretreatment are necessary, and the shape and size necessary to accomplish the desired treatment. The Interagency Workgroup on Constructed Wetlands (2000) recommends that the following guidelines be considered in the design of constructed wetland systems.

1. *Minimal Impact.* Adverse impacts on waters of the United States should be avoided. Examples of impacts to be avoided include changes in hydrology, disruption of the composition and diversity of plant and animal communities, and degradation of water quality. Assessment and pre-treatment for sediment removal and management should also be addressed.
2. *Natural Structure*. Whenever possible, use soft structures, sinuous lines, and bioengineering practices in constructed wetlands design. Natural landscape formations, native vegetation, and gravity should be used to their best advantage.
3. *Buffer Zones.* Constructed wetlands should be surrounded by buffers or transition zones. These areas can also be used in the design as open space or wildlife corridors.
4. *Vector Control.* Facilities should be designed to minimize stagnant water as a precaution against mosquito problems. Healthy, functioning wetlands potentially decrease mosquito populations by providing habitat for natural enemies of mosquitoes, and by preventing and reducing flooding in areas that are not normally wet and would, therefore, support mosquitoes, but not their predators.

   Surveillance programs track diseases in bird populations, vector-borne pathogens in mosquitoes, mosquito populations, larval habitats, mosquito traps, biting counts, and reports by the public (Rose, 2001). Control activities are initiated when threshold populations are exceeded. Predictions are made from seasonal records and weather data.

   Reducing mosquito populations entails eliminating or altering larval habitats. This can be achieved through public education campaigns, with outreach to both children and adults. Additionally, state and local mosquito control agencies can alter the hydrology of open water and marshy areas to reduce or prevent the proliferation of mosquito larvae. Rose (2001) suggests techniques in which mosquito-producing areas in marshes are connected by shallow ditches to deep water habitats to allow drainage or fish access; and minimally flooding the marsh during the summer but flap-gating impounded areas to reintegrate them to the estuary for the rest of the year.

Open Marsh Water Management (OMWM) was developed to control mosquitoes by introducing their natural predators to areas where mosquitoes breed. USFWS in partnership with Massachusetts modified extensive grid-ditching systems installed during the Depression, to allow small fish that eat mosquito larvae to move into ponds where mosquitoes breed. With a system of pools connected by radial ditches, fish feed on mosquitoes during high tide, then retreat to reservoirs at low tide (Scheirer, 1994). Restored pools in the saltmarshes also provide feeding and resting areas for migratory birds.

Biological control can be achieved by using various predators such as dragonfly nymphs and predacious mosquitoes (Rose, 2001). Mosquito fish (*Gambusia affinis* and *Gambusia holbrooki*) are the most commonly used agents for biological control because they are easily reared, although they also feed on nontarget species. Other types of organisms that might be used for mosquito control include several fish types other than Gambusia (Check with local fish and wildlife agencies for potential species), birds, bats, fungi, protozoans, nematodes, and predacious copepods.

It is essential that stormwater managers and public works crews who maintain stormwater practices be educated in integrated pest management. They should be trained to identify design flaws or maintenance needs that might create mosquito-breeding habitat and be clear on the procedures for reporting and remedying the problem. Pesticide handlers should have the required training under FIFRA, and all chemicals should be applied at rates as recommended on the packaging. Treated areas should be monitored after application to determine the efficacy of the applications and identify where pesticide resistance might be occurring.

Livingston (no date) recommends the following design considerations to minimize mosquitoes in Florida stormwater management systems:

— Designs must be based on site characteristics to assure that the most appropriate type of stormwater practice is selected. Vegetated dry retention systems should be designed as off-line systems. They should be used only where the soil and water table conditions will assure that the system goes dry within 24 to 36 hours and where the seasonal high water table is at least two feet below the bottom of the system. If on-line retention areas are used, they should be designed to be dry within three days of a 25-year, 24-hour design storm.

— Dry retention systems need to be carefully constructed to avoid compacting the soil and reducing its infiltration rate. They also need to have flat bottoms to avoid having areas of standing water.

— To minimize decaying organic matter, the grass or other vegetation in dry retention areas should be regularly mowed with the clippings removed and properly composted.

— The littoral zone of wet detention areas should be planted with aquatic macrophytes such as *Sagittaria latifolia* (duck potato), *Sagittaria lancifolia* (lance-leaf arrowhead), *Juncus effuses* (soft rush), *Pontedaria lancifolia* (pickerelweed), *Juncus roemerianus* (needle rush), *Scirpus californicus* (giant bulrush), and *Scirpus validus* (soft stem bulrush). Cattails (*Typha* spp.) should never be planted in or allowed to remain in stormwater systems as they grow very profusely, creating a large quantity of decaying matter.

— Wet detention systems should be stocked with native *Gambusia* spp. Minnows (mosquito fish) to foster biological predation of mosquito larvae. If needed because of site conditions, a "minnow sump" should be excavated in the deepest part of the pond to assure permanent habitat and survival during droughts.

— Sustained-release larvicides should be used whenever necessary with systems known to be mosquito productive treated before the onset of the mosquito life cycle.

— Regular inspection and maintenance of stormwater systems is essential.

Regular monitoring for mosquito adults and larvae, retrofitting and maintenance of practices to reduce the likelihood for breeding, and pesticide application where needed are the three key actions for eliminating mosquito breeding in stormwater facilities. The Centers Disease Control and Prevention (CDC) discussed the role of pesticides that kill adult mosquitoes (adulticides) in mosquito management and recommended that their use be incorporated into an integrated pest management program that includes surveillance, source reduction, chemical control (larvicide and adulticide), biological control, and public relations and education.

5. *Hazing and Exclusion Devices.* In constructed wetlands where the water quality could present a significant threat to the health of wildlife, hazing or wildlife exclusion devices should be used, maintained, and regularly evaluated for their effectiveness. Examples include fencing, netting, and noise-makers.
6. *Dedicated Water Source.* A dedicated water supply should be available for the life of the constructed wetland and preferably longer. The water supply should be sufficient to maintain the wetland in times of drought. It is important that the water supply for adjacent waterways not be negatively impacted as well.
7. *Biological Diversity and Physical Heterogeneit*y. If possible, constructed wetlands should be designed to maximize species diversity native species. There are several guides for the selection of wetland plants; see Table 5-2 for a list of resources. To achieve this goal of diversity, it might be necessary to provide for physical heterogeneity in the facility design. Some examples of physical heterogeneity include having both surface and subsurface flow as well as some open areas of water, and designing islands for waterfowl nesting as well as buffer or upland areas for other bird species.

The types of vegetation used in constructed wetlands depend on region and climate (Mitsch, 1977). For example, emergent wetlands are usually characterized by herbaceous vegetation, while eastern riparian wetlands are generally forested wetlands. When possible, use native plant species to avoid negative impacts on nearby natural wetland areas. Plants should be selected based on their ability to withstand fluctuating water levels. Select appropriate vegetation based on the water supply. If the water table will fluctuate over time, select plants that can withstand these changes. Hydrophytic plant species are the most suitable wetland plant. In coastal areas, the plants should be adapted to fluctuating salinity levels. There are several guides for the selection of wetland plants such as *Aquatic and Wetland Vascular Plans of the Northern Great Plains* (USDA, 1993), many resources listed in Table 5-2, or the U.S. Fish and

Wildlife Service's *National List of Plant Species that Occur in Wetlands* (http://www.nwi.fws.gov/bha).

8. *Seasonality and Capacity Exceedances.* Planners should consider extreme meteorological events and how exceedances of storage and treatment capacity will affect the facility.
9. *Forebays.* Constructed wetlands should contain sediment collection/settling forebays to trap sediment before runoff enters the vegetated area of the constructed wetland. Baffles and diversions should be strategically placed to prevent trapped sediment from becoming resuspended during subsequent storm events prior to cleanout. These components should be designed for ease of maintenance and removal of sediments. Appropriate upland disposal sites that meet applicable regulatory requirements should also be identified.
10. *Multiple Cells.* The benefits of using multiple treatment cells should be considered. Multiple cells can allow for greater flexibility in the operation and maintenance of constructed facilities, as well as potentially providing better treatment than single-cell systems.
11. *Maintenance Access.* Safe and easy access to the facility for personnel and vehicles is important for proper operation and maintenance with a minimum of disturbance.
12. *Public Acceptance.* Planners should take into consideration how the public perceives the facility. Mosquitoes, odors, and safety issues are common questions raised by the public. Engaging the community early in the project development process can help in gaining support and approval.
13. *Public Use.* Public access to constructed wetlands might or might not be appropriate depending on the intended purpose of the facility. If safety and health concerns are not an issue, designers may wish to develop educational displays for the facility to encourage better understanding of constructed wetlands and their many benefits.
14. *Pilot Projects and Design Criteria*. Pilot projects might be necessary to assist in designing full-scale projects. When pilot projects are not used, the design considerations should be fully described and documented for future reference.

PREWet

A screening level PC-based mathematical model (PREWet) is available for making pollutant removal estimates for wetlands. PREWet assumes steady-state conditions and either fully mixed or one-dimensional longitudinally varying concentrations to allow rapid model implementation with minimal input data requirements. Given basic wetland characteristics and the pollutants of concern, PREWet estimates the amount of pollutant treatment provided by the wetland.

Source: USACE, 1997.

Constructing and Maintaining Constructed Wetlands

The following guidelines should be considered during the active construction and operation phases of a constructed wetland.

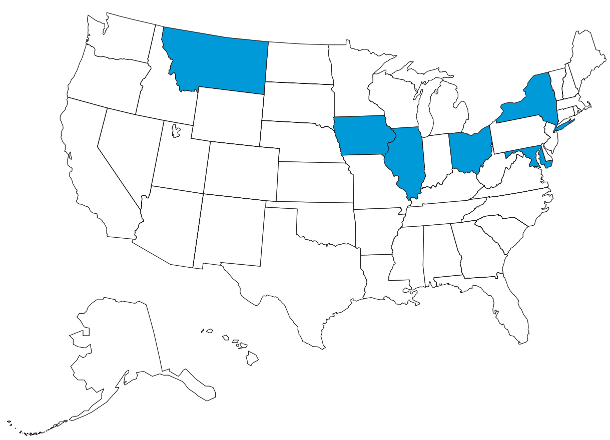
1. *Construction Practices/Specification/Drawings.* The construction site should be properly evaluated prior to construction to ensure its suitability; site survey elevations should be established; proper engineering drawings should be used to clearly convey the design specification; and damage to surrounding land should be minimized by limiting excavation and surface runoff from the site. It is also important to note that a Clean Water Act section 402 permit may be required depending on the size of the project.
2. *Soils.* Soils used in the wetland should be carefully evaluated to match their permeability and other physical properties to the objectives of the project. The use of soils that may contain the seeds of unwanted plant species or unwanted contaminants should be avoided. Given time and water, native soils can take on wetland soil properties.
3. *Vegetation Selection.* Plant species should be chosen for their abilities to adapt to the water, soil, and light conditions of the constructed wetland. A variety of native species is preferable; the use of weedy or invasive species should be avoided. There are several guides for the selection of wetland plants; see Table 5-2 for a list of resources.
4. *Management Plan.* Develop a long-term plan for the maintenance, operation, funding, and monitoring of the constructed wetland. This plan should outline the routine maintenance activities required for proper operation and specify the person or group responsible for caring for the wetland.
5. *Regular Inspections and Maintenance Activities*. Operators should inspect the constructed wetland as necessary depending on the site and design. The inspection criteria and frequency should be described in the maintenance plan. The effectiveness of the constructed wetland for removing pollutants will depend on how well it is maintained. The operation and maintenance plan should consider the monitoring and data needs that are required to determine how well the constructed wetland is performing relative to its design criteria. Maintenance activities that affect the pollutant removal performance of the constructed wetland (e.g., sediment removal, plant harvesting, and other vegetation maintenance activities) should be done when the monitoring data indicate a decline in performance under designed operating conditions. This will ensure that the constructed wetland is achieving its pollutant removal effectiveness over time. Examples of maintenance activities include checking weir settings and inlet and outlet structures, cleaning surfaces that have solids or floatables accumulating on them, removing nuisance species, maintaining vegetation, and removing sediment from forebays.
6. *Operator Training.* Operators should be trained in the proper maintenance and operation of the wetland. State regulatory agencies, as well as some public or private training centers, may be able to assist with this training.
7. *Contingency Plan.* A contingency plan should address problems that may develop during the lifetime of the wetland due to construction or operation errors and unpredictable events. The plan might also include instructions for dealing with potential nuisance conditions.

There are many challenges as well as benefits for farmers installing and maintaining vegetative buffers, as described in the February 1999 NRCS publication, The National Conservation Buffer Initiative: A Qualitative Evaluation. <*http://www.nrcs.usda.gov/feature/buffers/pdf/BuffQual.pdf*>

6.2 Costs and Benefits of Practices

This section describes the economic costs and benefits of creating vegetated treatment systems to control nonpoint sources of pollution. This information is intended to demonstrate the cost savings accrued by implementing the management measure as compared to the costs of not implementing it. Because of regional diversity, no single cost or economic benefit can be applicable across the United States. Instead, the information provided below and in Table 6-4 are examples of such costs and benefits in specific areas of the country.

Table 6-4. Costs and Economic Benefits Associated with Vegetative Treatment Systems



Examples from throughout the United States show the expected cost of many types of vegetated treatment systems as well as their value to the respective communities. For some of these projects, the value of the vegetated treatment systems is based on the dollar value saved from not using the structural or conventional approach. The cost to install structural or conventional technologies to replace the functions of constructed wetlands, buffers, and vegetated filter strips are shown to be much greater than the actual cost of the vegetated treatment systems. When available, the dates for project costs are provided. Results from studies in various states (see map at left) are shown in the table below. Additional information and references about each study is provided in Appendix F.

Description	Cost of Conventional Project (without VTS)	Vegetated Treatment Systems Project Costs	Estimated Benefit to Community	Study Title and State/Tribe/Agency
Installation of stream buffers and riparian zones		$6,600 (CRP rent: $150/acre times 44 acres) (1997)	Exclusionary fencing keeps cattle out of stream, and filters and buffers help protect and improve water quality.	Allamakee County (IA)
Valuation of creating vegetative filter strips for reducing water treatment costs		$803 to $10,522 per acre	$2.7 million per year (based on 25% sediment reduction).	Middle Raccoon Watershed Partnership (IA)
Establishment of filter strips along waterways		$26,000 worth of switchgrass seed given to farmers (2000)	Installation of filter strips will remove chemicals and sediment and lead to improved water quality.	Iroquois County (IL)
Addition of best management practices (BMPs) through the Skaneateles Lake Watershed Agricultural Program		$150,000 (no date)	BMPs will help improve farm planning and nutrient management to improve water quality.	Skaneateles Laket (NY)
Structural versus nonstructural shore erosion/control approaches	$3.7 million to $4.3 million per year (1997)	$1.6 million per year (1997)	$1.5 million to $2.1 million per year.	Chesapeake Bay (MD)
Restoration of Ronan Spring Creek		$5,000 for shrubs (no date)	Stream restoration, through dredging and deepening, will bring back fish habitat and backwaters for waterfowl.	Ronan Spring Creek (MT)
Valuation of local agricultural benefits from riparian improvement from 25% reduction of sediment			$2.7 million in treatment costs. (1993)	Ohio State University Extension Service (OH)

The use of appropriate practices for pretreatment of runoff and prevention of adverse impacts on wetlands and other waterbodies involves the design and installation of vegetated treatment systems such as VFS or constructed wetlands, or the use of structures such as detention or retention basins. These types of systems are discussed individually elsewhere in this guidance document. The purpose of VFS and constructed wetlands is to remove, to the extent practicable, excessive levels of NPS pollutants and to minimize the impacts of hydrologic changes. Both VFS and constructed wetlands can function to reduce levels of pollutants in runoff or attenuate runoff volume before the runoff enters a natural wetland or riparian area or another water body.

One of the largest programs promoting the use of vegetated buffers is the National Conservation Buffer Initiative, which is funded through the USDA Natural Resources Conservation Service (NRCS). In April 1997, USDA initiated the National Conservation Buffer Initiative with the goal to help landowners install 2 million miles of conservation buffers by the year 2002. As of January 2003, the National Conservation Buffer initiative contributed to the installation of over 1.3 million miles of buffers on almost 5 million acres of land (BufferNotes, 2003). The National Conservation Buffer Initiative encourages agricultural producers and other landowners to install buffers that can improve soil, air, and water quality; enhance wildlife habitat; restore biodiversity; and create scenic landscapes. The initiative is led by the NRCS in cooperation with the Agricultural Research Service, Farm Service Agency; Forest Service; Cooperative State Research, Education, and Extension Service; state conservation agencies; conservation districts; and numerous other public and private partners (USDA, 2000).

Most of the buffer development is focused on farmland. There are many challenges associated with the buffer program. For example, coordinators find it difficult to get buffers installed on rented land. Landlords are reluctant to forego the rent on that land, yet tenants have no guarantee that they will benefit from proposed buffers. Farmers have also voiced concerns about the program's low rental rates and about the restrictions it places on the use (haying, grazing) of buffers. The NRCS is addressing these issues along with educating the public on the benefits of buffers.

The costs for establishing of multispecies riparian buffer strip systems have been estimated at $358 to $396 per acre, and annual maintenance costs are estimated at $20 per acre. The establishment and maintenance costs do not include any existing governmental cost-share or other subsidy. Currently, there are several cost-share programs available that will cover up to 75 percent of the expenses (USEPA, 1996a).

Constructed wetlands are finding increasing uses in residential areas because they cost less than conventional wastewater treatment plants. They can be readily accommodated in areas that have the land such systems require. However, urban areas are also expressing a growing interest.

The town of Jerome, Arizona, recently chose to construct a wetland rather than build a mechanical treatment plant to treat its wastewater. Maintenance of the mechanical treatment plant was to cost about $1,000 per month (in 1997), whereas maintaining the wetland was expected to cost “little or nothing.” The city of Sierra Vista, Arizona, has partnered with the U.S. Bureau of Reclamation on a constructed wetland project that is expected to demonstrate the technology’s environmental benefits. Such benefits would derive from using treated wastewater for aquifer recharge and for release directly to the river (University of Arizona, 1997).

The city of Des Moines, Washington, is using SRF funds to purchase and reconstruct a badly degraded wetland area and to construct a sediment trap/pond facility. The wetlands serve the dual purpose of providing flood protection by collecting stormwater runoff and acting as a preliminary filter by removing suspended solids. This $222,500 project is part of the National Estuary Program.

Five communities in South Dakota have received SRF loans for wetlands projects. The communities of Clear Lake, Huron, Lake Cochrane, Pickerel Lake, and Richmond Lake have used SRF loans to construct wetlands as part of improvements to their publicly owned treatment works (POTW). Constructed wetlands are a complex of saturated substrates, emergent and submergent vegetation, animal life, and water that simulates natural wetlands for various benefits. In these cases, the wetlands follow a lagoon treatment system to further reduce pollutant levels in the wastewater prior to discharge. User charges are being used to repay the loans, which total about $7.5 million for all five communities.

Conservation Reserve Program (CRP)

The CRP is based on the premise that financial incentives make conservation buffers economically attractive. Annual rental payments are based on the relative productivity of the soil type being offered and the average dryland cash rental rate for comparable land in the county. A 20 percent incentive is added to the annual rental rate for field windbreaks, grassed waterways, filter strips, and riparian buffers. A 10 percent incentive is added to the annual rental rate for land within designated wellhead protection areas.

Cost-sharing payments up to 50 percent of the cost of establishing a permanent cover are provided. Some of the measures eligible for cost sharing are site preparation, temporary cover until permanent cover is established, grading or shaping, seeds, trees or shrubs, plastic mulch, and supplemental irrigation or fencing.

Contracts under the continuous CRP sign-up are 10 to 15 years in length, depending on the approved practice. Annual rental payments are made after October 1 each year and cost-share payments are made when the approved practices are completed.

Source: NRCS, 2000a.

Resources

Documents

EPA Wetlands Fact Sheets. 1995. EPA Office of Water. EPA 843-F-95-001.
http://www.epa.gov/owow/wetlands/facts/contents.html

Created and Natural Wetlands for Controlling Nonpoint Source Pollution. 1993. CRC Press, Inc. Boca Raton, Florida.

Natural Wetlands and Urban Stormwater: Potential Impacts and Management. 1993. EPA Office of Water. EPA 843-R-001.
http://www.epa.gov/owow/wetlands/pdf/stormwat.pdf

Protecting Natural Wetlands: A Guide to Stormwater Best Management Practices. 1996. EPA Office of Water. EPA 843-B-96-001.

Top Ten Watershed Lessons Learned. 1997. EPA Office of Water. EPA 840-F-97-001.
http://www.epa.gov/owow/lessons

Clean Water Action Plan: Restoring and Protecting America's Waters. 1998. EPA and USDA. EPA 840-R-98-001.
http://www.epa.gov/history/topics/cwa/03.htm

Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters. 1993. EPA Office of Water. EPA 840-B-92-002.
http://www.epa.gov/owow/nps/MMGI/

National Guidance: Water Quality Standards for Wetlands. 1990. EPA Office of Water. EPA 440-S-90-011.
http://www.epa.gov/OWOW/wetlands/regs/quality.html

Wetlands Assistance Guide for Landowners. 1995. Texas Parks and Wildlife. State Wetlands Conservation Plan, Austin, TX.
http://www.tpwd.state.tx.us/wetlands/programs/landowner/

National Water Summary of Wetland Resources. 1996. USGS. Water Supply Paper 2425.
http://water.usgs.gov/public/nwsum/WSP2425/index.html

Wetlands. 1993. W. Mitsch and J. Gosselink.

Protecting America's Wetlands: An Action Agenda - The Final Report of the National Wetlands Forum. 1989. The Conservation Foundation. Washington, D.C.

Statewide Wetlands Strategies: A Guide to Protecting and Managing the Resource. 1992. World Wildlife Fund. Island Press. Washington, D.C.

Our National Wetland Heritage: A Protection Guide. 1996. Environmental Law Institute, Washington, DC.

The Impact of Federal Programs on Wetlands. 1994. USDOI. Report to Congress by the Secretary of the Interior. *http://www.doi.gov/oepc/wetlands2/*

An Introduction to Wetland Restoration, Creation, and Enhancement. 2001. Review Draft. Interagency Workgroup on Wetland Restoration.
http://www.epa.gov/owow/wetlands/restore/finalinfo.html

For information on receiving EPA publications:
U.S. EPA
National Center for Environmental Publications and Information (NCEPI)
P.O. Box 42419
Cincinnati, OH 45242
1-800 490-9198
FAX (513) 489-8695
http://www.epa.gov/ncepihom/orderpub.html

EPA Wetlands Protection Hotline – toll-free telephone service and e-mail correspondent, answering requests for information about wetland regulation, legislation, and policy pursuant to section 404 of the Clean Water Act; wetland values and functions; and wetland agricultural issues. For a listing of the available publications, see *http://www.epa.gov/owow/wetlands/wetline.html*
M-F 9 am to 5:30 pm EST.
1-800-832-7828
wetlands-hotline@epamail.epa.gov

Riparian Area Management: A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic Areas. 1998. Technical Reference 1737-15. U.S. Department of the Interior, Bureau of Land Management, National Applied Resources Sciences Center, Boulder, CO.

Riparian Area Management: A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lentic Areas. 1999. Technical Reference 1737-16. U.S. Department of the Interior, Bureau of Land Management, National Applied Resources Sciences Center, Boulder, CO.

Technical Guidance

A Hydrogeomorphic Classification for Wetlands. 1993. Mark M. Brinson. USACE. Wetlands Research Program Technical Report WRP-DE-4. Currently being developed and updated.

Wetland Evaluation Technique (WET II). 1987. Paul R. Adamus. USACE, Waterways Experiment Station.

Habitat Evaluation Procedures (HEP). 1980. USFWS, Division of Ecological Services.

Journals

Journal of the Society of Wetland Scientists. (785) 843-1221
http://www.sws.org

Wetland Journal. Environmental Concern Inc. (410) 745-9620
http://www.wetland.org

Association of State Wetland Managers Newsletter. (518) 872-1804.
http://aswm.org/index.htm

National Wetlands Newsletter. Environmental Law Institute. 1-800-433-5120.
http://www.elistore.org/nwn.asp

Land and Water: The Magazine of Natural Resource Management and Restoration. (515) 576-3191. *http://www.landandwater.com*

Nonpoint Source News-Notes. Terrene Institute. fax: (202) 260-1517 or (202) 296-4071.
http://www.epa.gov/owow/info/NewsNotes/

Funding Information

Catalog of Federal Funding Sources for Watershed Protection. 1997. EPA Office of Water. EPA 841-B-97-008.
http://cfpub.epa.gov/fedfund/

> The Clean Water State Revolving Fund (SRF), a loan program administered by EPA, can be used to obtain water rights, easements, and fee simple titles to wetlands and riparian areas if the areas protected or acquired serve a demonstrated water quality improvement function. Additional information on this program as well other federal, state, nonprofit, and private programs providing financial and technical assistance can be found in Appendix A and Appendix F.

Section 319 Success Stories: Volume II - Highlights of State and Tribal Nonpoint Source Programs. 1997. EPA Office of Water. EPA 841-R-97-001.

Catalog of State Wetlands Protection Grants: Fiscal Year 1991-Fiscal Year 1994. EPA Office of Water.
http://www.epa.gov/OWOW/wetlands/initiative/grntcatalog.html

EPA Environmental Financing Information Network (EFIN). *http://www.epa.gov/efinpage/efin.htm*

A State and Local Government Guide to Environmental Program Funding Alternatives. 1994. EPA Office of Water. EPA 841-K-94-001.

U.S. Fish & Wildlife Service, Division of Federal Assistance. *http://federalaid.fws.gov/*

Farm Bill Network. *http://www.fb-net.org/*

General Wetland Internet Links

EPA Office of Water Homepage
http://www.epa.gov/OW/

EPA Wetlands Homepage
http://www.epa.gov/OWOW/wetlands/

EPA Nonpoint Source Pollution Control Program Homepage
http://www.epa.gov/OWOW/NPS/

EPA Surf Your Watershed
http://www.epa.gov/surf

EPA Watershed Academy
http://www.epa.gov/owow/watershed/wacademy/

EPA BASINS http://www.epa.gov/ost/basins/

Wetlands Conservation and Restoration, National Wetlands Conservation Alliance.
http://users.erols.com/wetlandg/#top

North Carolina State University - WATERSHEDSS (Water, Soil, and Hydro-Environmental Decision Support System) for Nonpoint Source Pollution
http://www.water.ncsu.edu/watershedss/

Izaak Walton League-American Wetlands Campaign
http://www.iwla.org/sos/awm.

Ramsar Convention on Wetlands
http://www.ramsar.org

University of Nebraska-Lincoln Agriculture Network Information Center Water Quality Page
http://ianrhome.unl.edu/dlc/projects/unlagnic.shtml

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

The U.S. Army Engineer Waterways Experiment Station, U.S. Army Corps of Engineers
http://www.wes.army.mil/

Listservers

Subscribing to a listserver is a good way to recieve the most up-to-date information.

Wetlands Listserver - Environmental Law Institute
http://www2.eli.org/index.cfm

NPSINFO Listserver - EPA
http://www.epa.gov/owow/nps/npsinfo/

WaterNews Listserver - EPA
http://www.epa.gov/ow/waternews/

Education Materials

Wetland Reading List. 1995. EPA Office of Water. EPA 843-B-94-002.
http://www.epa.gov/OWOW/wetlands/science/readlist.html

The Young Scientist's Introduction to Wetlands. 1993. USACE, Waterways Experiment Station.
http://el.erdc.usace.army.mil/wetlands/ysi.html

WOW! The Wonders of Wetlands. 1995. Britt E. Slattery and Alan S. Kesselheim. Co-published by Environmental Concern and The Watercourse.
http://www.wetland.org/wowteacher.html

National Wildlife Federation Kids Page
http://www.nwf.org/kids/

Ducks Unlimited Puddler Page
http://www.ducks.org/puddler/index.html

Project WET Homepage
http://www.projectwet.org/

National Audubon Society - Wetlands
http://www.audubon.org/campaign/wetland/index.html

Glossary

Abiotic: Not biological; not involving or produced by organisms (Merriam-Webster, 1991).

Adsorption: The accumulation of substances at the interface between two phases; in water treatment, the interface is between the liquid and solid surfaces that are artificially provided (Peavy et al., 1985).

Best Management Practice (BMP): Methods that have been determined to be the most effective, practical means of preventing or reducing pollution from nonpoint sources.

Biofiltration: The removal and oxidation of compounds from contaminated air using microorganisms. (Environmental Engineering Program, University of Southern California; http://www-rcf.usc.edu/~bfilter/intro.html)

Biological assimilation: The conversion of nonliving substances into living protoplasm or cells by using energy to build up complex compounds of living matter from the simple nutritive compounds obtained from food (Barnhart, 1986).

Biotic: Caused or produced by living beings (Merriam-Webster, 1991).

Chemical decomposition: Separation into elements or simpler compounds; chemical breakdown (Merriam-Webster, 1991).

Complexation: The process by which one substance is converted to another substance in which the constituents are more intimately associated than in a simple mixture; chelation is one type of complexation (Merriam-Webster, 1991).

Connectedness: Having the property of being joined or linked together, as in aquatic or riparian habitats.

Constructed wetland: Engineered wetlands that utilize natural processes involving wetland vegetation, soils, and their associated microbial assemblages to assist, at least partially, in treating an effluent or other source water. These systems are engineered and constructed in uplands, outside "waters of the United States," unless the water source can serve a significant restoration function to a degraded system (USEPA, 1998).

Denitrification: The biochemical reduction of nitrate or nitrite to gaseous nitrogen, either as molecular nitrogen or as an oxide of nitrogen.

Ecosystem: The complex of a community and its environment functioning as an ecological unit in nature; a basic functional unit of nature comprising both organisms and their nonliving environment, intimately linked by a variety of biological, chemical, and physical processes (Barnhart, 1986; Merriam-Webster, 1991).

Erosion and Sediment Control: A set of plans prepared by or under the direction of a licensed professional engineer indicating the specific measures and sequencing to be used to control sediment and erosion on a development site during and after construction (USEPA, 1993c).

Filtration: The process of being passed through a filter (as in the physical removal of impurities from water) or the condition of being filtered (Barnhart, 1986).

Habitat: The place where an organism naturally lives or grows.

Mitigation: For the purpose of CWA section 404, compensatory mitigation is the restoration, creation, or enhancement of wetlands.

Riparian area: Vegetated ecosystems along a waterbody through which energy, materials, and water pass. Riparian areas characteristically have a high water table and are subject to periodic flooding and influence from the adjacent waterbody. These systems encompass wetlands, uplands, or some combination of these two landforms; they do not in all cases have all of the characteristics necessary for them to be classified as wetlands (Lowrance et al., 1983; Mitsch and Gosselink, 1986).

Sedimentation: The formation of earth, stones, and other matter deposited by water, wind, or ice (Barnhart, 1986).

Species diversity: The variations between groups of related organisms that have certain characteristics in common (Barnhart, 1986; Merriam-Webster, 1991).

Synoptic Assessment Approach: An approach that involves compiling, organizing, and depicting environmental information in a manner that ranks watersheds according to the relative significance and risks to wetlands and other ecosystems. The approach considers the environmental effects of cumulative impacts on wetlands and other ecosystems.

Upland: Ground elevated above the lowlands along rivers or between hills (Merriam-Webster, 1991).

Vegetated buffer: Strips of vegetation separating a waterbody from a land use that could act as a nonpoint pollution source. Vegetated buffers (or simply buffers) are variable in width and can range in function from vegetated filter strips to wetlands or riparian areas.

Vegetated filter strip: Created areas of vegetation designed to remove sediment and other pollutants from surface water runoff by filtration, deposition, infiltration, adsorption, decomposition, and volatilization. A vegetated filter strip is an area that maintains soil aeration as opposed to a wetland, which at times exhibits anaerobic soil conditions (Dillaha et al., 1989a).

Vegetated treatment system: A system that consists of a vegetated filter strip, a constructed wetland, or a combination of both.

Watershed: The land area that drains into a stream; the watershed for a major river may encompass a number of smaller watersheds that ultimately combine at a common point.

Waters of the United States: As defined by 40 CFR 230.3:

(s) The term waters of the United States means:

(1) All waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide;

(2) All interstate waters including interstate wetlands;

(3) All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation or destruction of which could affect interstate or foreign commerce including any such waters:

(i) Which are or could be used by interstate or foreign travelers for recreational or other purposes; or

(ii) From which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or

(iii) Which are used or could be used for industrial purposes by industries in interstate commerce;

(4) All impoundments of waters otherwise defined as waters of the United States under this definition;

(5) Tributaries of waters identified in paragraphs (s)(1) through (4) of this section;

(6) The territorial sea;

(7) Wetlands adjacent to waters (other than waters that are themselves wetlands) identified in paragraphs (s)(1) through (6) of this section; waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of CWA (other than cooling ponds as defined in 40 CFR 423.11(m) which also meet the criteria of this definition) are not waters of the United States.

Waters of the United States do not include prior converted cropland. Notwithstanding the determination of an area's status as prior converted cropland by any other federal agency, for the purposes of the Clean Water Act, the final authority regarding Clean Water Act jurisdiction remains with EPA.

Wetlands: Those areas that are inundated or saturated by surface water or groundwater at a frequency and duration 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. (This definition is consistent with the federal definition at 40 CFR 230.3, promulgated December 24, 1980. As amendments are made to the wetland definition, they will be considered applicable to this guidance.)

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Appendix A
Federal, State, Nonprofit, and Private Financial and Technical Assistance Programs to Protect and Restore Wetlands

This appendix contains examples of financial and technical assistance programs to protect and restore wetlands. It also contains incentive programs offered by state, nonprofit, and private organizations. For each agency and organization, contacts are provided for further information.

Federal Programs

United States Army Corps of Engineers

The United States Army Corps of Engineers (USACE) provides design and engineering services and construction support for a variety of military and civilian projects worldwide. One civil duty includes protecting the integrity of the navigable waters of the United States, wetland resources, and the nation's water resources. USACE's duties also include maintaining navigation and shipping channels, providing emergency response to natural disasters, regulating discharges of dredged or fill material, operating and maintaining flood control reservoirs, and regulating activities in wetlands.

- Wetlands are managed by the USACE by the issuance or denial of Clean Water Act section 404 and other permits authorizing certain activities in wetlands and other waters of the United States. Of the approximately 15,000 permits requested each year, approximately 67 percent are granted.

For more information on the U.S. Army Corps of Engineers, contact:
U.S. Army Corps of Engineers Regulatory Branch
20 Massachusetts Avenue, NW
CECW-OR
Washington, DC 20314-1000
Phone: (202) 761-0199
Web site: www.usace.army.mil

United States Department of Agriculture

The missions of the United States Department of Agriculture (USDA) are to enhance the quality of life for the American people by supporting production of agriculture by

- Ensuring a safe, affordable, nutritious, and accessible food supply.
- Caring for agricultural, forest, and range lands.
- Supporting sound development of rural communities.
- Providing economic opportunities for farm and rural residents.
- Expanding global markets for agricultural and forest products and services.
- Working to reduce hunger in America and throughout the world.

Within the USDA, the Natural Resources Conservation Service, Farm Service Agency, Forest Service, Cooperative State Research, Education, and Extensive Service, and the National Association of Conservation Districts participate in wetland incentives programs.

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The ***Farm Service Agency (FSA)*** of the USDA is interested in ensuring the well-being of American agriculture, the environment, and the American public through efficient management of farm commodities, emergency and disaster assistance, domestic and international food assistance and credit programs, and conservation and environmental programs.

- The Conservation Easement Debt Cancellation Program of the FSA allows for reduction of Farmer's Home Administration borrower debt in exchange for granting conservation easements for valuable habitat, including wetlands, on their property for a period of not less than 50 years.
- The Conservation Reserve Enhancement Program (CREP) is a cooperative partnership between the federal and state governments. The program has been administered by the USDA FSA since 1986. The program provides ranchers and farmers with incentives to remove land from production. These lands are then planted with trees or grass to prevent

erosion, improve air and water quality, and establish wildlife habitat.

- Farmers nationwide have contributed 36 million acres of cropland into the Conservation Reserve Program (CRP) (as of 1997). These farmers receive annual rental payments, cost-sharing, and technical assistance to plant vegetation for land they put into reserve for 10 to 15 years. Few of the fields placed in reserve have yet to have their full wetlands values restored. Although CRP funds are no longer available to help restore wetlands on these lands, the landowner may do so at any time with any other non-USDA assistance. The CRP is administered by the CFSA in cooperation with the NRCS.The Conservation Reserve Enhancement Program (CREP), under the Conservation Reserve Program, is a 1996 initiative continued in the 2002 Farm Bill. CREP targets state and federal funds to achieve shared environmental goals of national and state significance. The program uses financial incentives to encourage farmers and ranchers to voluntarily protect soil, water, and wildlife resources.
- Grassland Reserve Program (GRP) - This 2002 provision of the Farm Bill will use 30-year easements and rental agreements to improve management, restore, or conserve up to 2 million acres of private grasslands. 500,000 acres are to be reserved for protected tracts of 40 acres or less as native grasslands. Restoration cost payments may be up to 75 percent of eligible projects.

For more information, contact:
U.S. Department of Agriculture
Farm Service Agency
14th and Independence Avenues, SW
Washington, DC 20250
Phone: (202) 720-3467
Web site: http://www.fsa.usda.gov/

The ***Forest Service*** (FS) is a USDA agency that manages public lands in national forests and grasslands and is also the largest forestry research organization in the world. The agency provides technical and financial assistance to state and private forestry agencies "to provide the greatest amount of good for the greatest amount of people in the long run."

- Forest Stewardship Program (FSP) and Stewardship Incentive Program (SIP) - FSP and SIP are U.S. Forest Service programs established to help landowners protect and enhance their forestlands and associated wetlands. FSP provides technical assistance to help landowners enhance and protect the timber, fish and wildlife habitat, water quality, wetlands, and recreational and aesthetic values of their property. SIP provides cost-share assistance to private landowners for implementing the management plans developed under FSP.

  http://www.fs.fed.us/spf/coop/programs/loa/fsp.shtml
- Forest Legacy Program - The Forest Legacy Program is a U.S. Forest Service program that purchases easements to conserve environmentally important forestlands, which often contain wetlands, threatened with conversion to other uses. Puerto Rico and 17 states are currently active in the program (as of 1997) (USEPA, 1997c).
- Forest Land Enhancement Program (FLEP) - Authorized in the 2002 Farm Bill, the FLEP is a new conservation program to provide financial, technical, and educational assistance to State Foresters who will help private landowners actively manage their land. It replaces and expands the Stewardship Incentive program and Forestry program. The new FLEP will provide up to $100 million over 6 years to private, non-industrial forest

owners. The new title also provides $210 million to help fight fire on private land and address fire prevention.

For more information on the Forest Service, contact:
U.S. Department of Agriculture Forest Service
Public Affairs Office
P.O. Box 96090
Washington, DC 20090-6090
Phone: (202) 205-1760
Fax: (202) 205-1765
Web site: http://www.fs.fed.us

The ***Natural Resources Conservation Service*** (NRCS) [formerly USDA Soil Conservation Service] is a federal agency that works in partnership with the public to conserve and sustain natural resources. The NRCS provides technical assistance to landowners in development of resource management systems that conserve soil, air, water, plant, and animal resources. This agency employs soil scientists, plant scientists, and engineers who can provide assistance in identifying, restoring, enhancing, and creating wetlands. The NRCS provides technical assistance and information for making wetland determinations for wetland protection and management programs; developing conservation plans for protecting and managing wetlands; providing income-producing alternatives for use and management of wetlands; developing standards and specifications and designing and installing conservation measures for wetland restoration, creation, and enhancement; providing information on plant materials for wetland planting; and providing soil surveys and information for identifying, planning, and managing wetlands. Wetland incentive programs administered by the NRCS include the following:

- Conservation of Highly Erodible Lands - The highly erodible land part of the 1985 Food Security Act restricts access by agricultural producers who grow crops on highly erodible land to specified farm program benefits. The goals are to reduce soil lost to wind and water erosion and to improve water quality. Compliance requires the development of a conservation plan for all highly erodible fields on a farm. The plans must be approved by the producer, NRCS, and the local Natural Resources District. NRCS provides technical assistance to the producer in developing the plan.
- Conservation of Private Grazing Land - This program was authorized by the 1996 Farm Bill for the purpose of providing technical and educational assistance to owners of private grazing lands. It offers opportunities for better land management, erosion reduction, water conservation, wildlife habitat, and improving soil structure.
- Environmental Quality Incentives Program (EQIP) - EQIP provides a voluntary conservation program for farmers and ranchers to address threats to soil, water, and related natural resources. It offers 5- to 10-year contracts that provide incentive payments and cost-sharing for conservation practices called for in the site-specific plan. NRCS conducts an evaluation of the environmental benefits the producer offers, and funding is approved for the highest-priority applications first. Cost sharing may pay up to 75 percent of the costs of certain conservation practices, such as grassed waterways, filter strips, and other practices important to improving and maintaining the health of natural resources in the area.
- National Conservation Buffer Initiatives - The National Conservation Buffer Initiative plans to install 2 million miles of conservation buffers nationwide by the year 2000. This initiative does not specifically target streamside areas for buffers, but it includes buffers between fields, wind breaks, and a variety of other practices.
- Resource Conservation and Development (RC&D) - The RC&D is a program for landowner associations and interest groups that allocates grants to RC&D areas to accelerate resource protection projects and programs in multicounty areas as a base for economic development and environmental protection.
- Swampbuster - The Swampbuster program is a provision of the Food Security Act of 1985. It discourages the draining, filling, and other alteration of wetlands for agricultural uses

through financial disincentives. The NRCS determines compliance with Swampbuster provisions and assists farmers in identifying wetlands and developing wetland protection, restoration, and creation plans.

- Wetlands Reserve Program (WRP) - The WRP is a voluntary USDA program offering landowners a chance to receive payments for restoring and protecting wetlands. Authorized by the Food Security Act of 1985, the WRP provides a unique opportunity for farmers to retire marginal lands through permanent easements, 30-year easements, or restoration cost-share agreements and reap the many benefits of having wetlands on their property.
- Wildlife Habitat Incentives Program (WHIP) - WHIP is a voluntary program for people who want to develop and improve wildlife habitat on private lands. The USDA provides both technical assistance and cost-share incentives to help establish and improve fish and wildlife habitat. Participants who own or control land agree to prepare and implement a wildlife habitat development plan.

For more information on the NRCS programs, contact:
U.S. Department of Agriculture
Natural Resources Conservation Service
14th and Independence Avenues, SW
Washington, DC 20250
Phone: (202) 720-4525
Web sites: http://www.nrcs.usda.gov/
http://www.nrcs.usda.gov/programs/farmbill/2002/

United States Department of The Interior

The mission of the United States Department of the Interior (DOI) is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American people.

The **Bureau of Reclamation** (Reclamation) is an agency within the DOI whose mission is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public. Reclamation operates and manages dams and reservoirs throughout the western United States for irrigation, hydroelectricity, municipal and industrial water supply, fish and wildlife, and recreation uses.

- Reclamation's Wetland Development Program restores, enhances, and develops wetlands, riparian habitat, and associated habitats on Reclamation lands and on lands associated with water supplies and systems affected by Reclamation projects. The program aims to improve water quality and habitat for wildlife at Reclamation projects and to support the North American Waterfowl Management Plan and other migratory bird initiatives. Although not required, almost every project involves partnership development and cost-sharing with federal and non-federal entities. Recent collaborative projects include restoration of the 300-acre Alpine wetland on the Idaho-Wyoming border, restoration of the 8,000-acre Rincon Bayou-Nueces estuary on the Texas Gulf Coast, development of wetlands to improve waste-water and provide habitat for endangered species in Arizona and Nevada, restoration of vernal pools and habitat for endangered species in California, development and restoration of wetlands in the Devils Lake basin in North Dakota to attenuate runoff and reduce high lake levels in Devils Lake, restoring wetlands and water control structures on national wildlife refuges and water-fowl management areas, and working with irrigation districts to develop wetlands to improve the quality of return flows.
- Reclamation partnerships with the National Fish and Wildlife Foundation have funded wetland restoration and development projects

for fish and wildlife throughout the western United States. Funds have been provided to restore wetlands in Oklahoma for migratory birds, develop wetlands for endangered species in Nevada, and stabilize channel morphology and restore riparian habitat to improve water quality in Montana.

- The DOI's National Irrigation Water Quality Program was established in 1986 to develop coordinated remediation plans with appropriate federal, state, and local entities to implement corrective actions where irrigation drainage from federal irrigation projects has affected endangered species or migratory birds or created water quality problems from naturally occurring sources. Reclamation is responsible for program management. The U.S. Geological Survey, Fish and Wildlife Service, and Bureau of Indian Affairs work cooperatively with Reclamation on program oversight and technical issues.

For more information, contact:
Department of the Interior
Bureau of Reclamation, Public Affairs
1849 C Street, NW

Main Interior Building
Washington, DC 20240
Phone: (202) 513-0575
Web Site: http://www.usbr.gov/

National Park Service (NPS) was created to promote and regulate the use of national parks to conserve scenery and the natural and historic resources within them to serve for enjoyment today and in the future.

- The Rivers, Trails, and Conservation Assistance Program (RTCA) is a program that works in partnership with project cooperators to help them obtain funding for their projects. Several projects have some focus on wetland protection and restoration. Examples of such programs include the protection of 2,500 acres of wetlands in the upper Des Plaines River Macrosite (Illinois and Wisconsin) and the rehabilitation of habitat of wetlands in the Missouri River Corridor (Kansas, Nebraska, and Iowa).

For more information on NPS projects, contact:
U.S. Department of the Interior
National Park Service
1849 C Street, NW
Washington, DC 20240
Phone: (202) 208-6843
Web site: http://www.nps.gov/

United States Fish and Wildlife Service (USFWS) is the principal federal agency responsible for conserving, protecting, and enhancing certain fish and wildlife and their habitats, in particular migratory game and endangered species. Among other roles, the USFWS administers the federal Endangered Species Act and establishes and maintains a system of more than 500 National Wildlife Refuges nationwide. The USFWS also manages the taking of migratory waterfowl and conducts research and monitoring programs to inventory and record changes in populations of fish and wildlife and in habitats.

- Challenge Cost Share Program - The USFWS designed this program to manage, restore, and enhance fish and wildlife resources and natural habitats on public and private lands. The program is a partnership with non-federal public and private institutions, organizations, and individuals. Challenge Cost Share allows the USFWS to provide matching funds for projects that support the management, restoration, and protection of natural resources on more than 500 National Wildlife Refuges, 70 fish hatcheries, research facilities, and private lands.

- The National Coastal Wetlands Conservation Grant Program was founded with the enactment of the Coastal Wetlands Planning, Protection, and Restoration Act (Title III of P.L. 101-646) in 1990. The program allows the USFWS to work directly with states to acquire, restore, manage, or enhance coastal wetlands through a matching grants program. Louisiana is the only coastal state that is not eligible for grant monies because that state has its own coastal wetland program under the act. The program has awarded $53 million to 24 states and one territory, allowing more than 63,000 acres of coastal wetlands to be acquired, protected, or restored.
- The Small Wetlands Acquisition Program (SWAP) was created by the Migratory Bird Hunting Stamp Act to preserve wetlands and increase waterfowl production. The primary focus of the program is on the Prairie Pothole Region of the United States (Montana, North Dakota, South Dakota, Iowa, and Minnesota). Prairie potholes are freshwater depressions, usually less than 2 feet deep and smaller than 1 acre, that were carved by glaciers. Since 1989 more than 23,000 easements on 1.2 million acres of wetlands have been obtained by the USFWS to protect these areas.
- Conservation Easement Debt Cancellation Program - The Consolidated Farm Service Agency (CFSA) allows for reduction of Farmer's Home Administration (FmHA) borrower debt in exchange for granting conservation easements for valuable habitat, including wetlands, on their property for a period of not less than 50 years. Wetlands placed in easements by farmers for FmHA debt reduction may be managed by the USFWS. FmHA has become part of the CFSA; therefore, CFSA now manages FmHA loans.
- The North American Wetlands Conservation Act (NAWCA), established in 1989, encourages partnerships among public agencies and other interests in the United States, Canada, and Mexico to (1) protect, enhance, restore, and manage wetland ecosystems and other habitats for migratory birds, fish, and wildlife in North America; (2) maintain current or improved distribution of migratory bird populations; and (3) sustain an abundance of waterfowl and other migratory birds consistent with the goals of the North American Waterfowl Management Plan and international treaty obligations.
- The North American Waterfowl Management Plan (NAWMP) was signed in 1986 between the United States and Canada to protect, restore, and enhance wetlands important to waterfowl and other wetland-dependent bird species. Mexico has recently signed the NAWMP as well. The NAWMP's primary objective is to return waterfowl populations to levels observed in the 1970s, when fall flights exceeded 80 million ducks. The plan is implemented at the grassroots level by partnerships called joint ventures. Wetlands identified under NAWMP as "areas of major concern" for waterfowl habitat (e.g., migration, nesting, and forage areas) are targets for these joint ventures.

Examples of NAWMP projects include the Gulf Coast Joint Venture, which focuses on perpetuating healthy wintering grounds for migrating waterfowl and other birds and wildlife species along the Gulf Coast from Alabama to Texas, and the Lower Mississippi Valley Joint Venture, covering 22 million acres in 10 Delta states. Its target is the enhancement of wetlands on private lands. In California, there are three joint ventures: the Central Valley Habitat Joint Venture (1988), the Pacific Coast Joint Venture (1994), and the Intermountain West Joint Venture (1994). A fourth, covering the southern region of the state, is being planned.

Partners *for* Fish and Wildlife

The **Partners for Fish and Wildlife Program** (PFFW), also known as the Private Lands Assistance and Restoration Program, offers technical and cost-share assistance to landowners who wish to restore wildlife habitat, including degraded or converted wetlands and those upland habitats that meet specific eligibility criteria. The objectives of PFFW programs, which operate in all 50 states, are to restore, enhance, and manage wetlands for fish and wildlife habitat; promote profitable land use for agriculture, industry, and private landowners; and promote a wise and lasting land-use ethic. Formerly known as the Partners for Wildlife Program (PFW), the USFWS will enter into agreements with private landowners for the restoration, creation, and enhancement of wetlands and associated habitats. The PWF and PFFW have protected almost 1 million acres of wetlands and other habitats since 1987.

- The Montana PFFW has focused on five areas for restoration projects: Northern Continental Divide Ecosystem, the Rocky Mountain Front, Beaver Creek Prairie Pothole Joint Venture, and Centennial and Big Hole Valleys. Under these projects, Montana PFFW has worked with the Montana Department of Fish, Wildlife and Parks, Ducks Unlimited, Pheasants Forever, and the Flathead Indian Reservation to restore wetlands, fence riparian areas, and manage livestock.
- In South Dakota, 1,879 landowners are participating in the program (as of 1997).
- The Prairie Wetlands Project (PWP) was designed to accomplish the goals and objectives of the Gulf Coast Joint Venture (GCJV); the PWP is a partnership effort to restore, create, or enhance wetlands beneficial for waterfowl and other wildlife use. PWP projects include management of water on cropped lands, restoration of converted wetlands, enhancement of natural wetlands, or creation of wetlands on non-wetland sites. The PWP is a FWS partnership effort to restore, create, or enhance wetlands beneficial for waterfowl and other wildlife. In exchange for financial and technical incentives, landowners develop a management plan, which may include management of water on cropped lands, restoration of converted wetlands, enhancement of natural wetlands, or creation of wetlands on non-wetland sites. Cost-share assistance of up to 75 percent is available.

For more information on the USFWS programs, contact:
U.S. Department of the Interior
Fish and Wildlife Service, Division of Federal Aid
Arlington Square, Room 140
4401 North Fairfax Drive
Arlington, VA 22203
Phone: (703) 358-2156
Fax: (703) 358-1837
Web site: http://www.fws.gov/

For information specific to the Coastal Habitat Conservation Program, contact USFWS':
Division of Habitat Conservation
4401 N. Fairfax Drive Room 400
Arlington, VA 22203
Phone: (703) 358-2201
Fax: (703) 358-2232
Web site: http://www.fws.gov/coastal/coastalgrants

The **United States Geological Survey** (USGS) provides the nation with reliable, impartial information to describe and understand the earth.

- The National Wetlands Research Center (NWRC) was established by USGS to develop and disseminate scientific information needed for understanding the ecology and values of the nation's wetlands and for managing and restoring wetland habitats and associated plant and animal communities. The Water Quality Incentives Program (WQIP) is a voluntary incentive program designed to protect water sources on farmlands through 3- to 5-year agreements with the CFSA. These agreements require the development and implementation of a water quality management program that provides water quality benefits, wetland protection, and wildlife benefits. The Wetland Ecology Branch of the NWRC conducts research related to sustainable management and restoration of the nation's coastal saltwater wetlands, coastal and inland freshwater wetlands, submerged aquatic ecosystems, and coastal prairie.

For more information, contact:
U.S. Geological Survey
12201 Sunrise Valley Drive
Reston, VA 20192
Phone: (703) 648-4748
Web site: http://www.usgs.gov/

EPA

United States Environmental Protection Agency

The mission of the U.S. Environmental Protection Agency (EPA) is to protect human health and to safeguard the natural environment—air, water, and land—upon which life depends.

EPA is responsible for implementing federal laws designed to protect the nation's natural resources. This is done primarily through regulation, but EPA has also developed a wide variety of funding, planning, and education programs. EPA has the authority to regulate wetlands under section 404 of the Clean Water Act.

Under Section 319 of the Clean Water Act, EPA awards funds to states and eligible tribes to implement NPS management programs. These funds can be used for projects that include protection and restoration of wetlands and the development of vegetated treatment systems. More information about the Section 319 program is provided at *www.epa.gov/owow/nps/cwact.html*.

- EPA's Wetland State Partnership Grant Program provides money to states that encourage wetlands protection and restoration. For example, the Division of Natural Heritage of the Tennessee Department of Environment and Conservation received a $208,207 grant to encourage property owners to voluntarily enroll wetlands in state and federal wetland conservation and assistance programs; to work with state, county, and local governments to avoid or minimize impacts on wetlands; and to encourage voluntary wetland conservation in four of the state's counties: Fayette, Franklin, Lauderdale, and Rutherford.
- The 51 Clean Water State Revolving Funds (SRF) programs currently issue approximately $3 billion in loans annually. SRF loans are issued at below market rates (0 percent to less than market), offering borrowers significant savings over the life of the loan. Based on the serious threats to wetland resources across the country, EPA would like to see the SRF become a major source of funding for wetland protection. In creating the SRF, Congress ensured that it would be able to fund virtually any type of water quality project, including nonpoint source, wetlands, estuary, and other types of watershed projects, as well as more traditional municipal wastewater treatment systems. Today, the SRF provisions in the Clean Water Act give no more preference to one category or type of project than any other. Wetland projects typically fall under approved state nonpoint source management plans or are included in national estuary management plans. Constructed wetlands may be considered wastewater or stormwater management projects and are also eligible for funding. SRF-fundable projects include wetland restoration, wetland protection, and constructed wetlands.

For more information, contact your Clean Water State Revolving Fund Program or contact:
The Clean Water State Revolving Fund Branch
U.S. EPA
Ariel Rios Building
1200 Pennsylvania Ave., NW
Washington, DC 20460
Phone: (202) 260-7359
Web site: http://www.epa.gov/OWM

For more information on EPA's other wetlands programs, contact:
U.S. Environmental Protection Agency
OWOW, OW, Office of Wetlands
Phone: (800) 832-7828 (Monday through Friday from 9:00 am to 5:30 pm EST)
Web site: http://www.epa.gov/owow/wetlands/

State, Nonprofit, and Private Organizations

Alliance for the Chesapeake Bay

The Alliance for the Chesapeake Bay is a private, nonprofit organization that recruits and mobilizes broad participation in restoration of the bay's resources, public policy, and education by providing citizens with the information and opportunities to make a difference at home, in their communities, and on a regional basis.

- The Alliance was chosen to manage the Small Watershed Grants program, developed by the Chesapeake Bay Program. This program was allocated $750,000 by Congress for grants to local governments and watershed-based nonprofit groups in the Chesapeake Bay drainage basin. In 1998 more than 160 organizations applied for the grants, and 37 were chosen. The major criterion for selection was that the project must have tangible results showing bay or river improvement that includes community involvement.

For more information, contact:
Alliance for the Chesapeake Bay
6600 York Road, Suite 100
Baltimore, MD 21212
Phone: (410) 377-6270 (or call the Chesapeake Regional Information Service (800) 662-CRIS)
Web site: http://www.acb-online.org

American Farmland Trust

The American Farmland Trust (AFT) was established as a nonprofit organization that works with farmers, business people, legislators, and conservationists to encourage sound farming practices and preserve the country's most critical agricultural resources.

- The Farm Legacy Program of the AFT encourages farm owners threatened by development to donate their lands to AFT. By donating their land, the landowners may retain lifetime use of the property because the AFT sells the farm with conservation easements to guarantee the preservation of the property. The AFT also accepts nonfarm properties and appreciated securities.

For more information, contact:
American Farmland Trust National Office
1920 N Street, N.W., Suite 400
Washington, D.C. 20036
Phone: (202) 659-5170
Fax: (202) 659-8339
Web site: http://www.farmland.org

California Coastal Conservancy

The California Coastal Conservancy was established by the California legislature to protect, restore, and enhance coastal resources by working in partnership with local governments, other public agencies, nonprofit organizations, and private landowners.

The California Coastal Conservancy has done more than 700 projects along California's 1,110 mile coastline and San Francisco Bay. The goals of the California Coastal Conservancy include:

- Improving public access to the coast and bay shores.
- Protecting and enhancing coastal wetlands, steams, and watersheds.
- Restoring urban waterfronts for public use and coastal development.
- Resolving coastal land use conflicts.
- Acquiring and holding environmentally valuable coastal land.
- Protecting agricultural lands.

For more information, contact:
California Coastal Conservancy
1330 Broadway, 11th Floor
Oakland, CA 94612
Phone: (510) 286-1015
Fax: (510) 286-0470
Web site: http://www.coastalconservancy.ca.gov/

California Waterfowl Association

The California Waterfowl Association (CWA) is a nonprofit organization that preserves, protects, and enhances California's waterfowl and wetland resources. The CWA provides technical assistance to landowners, conducts research, and lobbies state and federal governments to promote protection of waterfowl and provision of habitat.

- The Waterfowl Programs seek increases in populations of waterfowl, especially mallards, pintails, wood ducks, and Canada geese.
- Under the California Waterfowl Habitat Program, CWA assists the California Department of Fish and Game in providing incentive funds and preparing detailed plans for habitat management on private lands.
- A nontraditional effort involving salvage of eggs from nests destroyed by agricultural operations is being closely monitored to determine if released ducklings can assist waterfowl population enhancement efforts.

For further information, contact:
California Waterfowl Association
4630 Northgate Boulevard, Suite 150
Sacramento, CA 95834
Phone: (916) 648-1406
Fax: (916) 648-1665
Web site: http://www.calwaterfowl.org/

Chesapeake Bay Foundation

The Chesapeake Bay Foundation (CBF) is a nonprofit organization whose mission is to restore and sustain the bay's ecosystem by substantially improving water quality and productivity of the watershed.

- Restoration programs by CBF are voluntary and include citizens, school groups, and corporate participants. Examples of wetland restoration projects include wetland plantings, wetland mapping, and educational activities.

For more information, contact:
162 Prince George Street
Annapolis, MD 21401
Phone: (410) 268-8816
Fax: (410) 268-6687
Web site: http://www.cbf.org

Chesapeake Bay Trust

The Chesapeake Bay Trust is a nonprofit organization that promotes public awareness and participation in the restoration and protection of the Chesapeake Bay.

- The Trust was created by the Maryland General Assembly in 1985.
- More than 1,000 communities, volunteer groups, and schools in Maryland have received grant money totaling $933,287 for habitat restoration, cleanups, and other bay resource-related projects.
- The Trust is supported by private citizens and the business community. The purchase of Chesapeake Bay license plates funds part of the Trust. In addition, taxpayers may make donations of their refund to the Trust.

For further information, contact:
Chesapeake Bay Trust
60 West Street, Suite 200A
Annapolis, MD 21401
Phone: (410) 974-2941
Fax: (410) 269-0378
Web site: http://www.chesapeakebaytrust.org

Ducks Unlimited

Ducks Unlimited (DU) is a private, nonprofit organization that works to help fulfill annual life cycle needs of waterfowl by protecting, enhancing, restoring, and managing important wetland and associated upland habitat throughout the states.

- DU cost-shares in the improvement of habitat through the Matching Aid to Restore States' Habitat (MARSH) Program. This reimbursement program provides matching funds for wetland acquisition and development.
- Habitat 2000: Campaign for a Continent - This is DU's six year comprehensive campaign to ensure a future for North America's wetlands and waterfowl. The program's goal is to restore 1.7 million acres of wetland and upland habitat by raising $600 million.

For further information, contact:
Ducks Unlimited National Headquarters
One Waterfowl Way
Memphis, TN 38120-2351
Phone: (901) 758-3825 or (800) 45-DUCKS
Web site: http://www.ducks.org

Great Plains Partnership

Spanning the 13 Great Plains states and the corresponding regions of Canada and Mexico, the Great Plains Partnership (GPP) is an outcome-oriented partnership composed of federal, state, and local agencies, tribes, nongovernmental organizations, and landowners. Its mission is to catalyze and empower the people of the Great Plains to define and create their own generational sustainable future.

- The GPP provides technical assistance and help in overcoming institutional and regulatory hurdles that local partnerships cannot resolve on their own.
- Sandhills (NE) - Ranchers in the Sandhills of Nebraska have been working with a local coordinator from the USFWS to preserve and restore wetlands areas that are important for hay meadows and fens, which are globally unique natural communities. Their coalition has grown to include representatives from other state and federal agencies. Their work provides an important example of successful cooperation.
- Rainwater Basin (NE) - The Rainwater Basin is a North American Waterfowl Management Plan Joint Venture in Nebraska to restore wetlands for migratory birds. GPP will test the use of a newly developed model that classifies wetland by functional value, in order to foster an alternative compliance strategy that allows farmers to develop a wetland restoration program through wetlands banking and trades to protect both the most valuable wetlands and croplands. Regulatory agencies, which will have to suspend current regulations, will be important partners and will oversee that the results equal or exceed those achievable through normal enforcement.

For more information, contact:
Great Plains Partnership
Web site: http://www.npwrc.usgs.gov

Illinois Wetlands Conservation Strategy

The Illinois Wetlands Conservation Strategy (IWCS) is a comprehensive plan to guide the development and implementation of Illinois's wetland programs and protection initiatives. It is an organizational tool used to identify opportunities for making programs work better. The goal of the IWCS is to ensure that there will be no net loss of wetlands or their functions in Illinois.

For further information, contact:
Illinois Wetlands Conservation Strategy
15536 Sr. 78
Havana, IL 62644
Web site: http://www.inhs.uiuc.edu/chf/pub/surveyreports/jul-aug95/wetland.html

Iowa River Corridor Project

The Iowa River Corridor Project uses a voluntary approach to wetland restoration by giving landowners economic alternatives for frequently flooded farmland, and the project is intended to improve water quality and wildlife habitat. It is sponsored by the Iowa NRCS. The farmers can choose to continue farming as they have, sell an easement and have a wetland restored, sell an easement and title to the USFWS, or try some alternative farming practices.

For further information, contact:
Iowa River Corridor Project
Web site: http://www.fws.gov/midwest/IowaRiverCorridor/

Izaac Walton League of America

The mission of the Izaac Walton League of America (IWLA) is to protect the nation's soil, air, woods, waters, and wildlife.

- The Wetlands Conservation and Sustainability Project, part of the Save Our Streams Program, helps bring citizens, planners, government agencies, businesses, and others together to become wetland stewards by taking a proactive role in wetland conservation and protection. The IWLA has lobbied at the national level to create and protect wetland legislation, and League members have worked for wetland protection and restoration through 350 local chapters nationwide.

For further information, contact:
Izaac Walton League of America National Office
707 Conservation Lane
Gaithersburg, MD 20878
Phone: (301) 548-0150
Fax: (301) 548-0146
Web site: http://www.iwla.org

Land Trust Alliance

The Land Trust Alliance supports conservation in communities across the country by ensuring that people who work through voluntary land trust organizations have the information, skills, and resources they need to save land.

- Land trusts are used to acquire land and then either transfer it to a governmental agency or retain it for long-term ownership and stewardship.
- Conservation easements are the principle tool used by most land trusts to achieve their land conservation objectives.
- There are currently more than 1,100 land trusts in America, including many for wetlands.

For more information, contact:
Land Trust Alliance
1319 F Street, NW, Suite 501
Washington, DC 20004
Phone: (202) 638-4725
Fax: (202) 638-4730
Web site: http://www.lta.org/

Michigan Wildlife Conservancy

The Michigan Wildlife Conservancy provides technical and financial assistance that landowners and managers need to restore and maintain wildlife habitat through cost-effective projects.

For more information, contact:
Michigan Wildlife Habitat Conservancy
Web site: http://www.miwildlife.org

National Audubon Society

The mission of the National Audubon Society (NAS) is to conserve and restore natural ecosystems, focusing on birds and other wildlife for the benefit of humanity and the earth's biological diversity.

- One of the high-priority campaigns of the NAS is to preserve wetlands. The goal of the Wetlands Campaign is to preserve and restore the nation's wetland ecosystems through a partnership of Audubon volunteer leaders, staff, and directors to protect birds, other wildlife, and their habitats, as well as to protect human health and safety and to sustain a healthy economy. The campaign includes a community-based effort to protect and restore 1,000,000 wetland acres within 3 years, establishment of strong wetland protection and restoration laws, creation of a network of thousands of Audubon volunteers and chapters, working together to promote sound measures to manage and protect wetland ecosystems, and public communication and education.

For more information, contact:
National Audubon Society
700 Broadway
New York, NY 10003
Phone: (212) 979-3000
Web site: http://www.audubon.org/

National Fish and Wildlife Foundation

The National Fish and Wildlife Foundation (NFWF) is a nonprofit organization established by Congress in 1984 to foster cooperative efforts to conserve fish, wildlife, and plant species. Its mission is to provide creative and sustainable solutions for fish and wildlife, and plant conservation. All NFWF grants are a two-to-one match (non-federal to federal), and the match must be derived from a source other than the applicant.

NFWF projects include education projects about fish, wildlife, plants, and habitats for schoolchildren, higher education institutions, and professionals. The organization is involved in fisheries conservation and management, neotropical migratory bird conservation, wetlands and private lands, and wildlife and habitat.

For more information, contact:
National Fish and Wildlife Foundation
1120 Connecticut Avenue, NW, Suite 900
Washington, DC 20036
Phone: (202) 857-0166
Fax: (202) 857-0162
Web site: http://www.nfwf.org

National Wildlife Federation

The mission of the National Wildlife Federation (NWF) is to educate, inspire, and assist individuals and organizations of diverse cultures to conserve wildlife and other natural resources and to protect the earth's environment in order to achieve a peaceful, equitable, and sustainable future.

The NWF's main goal is to raise awareness and involve people of all ages in their fight to conserve and protect the environment.

For further information, contact:
National Wildlife Federation
8925 Leesburg Pike
Vienna, VA 22184
Phone: (703) 790-4000
Web site: http://www.nwf.org

National Wetlands Conservation Alliance

The National Wetlands Conservation Alliance is an informal partnership of private organizations and government agencies working to build broad support for and to improve the delivery of voluntary landowner wetlands restoration, enhancement, and conservation.

- The organization's vision is to become informed landowners voluntarily deciding to protect and manage existing wetlands and restore and enhanced drained and partially drained wetlands.
- Funding and program guidance are provided by participating organizations and government agencies and the National Association of Conservation Districts.
- A major emphasis of the organization is to support and improve USDA's Wetland Reserve Program, Conservation Reserve Program, and other "Farm Bill" programs, and the Fish and Wildlife Service's Partners for Wildlife and North American Waterfowl Management Plan programs.

For further information, contact:
National Wetlands Conservation Alliance
509 Capitol Court, NE
Washington, DC 20002-4946
Phone: (202) 547-6223
Fax: (202) 547-6450
Web site: http://www.erols.com/wetlandg

Nebraska Environmental Trust

The Nebraska Environmental Trust Fund was organized in 1992 as a means to raise money for Nebraska's environment. What is unique about this program is that it is funded by the Nebraska Lottery. The public is also involved in the state's environment because the fund is administered by a governor-appointed board of nine citizens and six state agency representatives.

- One of the major focuses of the trust fund is the preservation and restoration of wetlands and other areas critical to rare or endangered species.
- Applicants that receive grant money must meet economic, technical, and financial feasibility criteria and show that the public benefits of the proposed project will be as apparent as the environmental benefits.

For more information, contact:
Nebraska Environmental Trust Fund
2200 North 33rd Street, P.O. Box 3070
Lincoln, NE 68503-0370
Phone: (402) 471-5409
Web site: http://www.environmentaltrust.org

Operation Green Stripe

Operation Green Stripe was developed in 1992 to combat the problem of surface water runoff of soil sediment by encouraging the planting of grassy buffer strips along streams, lakes, and sinkholes on farm property.

- Through Operation Green Stripe, Future Farmers of America (FFA) chapters recruit farmers to establish vegetative buffers between their fields and surface water supplies. Cooperating agriculture retailers provide free grass seed for the strips, and Monsanto provides educational grants to FFA chapters based on the number of farmers the students recruit.

For further information, contact:
Monsanto Company
800 North Lindbergh Boulevard
St. Louis, MO 63167
Phone: (314) 694-2789
Fax: (314) 694-2922
Web site: http://www.monsanto.com

Pheasants Forever

Pheasants Forever (PF) is a nonprofit wildlife conservation group whose mission is to protect and enhance pheasant and other wildlife populations throughout North America through public awareness and education, habitat restoration, development and maintenance, and improvements in land and water management policies. Local PF chapters work with private landowners to provide for the creation and enhancement of wildlife habitat.

- Since its establishment, PF has spent more than $24 million on habitat restoration projects on 850,000 acres of land. These projects restore habitat by renovating nesting cover, planting windbreaks and hedgerows, establishing food plots, restoring wetlands, and acquiring lands.

For further information, contact:
Pheasants Forever National Headquarters
1783 Buerkle Circle
St. Paul, MN 55110
Phone: (612) 773-2000
Fax: (612) 773-5500
Web site: http://www.pheasantsforever.org

Public Service Electric & Gas Co.

The Public Service Electric & Gas Co. (PSE&G) is a leader in providing energy-efficient services and developing environmentally sound energy systems to improve the social, economic, and environmental standards of society.

- PSE&G is conducting the Estuary Enhancement Program (EEP) under the New Jersey Department of Environmental Protection and the Delaware Department of Natural Resources and Environmental Control. Of the land slated for restoration, 12,500 acres are in New Jersey, and 8,000 are in Delaware. Nearly 17,000 acres are going to be restored as salt marshes, creating the largest endeavor of its kind. PSE&G purchased land and made agreements with landowners to gain access to land.

For more information, contact:
Public Service Enterprise Group (PSE&G)
Englewood, NJ 07631
Phone: 800-350-PSEG
Web site: http://www.pseg.com

Quail Unlimited

Quail Unlimited is a nonprofit organization that was established in 1981 to improve and preserve upland game habitat. It has more than 400 chapters. QU funds are used for local habitat and education projects, state wildlife departments, upland game bird management, habitat research, and education programs.

- One of QU's habitat improvement initiatives is to create water sites in arid and semiarid areas for quail habitat. Much of the water site development work is performed in cooperation with the Forest Service and the Bureau of Land Management under cost-share agreements.

For further information, contact:
Quail Unlimited National Headquarters
P.O. Box 610
Edgefield, SC 29824
Phone: (803) 637-5731, ext. 28
Web site: http://www.qu.org

Restore America's Estuaries

Restore America's Estuaries (RAE) is a nonprofit coalition of community-based organizations working to save coastal resources. Its mission is to protect and restore coastal areas by increasing awareness and appreciation of the resources and leading a campaign to restore 1 million acres of estuarine habitat (including wetlands) by the year 2010.

- RAE's 11 members are American Littoral Society (Hudson-Raritan estuaries of New York and New Jersey), Chesapeake Bay Foundation, Coalition to Restore Coastal Louisiana, Conservation Law Foundation (Gulf of Maine), Galveston Bay Foundation; North Carolina Coastal Federation, North Carolina Coastal Federation, People for Puget Sound, Save San Francisco Bay Association; Save the Bay (Narragansett Bay), Save the Sound (Long Island Sound), and Tampa BAYWATCH.
- Estuary habitat restoration includes maintaining food supplies for aquatic life, creating and protecting jobs that rely on estuaries (fishing, tourism, boating), protecting human health, expanding recreational abilities, enhancing quality of life, and education.

For more information, contact:
Restore America's Estuaries
1200 New York Avenue, N.W.
Suite 400
Washington, DC 20005
Phone: (202) 289-2380
Fax: (202) 842-4932
Web site: http://www.estuaries.org

Sierra Club

The Sierra Club is a nonprofit organization that promotes conservation of the natural environment by influencing public policy decisions.

More information about wetlands is available from the Sierra Club's wetlands website at http://www.sierraclub.org/wetlands

For information on the Sierra Club, contact:
Sierra Club
85 Second Street, Second Floor
San Francisco, CA 94105-3441
Phone: (415) 977-5500
Fax: (415) 977-5799
Web site: http://www.sierraclub.org/

The Tahoe Conservancy

The Tahoe Conservancy, a California agency, is charged with preserving and enhancing the unique ecological and recreational values of the Tahoe basin through the Tahoe Conservancy Program. Its primary objectives goals are to protect the natural environment of the basin, to increase public access and recreation opportunities for visitors to the lake, and to preserve and enhance the broad diversity of wildlife habitat in the Tahoe Basin.

- The Conservancy's work with private owners of wetland property comes primarily through its acquisition program. It focuses on obtaining conservation easements, development rights, and full titles to lands that contain marsh, meadow, or riparian areas. The Conservancy offers 95 percent of what property would bring on the open market.

For further information, contact:
The Tahoe Conservancy
2161 Lake Tahoe Boulevard
South Lake Tahoe, CA 96150
Phone: (916) 542-5580
Fax: (916) 542-5591
Web site: http://www.tahoecons.ca.gov/

The Nature Conservancy

The Nature Conservancy's (TNC) mission is to preserve plants, animals, and natural communities that represent the diversity of life on earth by protecting the lands and water they need to survive.

- The Natural Areas Registries program of the TNC honors private landowners of outstanding natural areas for their commitment to the survival of the land's natural heritage. The registry is voluntary, and no payment is involved.

For more information, contact:
The Nature Conservancy, International Headquarters
1815 North Lynn Street
Arlington, VA 22209
Phone: (703) 841-5300
Web site: http://nature.org

Trout Unlimited

Trout Unlimited (TU) is an organization of conservation-minded anglers who promote quality trout and salmon fisheries for their intrinsic values, as well as a reminder of watershed health. TU conserves, protects, and restores North America's trout and salmon fisheries and their watersheds. This is accomplished on the local, state, and national level.

For more information, contact:
Trout Unlimited
1500 Wilson Boulevard, Suite 310
Arlington, VA 22209-2404
Phone: (703) 522-0200
Fax: (703) 284-9400
Web site: http://www.tu.org

Wetland Habitat Alliance of Texas

The Wetland Habitat Alliance of Texas (WHAT) is an organization dedicated to preserving Texas wetlands by raising public awareness and appreciation of wetlands and funding projects to manage wetland waters; protect, enhance, and restore natural wetlands; and create wetlands on non-wetland sites.

- The cooperator and WHAT agree to a proposed project, and NRCS verifies the operable conditions before the project is approved. Interested landowners can receive up to 100 percent financial assistance for a 10-year minimum agreement.

For more information, contact:
Wetland Habitat Alliance of Texas
118 East Hospital, Suite 208
Nachodoches, TX 75961
Phone: (409) 569-9428 or (800) 962-WHAT
Web site: http://www.whatduck.org/homepage.htm

Wildlife Habitat Council

The Wildlife Habitat Council seeks to increase the quality of wildlife habitat on corporate, private, and public lands.

- WHC's Corporate Wildlife Habitat Certification/International Accreditation Program recognizes corporate properties with meaningful wildlife habitat management programs, including environmental education programs. Certification through WHC provides third-party credibility and an objective evaluation of projects.
- WHC builds cooperative ventures between corporate, private, government, and conservation communities to improve and manage habitat along river corridors and watersheds.
- Under its Wastelands to Wetlands program, WHC reclaims sites considered unsalvageable for wildlife habitat.

For further information, contact:
Wildlife Habitat Council
1010 Wayne Avenue, Suite 920
Silver Spring, MD 20910
Phone: (301) 588-8994
Fax: (301) 588-4629
Web site: http://www.wildlifehc.org/

Appendix B
U.S. Environmental Protection Agency Contacts

This appendix provides wetlands contacts, nonpoint source regional contacts, and Clean Water State Revolving Fund Contacts.

U.S. Environmental Protection Agency Contacts

EPA is grouped into 10 Regions. For questions about a particular state, contact the appropriate EPA Regional Coordinator listed below.

EPA Region	Wetland Contact	Nonpoint Source Regional Coordinators	Clean Water State Revolving Fund Regional Coordinators
Region 1: CT, MA, ME, NH, RI, VT http://www.epa.gov/region01/	U.S. EPA-Region 1 Wetlands Protection Unit One Congress Street Boston, MA 02114-2023 http://www.epa.gov/region01/topics/ecosystems/wetlands.html	U.S. EPA-Region 1 Nonpoint Source Coordinator One Congress Street, Boston, MA 02114-2023 http://www.epa.gov/region01/topics/water/npsources.html	U.S. EPA-Region 1 SRF Program Contact One Congress Street Boston, MA 02114-2023 http://www.epa.gov/ne/cwsrf/index.html
Region 2: NJ, NY, PR, VI http://www.epa.gov/Region2	U.S. EPA-Region 2 Water Programs Branch Wetlands Section 290 Broadway New York, NY 10007-1866 http://www.epa.gov/region02/water/wetlands/	U.S. EPA-Region 2 Water Programs Branch Nonpoint Source Coordinator 290 Broadway New York, NY 10007-1866 http://www.epa.gov/region02/water/npspage.htm	U.S. EPA-Region 2 Water Programs Branch SRF Program Contact 290 Broadway New York, NY 10007-1866 http://www.epa.gov/Region2/water/wpb/staterev.htm
Region 3: DC, DE, MD, PA, VA, WV http://www.epa.gov/region03	U.S. EPA-Region 3 Wetlands Protection Section 1650 Arch Street (3WP12) Philadelphia, PA 19103 http://www.epa.gov/reg3esd1/hydricsoils/index.htm	U.S. EPA-Region 3 Nonpoint Source Coordinator 1650 Arch Street (3WP12) Philadelphia, PA 19103 http://www.epa.gov/reg3wapd/nps/	U.S. EPA-Region 3 Construction Grants Branch SRF Program Contact 1650 Arch Street (3WP12) Philadelphia, PA 19103 http://www.epa.gov/reg3wapd/srf/index.htm
Region 4: AL, FL, GA, KY, MS, NC, SC, TN http://www.epa.gov/region4/	U.S. EPA-Region 4 Wetlands Section 61 Forsyth Street, SW Atlanta, GA 30303 http://www.epa.gov/region4/water/wetlands/	U.S. EPA-Region 4 Nonpoint Source Coordinator 61 Forsyth Street, SW Atlanta, GA 30303 http://www.epa.gov/region4/water/nps/	U.S. EPA-Region 4 Surface Water Permits & Facilities SRF Program Contact 61 Forsyth St. Atlanta GA, 30303 http://www.epa.gov/Region4/water/gtas/grantprograms.html
Region 5: IL, IN, MI, MN, OH, WI http://www.epa.gov/region5/	U.S. EPA-Region 5 Watersheds and Wetlands Water Division (W-15J) 77 West Jackson Blvd. Chicago, IL 60604 http://www.epa.gov/region5/water/wshednps/topic_wetlands.htm	U.S. EPA-Region 5 Nonpoint Source Coordinator Water Division (W-15J) 77 West Jackson Blvd. Chicago, IL 60604 http://www.epa.gov/region5/water/wshednps/topic_nps.htm	U.S. EPA-Region 5 SRF Program Contact Water Division (W-15J) 77 West Jackson Blvd. Chicago, IL 60604 http://www.epa.gov/region5/business/fs-cwsrf.htm

EPA Region	Wetland Contact	Nonpoint Source Regional Coordinators	Clean Water State Revolving Fund Regional Coordinators
Region 6: AR, LA, NM, OK, TX http://www.epa.gov/region6	U.S. EPA-Region 6 Marine and Wetlands Section 1445 Ross Ave., Suite 1200 Dallas, TX 75202 http://www.epa.gov/region6/water/ecopro/index.htm	U.S. EPA-Region 6 Nonpoint Source Coordinator 1445 Ross Ave., Suite 1200 Dallas, TX 75202 http://www.epa.gov/region6/water/ecopro/watershd/nonpoint/	U.S. EPA-Region 6 SRF Program Contact 1445 Ross Ave., Suite 1200 Dallas, TX 75202 http://www.epa.gov/Arkansas/6en/xp/enxp2c4.htm
Region 7: IA, KS, MO, NE http://www.epa.gov/region7	U.S. EPA-Region 7 Wetlands Protection Section (ENRV) 901 N. 5th St. Kansas City, KS 66101 http://www.epa.gov/region7/wetlands/index.htm	U.S. EPA-Region 7 Nonpoint Source Coordinator 901 N. 5th St. Kansas City, KS 66101	U.S. EPA-Region 7 SRF Program Contact 901 N. 5th St. Kansas City, KS 66101 http://www.epa.gov/Region7/water/srf.htm
Region 8: CO, MT, ND, SD, UT, WY http://www.epa.gov/region8	U.S. EPA-Region 8 Wetlands Program 999 18th Street, Suite 500 Denver, CO 80202-2405 http://www.epa.gov/region8/water/wetlands/wetlands.html	U.S. EPA-Region 8 Nonpoint Source Coordinator 999 18th Street, Suite 300 Denver, CO 80202-2405 http://www.epa.gov/region8/water/nps/contacts.html	U.S. EPA-Region 8 SRF Program Contact 999 18th Street, Suite 300 Denver, CO 80202-2405
Region 9: AZ, CA, HI, NV, Pacific Islands http://www.epa.gov/region9/	U.S. EPA-Region 9 Water Division, Wetlands 75 Hawthorne Street San Francisco, CA 94105 http://www.epa.gov/region09/water/wetlands/index.html	U.S. EPA-Region 9 Nonpoint Source Coordinator 75 Hawthorne Street San Francisco, CA 94105 http://www.epa.gov/region09/water/nonpoint/index.html	U.S. EPA-Region 9 Construction Grants Branch SRF Program Contact 75 Hawthorne Street San Francisco, CA 94105 http://www.epa.gov/region9/funding/
Region 10: AK, ID, OR, WA http://www.epa.gov/region10/	U.S. EPA-Region 10 Wetlands Section 1200 Sixth Ave. Seattle, WA 98101 http://yosemite.epa.gov/R10/ECOCOMM.NSF/webpage/Wetlands	U.S. EPA-Region 10 Nonpoint Source Coordinator 1200 Sixth Ave. Seattle, WA 98101	U.S. EPA-Region 10 Ecosystems & Communities SRF Program Contact 1200 Sixth Ave. Seattle, WA 98101 http://yosemite.epa.gov/r10/ecocomm.nsf/webpage/Clean+Water+State+Revolving+Fund+in+Region+10
General Program Information	U.S. EPA Wetlands Division (4502F) Mail Code RC-4100T 1200 Pennsylvania Ave., NW Washington, DC 20460 http://www.epa.gov/owow/wetlands/	U.S. EPA Nonpoint Source Control Branch (4503-T) Ariel Rios Bldg. 1200 Pennsylvania Ave., NW Washington, DC 20460 http://www.epa.gov/owow/nps	U.S. EPA The Clean Water State Revolving Fund Branch (4204M) 1201 Constitution Ave., NW Washington, DC 20004 http://www.epa.gov/owm/cwfinance/cwsrf/index.htm

Wetlands Helpline

For general questions about wetlands and questions about the national wetlands program, call the EPA Wetlands Helpline at 1-800-832-7828 or send an e-mail to <wetlands.helpline@epa.gov>.

Appendix C
U.S. Army Corps of Engineers Wetland Contacts

This appendix provides information on Division Regulatory Offices and District Regulatory Offices for the U.S. Army Corps of Engineers.

US Army Corps
of Engineers

U.S. Army Corps of Engineers Wetland Contacts (Civil Works – Regulatory Office)

Headquarters Regulatory Office:

U.S. Army Corps of Engineers
Office of the Chief of Engineers
20 Massachusetts Ave., NW
Washington, DC 20314-1000
Phone: 202-761-0200
Fax: 202-761-5096

Division and District Offices:

Great Lakes and Ohio River Division
CELRD-ET-CO-F
550 Main Street
Cincinnati, OH 45201-1159
Phone: 513-684-6212
Fax: 513-684-2460

Mississippi Valley Division
CEMVD-ET-CO
1400 West Walnut Street
Vicksburg, MS 39181
Phone: 601-634-5821
Fax: 601-634-7073

North Atlantic Division
CENAD-ET-O
90 Church Street
New York, NY 10007-2979
Phone: 212-264-7636
Fax: 212-264-5037

Northwestern Division
CENWD-ET-OR
220 Northwest 8th Avenue
Portland, OR 97209-3589
Phone: 503-808-3888
Fax: 503-808-3880

Missouri River Regional Headquarters
CENWD-MR
12565 West Center Road
Omaha, NE 68144-3871
Phone: 402-697-2552

Pacific Ocean Division
CEPOD-ET-PO
Building 230
Ft. Shafter, HI 96858-5440
Phone: 808-438-0030
Fax: 808-438-4060

South Atlantic Division
CESADET-CO-R
77 Forsyth Street, SW
Atlanta, GA 30355-6801
Phone: 404-331-6744
Fax: 404-331-2613

South Pacific Division
CESPD-ET-CR
630 Sansome Street
San Francisco, CA 94111-2206
Phone: 415-977-8030
Fax: 415-977-8047

Southwestern Division
CESWD-ETO-R
1114 Commerce Street
Santa Fe Building
Dallas, TX 75242-0216
Phone: 214-767-2435
Fax: 214-767-5305

District Offices:

Alaska
U.S. Army Corps of Engineers, Alaska District
Attention: CEPOA-CO-RF
P.O. Box 898
Anchorage, AK 99506-0898
Phone: 907-753-2712
Fax: 907-753-5567

Albuquerque
U.S. Army Corps of Engineers, Albuquerque District
Attention: CESPA-OD-R
4101 Jefferson Plaza, NE
Albuquerque, NM 87109-3435
Phone: 505-342-3283
Fax: 505-342-3498

Baltimore
U.S. Army Corps of Engineers, Baltimore Distict
Attention: CENAB-OP-R
P.O. Box 1715
Baltimore, MD 21203-1715
Phone: 410-962-3670
Fax: 410-962-8024

Buffalo
U.S. Army Corps of Engineers, Buffalo District
Attention: CELRB-CO-S
1776 Niagara Street
Buffalo, NY 14207-3199
Phone: 716-879-4313
Fax: 716-879-4310

Chaleston
U.S. Army Corps of Engineers, Charleston District
Attention: CESAC-CO-P
P.O. Box 919
Charleston, SC 29402-0919
Phone: 803-727-4330
Fax: 803-727-4445

Chicago
U.S. Army Corps of Engineers, Chicago District
Attention: CELRC-CO-R
111 North Canal Street
Suite 600
Chicago, IL 60606-7206
Phone: 312-353-6428
Fax: 312-353-4110

Detroit
U.S. Army Corps of Engineers, Detroit District
Attention: CELRE-CO-L
P.O. Box 1027
Detoit, MI 48231-1027
Phone: 313-226-2432
Fax: 313-226-6763

Ft. Worth
U.S. Army Corps of Engineers, Ft. Worth District
Attention: CESWF-EV-R
P.O. Box 17300
Ft. Worth, TX 76102-0300
Phone: 817-978-2681
Fax: 817-978-2120

Galveston
U.S. Army Corps of Engineers, Galveston District
Attention: CESWG-CO-R
P.O. Box 1229
Galveston, TX 77553-1229
Phone: 409-766-3930
Fax: 409-766-3931

Huntington
U.S. Army Corps of Engineers, Huntington District
Attention: CELRH-OP-F
502 8th Street
Huntington, WV 25701-2070
Phone: 304-529-6900
Fax: 304-529-6086

Honolulu
U.S. Army Corps of Engineers, Honolulu District
Attention: CEPOH-CO-O
Building 230, Fort Safter
Honolulu, HI 96858-5440
Phone: 808-438-0030
Fax: 808-438-4060

Jacksonville
U.S. Army Corps of Engineers, Jacksonville District
Attention: CESAJ-RD
P.O. Box 4970
Jacksonville, FL 32232-0019
Phone: 904-232-1666
Fax: 904-232-1684

Kansas City
U.S. Army Corps of Engineers, Kansas City District
Attention: CENWK-CO-R
700 Federal Building
601 East 12th Street
Kansas City, MO 64106-2896
Phone: 816-983-3990
Fax: 816-426-2321

Little Rock
U.S. Army Corps of Engineers, Little Rock District
Attention: CESWL-CO-P
P.O. Box 867
Little Rock, AR 72203-0867
Phone: 501-324-6296
Fax: 501-324-6013

Los Angeles
U.S. Army Corps of Engineers, Los Angeles District
Attention: CESPL-CO-R
911 Wilshire Boulevard
P.O. Box 2711
Los Angeles, CA 90053-2325
Phone: 213-452-3425
Fax: 213-452-4196

Louisville
U.S. Army Corps of Engineers, Louisville District
Attention: CELRL-OP-F
P.O. Box 59
Louisville, KY 40401-0059
Phone: 502-582-6461
Fax: 502-582-5072

Memphis
U.S. Army Corps of Engineers, Memphis District
Attention: CEMVM-CO-G
Clifford Davis Federal Building Room B-202
Memphis, TN 38103-1894
Phone: 901-544-3471
Fax: 901-544-3266

Mobile
U.S. Army Corps of Engineers, Mobile District
Attention: CESAM-OP-S
P.O. Box 2288
Mobile, AL 36628-00001
Phone: 334-690-2658
Fax: 334-690-2660

Nashville
U.S. Army Corps of Engineers, Nashville District
Attention: CELRN-CO-F
P.O. Box 1070
Nashville, TN 37202-1070
Phone: 615-736-2761
Fax: 615-736-2745

New England
U.S. Army Corps of Engineers, New England District
Attention: CENAE-OD-R
424 Trapelo Road
Waltham, MA 02254-9149
Phone: 617-647-8338
Fax: 617-647-8303

New Orleans
U.S. Army Corps of Engineers, New Orleans District
Attention: CEMVN-OD-S
P.O. Box 60267
New Orleans, LA 70160-0267
Phone: 504-862-2255
Fax: 504-862-2289

New York
U.S. Army Corps of Engineers, New York District
Attention: CENAN-OP-R
26 Federal Plaza
New York, NY 10278-0090
Phone: 212-264-3996
Fax: 212-264-4260

Norfolk
U.S. Army Corps of Engineers, Norfolk District
Attention: CENAO-CO-R
803 Front Street
Norfolk, VA 23510-1096
Phone: 757-441-7068
Fax: 757-441-7678

Omaha
U.S. Army Corps of Engineers, Omaha District
Attention: CENWO-OP-N
P.O. Box 5
Omaha, NE 68101-0005
Phone: 402-221-4211
Fax: 402-221-4939

Philadelphia
U.S. Army Corps of Engineers, Philadelphia District
Attention: CENAP-OP-R
100 Penn Square East
2nd and Chestnut Street
Philadelphia, PA 19107-3396
Phone: 215-656-6725
Fax: 215-656-6724

Pittsburgh
U.S. Army Corps of Engineers, Pittsburgh District
Attention: CELRP-OP-F
Federal Building
1000 Liberty Avenue
Pittsburgh, PA 15222-4186
Phone: 412-644-4204
Fax: 412-644-4211

Portland
U.S. Army Corps of Engineers, Portland District
Attention: CENWP-OP-G
P.O. Box 2946
Portland, OR 97208-2946
Phone: 503-808-4371

Rock Island
U.S. Army Corps of Engineers, Rock Island District
Attention: CEMVR-OD-S
Clock Tower Building
Rock Island, IL 61201-2004
Phone: 309-794-5370
Fax: 309-794-5191

Sacramento
U.S. Army Corps of Engineers, Sacramento District
Attention: CESPK-CO-R
1325 J Street
Sacramento, CA 95814-2922
Phone: 916-557-5252
Fax: 916-557-6877

St. Louis
U.S. Army Corps of Engineers, St. Louis District
Attention: CEMVS-OD-F
210 Tucker Blvd North
St. Louis, MO 63101-1986
Phone: 314-331-8575
Fax: 314-331-8741

St. Paul
U.S. Army Corps of Engineers, St. Paul District
Attention: CEMVP-CO-RF
1135 USPO & Custom House
St. Paul, MN 55101-1479
Phone: 612-290-6376
Fax: 612-290-5330

San Francisco
U.S. Army Corps of Engineers, San Francisco District
Attention: CESPN-CO-R
333 Market Street, 8th floor
San Francisco, CA 94105-2197
Phone: 415-977-8460
Fax: 415-977-8483

Savannah
U.S. Army Corps of Engineers, Savannah District
Attention: CESAS-OP-F
P.O. Box 889
Savannah, GA 31402-0889
Phone: 912-652-6768
Fax: 912-652-5065

Seattle
U.S. Army Corps of Engineers, Seattle District
Attention: CENWS-OP-RF
P.O. Box C-3755
Seattle, WA 98124-2255
Phone: 206-764-3495
Fax: 206-764-6602

Tulsa
U.S. Army Corps of Engineers, Tulsa District
Attention: CESWT-OD-RF
P.O. Box 61
Tulsa, OK 74121-0061
Phone: 918-669-7401
Fax: 918-669-7373

Vicksburg
U.S. Army Corps of Engineers, Vicksburg District
Attention: CEMVK-Regulatory Branch
4155 Clay Street
Vicksburg, MS 39180-3435
Phone: 601-631-6276
Fax: 601-631-6459

Walla Walla
U.S. Army Corps of Engineers, Walla Walla District
Attention: CENWW-OP-RF
201 North 3rd Street
Walla Walla, WA 99362
Phone: 509-527-7151
Fax: 509-527-7823

Wilmington
U.S. Army Corps of Engineers, Wilmington District
Attention: CESAW-CO-E
P.O. Box 1890
Wilmington, NC 28402-1890
Phone: 910-251-4630
Fax: 910-251-4025

This information can be found at the following web sites:
<http://www.usace.army.mil/inet/functions/cw/cecwo/reg/district.htm>
<http://www.usace.army.mil/inet/functions/cw/cecwo/reg/division.htm>

Appendix D
U.S. Fish and Wildlife Service Regional Wetland Contacts

This appendix provides wetland contacts for each region of the U.S. Fish and Wildlife Service.

U.S. Fish and Wildlife Service Regional Wetland Contacts

This information can be found at the U.S Fish and Wildlife Service National Wetlands Inventory web site: http://wetlands.fws.gov/Regionofc/Rwc.htm

Region 1
(CA, HI, ID, NV, OR, WA)

U.S. Fish and Wildlife Service
911 Northeast 11th Avenue
Portland, OR 97232

Region 2
(AZ, NM, OK, TX)

U.S. Fish and Wildlife Service
P.O. Box 1306
Albuquerque, NM 87102

Region 3
(IL, IN, IA, MI, MN, MO, OH, WI)

National Wetlands Inventory Office
U.S Fish and Wildlife Service
9720 Executive Center Drive,
Monroe Building, Suite 101
St. Petersburg, FL 33702

Region 4
(AL, AR, FL, GA, KY, LA, MS, NC, SC, TN, PR, VI)

National Wetlands Inventory Office
U.S. Fish and Wildlife Service
1875 Century Blvd, Room 240
Atlanta, GA 30345

Region 5
(CT, DE, ME, MA, MD, NH, NJ, NY, PA, RI, VT, VA, WV)

U.S. Fish and Wildlife Service
300 West Gate Center Drive
Hadley, MA 01035

Region 6
(CO, KS, MT, NE, ND, SD, UT, WY)

U.S. Fish and Wildlife Service
P.O. Box 25486, DFC
Denver, CO 80225-0486

Region 7
(AK)

U.S. Fish and Wildlife Service
1011 East Tudor Road
Anchorage, AK 99503

Region 8
(Washington, DC National Office)

U.S. Fish and Wildlife Service
4401 North Fairfax Drive, Suite 110
Arlington VA, 22203

Appendix E
U.S. State and Territory Agency Wetland Contacts

This appendix provides agency wetland contact information for each state and trust territory.

U.S. State and Territory Agency Wetland Contacts

Alabama
Department of Environmental Management
1400 Coliseum Blvd.
Montgomery, AL 36111
(334) 271-7700
http://www.adem.state.al.us/

Alaska
Department of Environmental Conservation
Division of Water
410 Willoughby Avenue, Suite 303
Juneau, AK 99801-1795
(907) 465-5180
http://www.dec.state.ak.us

Arizona
Department of Environmental Quality
1110 W. Washington St.
Phoenix, AZ 85007
(602) 771-2300
http://www.azdeq.gov

Arkansas
Department of Environmental Quality
8001 National Drive
Little Rock, AR 72209
(501) 682-0744
http://www.adeq.state.ar.us/

California
California State Water Resources Control Board
1001 I Street
Sacramento, CA 95814
(916) 341-5250
http://www.swrcb.ca.gov

Colorado
Department of Natural Resources
Division of Water Resources
1313 Sherman Street, Rm. 818
Denver, CO 80203
(303) 866-3581
http://www.dnr.state.co.us/index.asp

Connecticut
Department of Environmental Protection
79 Elm Street
Hartford, CT 06106-5127
(860) 424-3009
http://dep.state.ct.us

Delaware
Department of Natural Resources
& Environmental Control
89 Kings Highway
Dover, DE 19901
(302) 739-5072
http://www.dnrec.state.de.us/dnrec2000

Florida
Department of Environmental Protection
3900 Commonwealth Blvd.
M.S. 49
Tallahassee, FL 32399
(850) 245-2118
http://www.dep.state.fl.us/

Georgia
Department of Natural Resources
2 Martin Luther King, Jr. Drive, S.E.
Suite 1252 East Tower
Atlanta, GA 30334
(404) 656-3500
http://www.gadnr.org

Hawaii
Department of Land and Natural Resources
Kalanimoko Bldg.
1151 Punchbowl St.
Honolulu, HI 96813
(808) 587-0400
http://www.state.hi.us/dlnr/

Idaho
Department of Water Resources
322 E. Front St.
P.O. Box 83720
Boise, ID 83720-0098
(208) 287-4800
http://www.idwr.state.id.us

Illinois
Environmental Protection Agency
500 Stratton Office Bldg.
Springfield, IL 62706
(217) 524-1321
http://www.epa.state.il.us/

Indiana
Department of Environmental Management
Indiana Govt. Center-North
100 N. Senate Ave.
Indianapolis, IN 46204
(317) 232-8603
http://www.state.in.us/idem

Iowa
Department of Natural Resources
Wallace State Office Building
502 E. 9th Street
Des Moines, IA 50319-0034
(515) 281-5918
http://www.iowadnr.com

Kansas
Department of Health and Environment
1000 SW Jackson
Topeka, KS 66612
(785) 296-1500
http://www.kdhe.state.ks.us

Kentucky
Division of Water
14 Reilly Road
Frankfort, KY 40601
(502) 564-3410
http://www.water.ky.gov

Louisiana
Department of Environmental Quality
602 N. 5th Street
Baton Rouge, LA 70802
(225) 342-1234
http://www.deq.state.la.us/

Maine
Department of Environmental Protection
17 State House Station
Augusta, ME 04333-0017
(207) 287-7688, (800) 452-1942
http://www.maine.gov/dep/index.shtml

Maryland
Department of Natural Resources
580 Taylor Avenue
Annapolis, MD 21401
(410) 260-8701
http://www.dnr.state.md.us/

Massachusetts
Department of Environmental Protection
1 Winter Street
Boston, MA 02108-4746
(617) 292-5500
http://www.state.ma.us/dep/brp/ww/rpwwhome.htm

Michigan
Department of Environmental Quality
525 W. Allegan St.
P.O. Box 30473
Lansing, MI 48909-7973
(517) 373-7917
http://www.michigan.gov/deq

Minnesota
Department of Natural Resources
500 Lafayette Rd., Box 7
St. Paul, MN 55155-4040
(612) 296-6157
http://www.dnr.state.mn.us/waters/index.html

Mississippi
Department of Environmental Quality
P.O. Box 10631
Jackson, MS 39289-0631
(601) 961-5171
http://www.deq.state.ms.us/mdeq.nsf/page/main_home?opendocument

Missouri
Department of Natural Resources
P.O. Box 176
Jefferson City, MO 65102
(573) 751-3443
http://www.dnr.state.mo.us/wpscd/wpcp/wp-index.html

Montana
Department of Natural Resources and Conservation
1625 Eleventh Avenue
P.O. Box 201601
Helena, MT 59620-1601
(406) 444-2074
http://www.dnrc.state.mt.us/index.htm

Nebraska
Department of Environmental Quality
1200 "N" Street, Suite 400
P.O. Box 98922
Lincoln, NE 68509
(402) 471-2186
http://www.deq.state.ne.us/

Nevada
Department of Conservation
& Natural Resources
901 S. Stewart St., Suite 5001
Carson City, NV 89701
(775) 687-4360
http://www.dcnr.nv.gov

New Hampshire
Department of Environmental Services
29 Hazen Dr.
P.O. Box 95
Concord, NH 03302
(603) 271-3503
http://www.des.state.nh.us/wetlands/

New Jersey
Department of Environmental Protection
P.O. Box 402
Trenton, NJ 08625-0402
(609) 292-2178
http://www.state.nj.us/dep/

New Mexico
Department of Labor
P.O. Box 1928
Albuquerque, NM 87103
(505) 841-8409
http://www.dol.state.nm.us/dol_asd.html

New York
Department of Environmental Conservation
625 Broadway
Albany, NY 12233
(518) 357-2234
http://www.dec.state.ny.us/

North Carolina
Department of Environment and Natural Resources
1601 Mail Service Center
Raleigh, NC 27699
(919) 733-4984
http://www.enr.state.nc.us/

North Dakota
Department of Health
600 East Boulevard Ave.
Bismarck, ND 58505-0200
(701) 328-2372
http://www.health.state.nd.us

Ohio
Department of Natural Resources
2045 Morse Rd.
Columbus, OH 43229
(614) 265-6717
http://www.dnr.state.oh.us/

Oklahoma
Conservation Commission
2800 North Lincoln Blvd., Suite 160
Oklahoma City, OK 73105
(405) 521-2384
http://www.okcc.state.ok.us

Oregon
Department of Environmental Quality
811 Southwest Sixth Ave.
Portland, OR 97204-1390
(503) 229-5696
http://www.deq.state.or.us

Pennsylvania
Department of Environmental Protection
16th Floor, Rachel Carson State Office Bldg.
P.O. Box 2063
Harrisburg, PA 17105-2063
(717) 787-4686
http://www.dep.state.pa.us/

Rhode Island
Department of Environmental Management
235 Promenade Street
Providence, RI 02908-5767
(401) 222-6800
http://www.dem.ri.gov

South Carolina
Department of Health and Environmental Control
2600 Bull Street
Columbia, SC 29201
(803) 898-3432
http://www.scdhec.gov/environment

South Dakota
Department of Environment & Natural Resources
Joe Foss Bldg.
523 East Capitol
Pierre, SD 57501
(605) 773-3151
http://www.state.sd.us/denr/denr.html

Tennessee
Department of Environment and Conservation
1st Floor L&C Annex
401 Church Street
Nashville, TN 37243-0435
(615) 532-0109
http://www.state.tn.us/environment/

Texas
Commission on Environmental Quality
P.O. Box 13087
Austin, TX 78711-3087
(512) 239-1000
http://www.tceq.state.tx.us/index.html

Texas Parks & Wildlife Department
4200 Smith School Road
Austin, TX 78744
(512) 389-4800
http://www.tpwd.state.tx.us

Utah
Department of Natural Resources
PO Box 145610
1594 W. North Temple
Salt Lake City, UT 84114-5610
(801) 538-7200
http://www.water.utah.gov

Vermont
Agency of Natural Resources
103 South Main Street, Center Bldg.
Waterbury, VT 05671-0301
(802) 241-3300
http://www.anr.state.vt.us/

Virginia
Department of Environmental Quality
629 East Main Street, P.O. Box 10009
Richmond, VA 23240-0009
(804) 698-4000
http://www.deq.state.va.us/

Washington
Department of Ecology
P.O. Box 47600
Olympia, WA 98504-7600
(800) 633-6193
http://www.ecy.wa.gov

West Virginia
DEP, Division of Water and Waste Mgt
601 - 57th Street
Charleston, WV 25304
(304) 926-0495
http://www.dep.state.wv.us/item.cfm?ssid=11

Wisconsin
Department of Natural Resources
101 S. Webster
P.O. Box 7921
Madison, WI 53707-7921
(608) 266-2621
http://www.dnr.state.wi.us/

Wyoming
Department of Environmental Quality
122 West 25th Street, Herschler Building
Cheyenne, WY 82002
(307) 777-7937
http://deq.state.wy.us/

Territories

American Samoa
American Samoa Coastal Management Program
Department of Commerce
Government of American Samoa
Pago Pago, AS 96799
(684) 633-5155

Guam
Coastal Management Program
Economic Research Center
P.O. Box 9970
Tamuning, Guam 96931
(617) 475-7062
http://www.spc.int/prism/country/gu/stats/divisions/gcmp.htm

Northern Marianas Islands
Coastal Resources Management Office
Nauru Building
Saipan, Northern Mariana Islands 96950
(670) 234-6623

Puerto Rico
Puerto Rico DNER
Bureau of Reserves, Refuges, and Coastal Resources
P.O. Box 5887
Puerto de Tierra, PR 00906
(809) 724-2816

Virgin Islands
Department of Planning and Natural Resources
Cyril E. King Airport Terminal Bldg., 2nd Floor
Charlotte Amalie
St. Thomas, VI 00800
(340) 774-3320
http://www.dpnr.gov.vi

Appendix F
Index of Case Studies Organized by State, Territory, and Tribe

Index of Case Studies Organized by State, Territory, and Tribe

STATES

Alabama

Gulf Oak Ridge

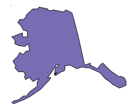
The Alabama Department of Conservation and Natural Resources will acquire 588 acres of Gulf Oak Ridge, the only remaining globally imperiled maritime forest in Alabama. The area will be included in Gulf State Park. Six rare plant species occur on the site, and a large number of neotropical migratory birds use the area as their first and last staging area in spring and fall. The federally endangered red-cockaded woodpecker, Mississippi sandhill crane, and jaguarundi and federally threatened indigo snake are likely inhabitants of the Gulf Oak Ridge.

Source: U.S. Fish and Wildlife Service (USFWS). 1998b. *1998 Coastal Wetlands Conservation Grant*. U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC.

Water Watch

Alabama Water Watch is dedicated to developing Citizen Volunteer Monitoring of Alabama's lakes, streams, and wetlands. The program, which is funded in part by a grant from EPA and the Alabama Department of Environmental Management, educates citizens about water issues, both statewide and worldwide, and trains them to measure water quality conditions at sites of concern. The program challenges citizens to make a difference and potentially improve environmental policy by actively participating in determining long-term water quality trends.

Source: Auburn University. 1995. *Alabama Water Watch*. Auburn University, Auburn, AL.



Alaska

Eagle River Watershed Wonders

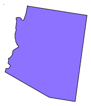
The Anchorage School District and partners are collaborating to restore riparian habitat along the habitat banks of the Eagle River, which supports all five species of Pacific salmon in addition to resident populations of rainbow trout. The project is bringing together the fourth-grade students from Ravenwood Elementary School with experts from Chugach Sate Park, the Anchorage Waterways Council, federal resource agencies, and others to promote stewardship of the Eagle River Watershed through the restoration projects. As part of their involvement, students learn scientific methods for collecting water samples and monitoring fish populations, as well as gaining an ecological understanding of human activities that affect the health of the watershed. Partial funding for this grant is being provided by the National Marine Fisheries Service Community-based Restoration Program.

Source: U.S. Environmental Protection Agency, *River Corridor and Wetland Restoration: Projects Funded by Five Star Restoration Program in FY00*. <www.epa.gov/owow/wetlands/restore/5star/fy00grants.html>. Accessed January 2003.

Local Wetland Management Plans

The municipalities of Anchorage and Juneau have implemented wetlands management plans that identify sensitive wetlands, specify practices for protection and restoration of high-value wetlands, and contain enforceable policies requiring compensation for wetland damages from development. Similar plans for wetlands management and conservation are anticipated for other populated areas of the state's coastal region.

Source: State of Alaska. 1995. *Alaska Coastal Clean Water Plan*. Draft. Alaska Coastal Management Program, Anchorage, AK.



Arizona

Chaparral Watershed

The effect of upstream shrub control on the establishment of riparian vegetation was evaluated on a chaparral watershed in central Arizona. The response of riparian vegetation to increased water yield through shrub control treatments was evaluated. Studies indicated that the continuity of flow had a greater effect on enhancing the riparian zones than did total streamflow increases.

Source: Debano, L., J. Brejda, and J. Brock. 1984. Enhancement of riparian vegetation following shrub control in Arizona chaparral. *Journal of Soil and Water Conservation*, September-October, pp. 317-320.

Ramsey Canyon

The Nature Conservancy acquired an in-stream water rights certificate for its Ramsey Canyon Preserve in the Huachuca Mountains. The certificate gives the Arizona Nature Conservancy the legal right to maintain in-stream flows in the stretch of Ramsey Creek along their property, which in turn preserves in-stream and riparian habitat and wildlife.

Source: Andy Lorenzi, The Nature Conservancy. 1992. Personal Communication.

Tres Rios Project

The Tres Rios Demonstration Constructed Wetlands Project was originally initiated to meet current and future NPDES discharge requirements for the 91st Avenue wastewater treatment plant (WWTP) in Phoenix. For 60 months, 12 acres of wetland system were created and monitored. This project has been underway since 1995. The use of constructed wetlands for wastewater treatment is preferred because the cost of initial upgrades to existing WWTP facilities to meet future NPDES charges were estimated at $625 million, and wetland treatment is estimated at $82 million. Other benefits would include habitat; environmental education; flood control; aesthetics; and reduction in vandalism, dumping, and nuisance conditions in the river corridor.

Source: International City/County Management Association and National Association of Counties (ICMA and NACO). 1999. *Protecting Wetlands, Managing Watersheds...Local Government Case Studies.* International City/County Management Association and National Association of Counties, Washington, DC.

Arkansas

Bottomland Hardwood Study

A long-term study was conducted to determine chemical and hydrological functions of bottomland hardwood wetlands along the Cache River. Hydrologic gauging stations were established at inflow and outflow points on the river, and more than 25 chemical constituents were measured. Preliminary results for the 1988 water year indicated that total and inorganic suspended solids and nitrate were retained in the wetlands, and organic suspended solids, total and dissolved organic carbon, inorganic carbon, total phosphorus, soluble reactive phosphorus, ammonia, and total Kjeldahl nitrogen were exported. All measured constituents were exported during low water when there was limited contact between the river and the wetlands and retained when the Cypress-Tupelo part of the floodplain was inundated.

Source: Kleiss, B.A., E.E. Morris, J.F. Nix, and J.W. Barko. 1989. Modification of Riverine Water Quality by an Adjacent Bottomland Hardwood Wetland. In *Proceedings of Wetlands: Concerns and Successes,* ed. D.W. Fisk, Tampa, Florida, September 17-22, 1989, pp. 429-438. TPS 89-3. American Water Resources Association, Bethesda, MD.

Cache River

The USACE studied a 20-mile stretch of the Cache River where floodplain deposition was shown to reduce suspended solids by 50%, nitrates by 80%, and phosphates by 50%.

Source: Stuart, G., and J. Greis. 1991. *Role of Riparian Forests in Water Quality on Agricultural Watersheds*. U.S. Department of Agriculture, Forest Service, Washington, DC.

Cache River Wetland

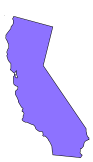
Suspended sediment dynamics were measured in a hardwood wetland adjacent to the Cache River during the 1988-1990 water years. A suspended sediment mass balance was calculated using depth-integrated, flow-weighted daily measurements at wetland inflow and outflow points. Measurements of sediment accretion were made at 30 sites in the wetland. Multiple regression was used to relate sedimentation rates to several biological factors. A combination of distance to the river, flood duration, and tree basal area accounted for nearly 90% of the variations in sedimentation rates.

Source: Kleiss, B.A. 1996. Sediment retention in a bottomland hardwood in eastern Arkansas. *Wetlands* 16:321-333.

Landowner's Guide

The purpose of the guide is to assist private landowners in the conservation and management of Arkansas' wetlands and associated agricultural lands. The guide contains information on voluntary programs that provide technical and/or financial assistance for wetland and riparian habitat restoration and agricultural land management activities.

Source: U.S. Environmental Protection Agency (USEPA). 1995-1996. *Landowner's Guide to Voluntary Wetland Programs in Arkansas*. U.S. Environmental Protection Agency, Washington, DC.



California

Nature Conservancy

The Nature Conservancy brought together a dozen public partners to acquire 5,000 acres critical to the Cosumnes River Preserve, which now covers 12,000 acres. The Cosumnes watershed supports significant natural communities, such as vernal pool grasslands, streamside forests, and wetlands, that are used by thousands of migratory birds.

Source: The Nature Conservancy. 1998b. *The Nature Conservancy Magazine*. January/February 1998. The Nature Conservancy, Arlington, VA.

Huichica Creek Vineyard

The Napa County Resource Conservation District of Napa, California, received a loan from the SRF for the Huichica Creek Vineyard Sustainable Agricultural Demonstration Project. The project will be an outdoor classroom designed to encourage the adoption of best management practices in perennial crops in California. The SRF loan will be used to install surface drainage improvements; restore wetland areas between vineyard blocks, which includes constructing a weir, planting native vegetative species, and developing the necessary habitat structures for waterfowl and raptors; and stabilize the creekbed and restore riparian vegetation. The overall project includes incorporating best management practices and low input viticulture techniques that include long-term monitoring of water quality, soil nutrition, insect pest populations, and biodiversity changes.

Source: U.S. Environmental Protection Agency (USEPA). 1998b. *Wetlands Projects Funded by the Clean Water State Revolving Fund (CW-SRF)*. U.S. Environmental Protection Agency, Office of Wastewater, Washington, DC.

Tahoe Conservancy

The Tahoe Conservancy is charged with preserving and enhancing the unique ecological and recreational values of the Tahoe basin. The Conservancy's work with private owners of wetland property comes primarily through its acquisition program. It focuses on obtaining conservation easements, development rights, and full titles to lands that contain wetlands, meadows, or riparian areas. The Conservancy offers 95% of what the property would bring on the open market .

Source: California Environmental Resources Evaluation System. 1995. CWIS, Tahoe Conservancy. Programs. California Environmental Resource Evaluation System, Sacramento CA.

Carmel River

A study was conducted that linked Mediterranean climate and ground water extraction with the decline of riparian vegetation and subsequent severe bank erosion on the Carmel River. Ground water is closely coupled with streamflow to maintain water supply to riparian vegetation, particularly where precipitation is seasonal.

Source: Groenveld, D.P., and E. Griepentrog. 1985. Interdependence of Groundwater, Riparian Vegetation, and Streambank Stability: A Case Study. In *Proceedings of Riparian Ecosystems and their Management: Reconciling Conflicting Issues*, Tucson, Arizona, April 16-18, 1985, pp. 44-48. GTR RM-120. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Little Lost Man Creek

Nitrate retention was evaluated in a third-order stream under background conditions and during four intervals of modified nitrate concentration caused by nutrient amendments or storm-enhanced discharge. Measurements of stream response to nitrate loading and storm discharge showed that nitrate was exported from the subsurface (11% greater than input) under normal background conditions. With increased nitrate input, there was an initial 39% reduction followed by a steady state reduction of 14%. Subsurface measurements taken during a storm event showed a 6% increase in exported nitrate.

Source: Triska, F.J., V.C. Kennedy, R.J. Avanzino, G.W. Zellweger, and K.E. Bencala. 1990. In situ retention-transport response to nitrate loading and storm discharge in a third-order stream. *Journal of North American Benthological Society* 9(3):229-239.

Lake Tahoe

A wetland was constructed near Lake Tahoe to determine the potential for treating urban runoff in sub-Alpine regions of the United States. The purpose of the project was to determine the effectiveness of the wetland in removing nitrate, phosphorus, iron, suspended solids, and other constituents from runoff. Nitrate concentrations were decreased by the wetland by 85%-90%. Particulate phosphorus concentrations decreased by 47%, soluble phosphorus decreased by 20%, iron was reduced by 84%, and turbidity and suspended solids were reduced by 85% by the wetland.

Source: Reuter, J.E., T. Djohan, and C.R. Goldman. 1992. The use of wetlands for nutrient removal from surface runoff in a cold climate region of California: Results from a newly constructed wetland at Lake Tahoe. *Journal of Environmental Management* 36(1):35(19).

Redwood City

Wetland loss near the port of Redwood City, California, is believed to be responsible for damage to shipping channels. The USACE recently spent $2.8 million on a dredging project there.

Sources: McAliney, M., ed. 1993. *Arguments for Land Conservation: Documentation and Information Sources for Land Resources Protection*. Trust for Public Land, Sacramento, CA.

U.S Army Corps of Engineers (USACE). 2001. *Annual Report to Congress on the Status of the Harbor Maintenance Trust Fund for Fiscal Year 1999*. IWR-Report 00-R-7.

San Luis Rey and San Diego Rivers

A restoration project was conducted to create and restore riparian habitat for the endangered least Bell's vireo. The most important aspects of restoration planning were found to include careful analysis of species composition, density, community structure, and arrangement, and ground water and soil characteristics.

Source: Baird, K. 1989. High quality restoration of riparian ecosystems. *Restoration & Management Notes* 7(2):60-64.

Stevinson Ranch

The Stevinson Ranch golf course has achieved Signature Status from Audubon International through the Audubon Cooperative Sanctuary Program for Golf Courses (see New York Audubon Golf Course Program). At Stevinson, great care has been taken to protect existing wetlands, and more than 100 acres of additional wetlands have been added.

Source: GolfWeb. 1997. *Golfing with Mother Nature at Stevinson Ranch.*

Wetland Conservation Guide

The guidebook describes the financial advisory and technical assistance available to private property owners who choose to create, protect, or enhance wetlands on their land. It also explains benefits that can be derived from having wetlands on private property and from making use of this assistance. All options presented in the program are voluntary.

Source: Heasley, P. 1994. *Options for Wetland Conservation: A Guide for California Landowners*. California Coastal Conservancy, Oakland, CA.

Colorado

Boulder Creek Restoration

Boulder reduced potential wastewater treatment costs significantly by deciding to restore Boulder Creek rather than construct a nitrification tower. Discharge effluent at the wastewater treatment plant met water quality standards; however, farther downstream ammonia concentrations exceeded the allowable level. Downstream the creek previously had been channelized and degraded. Through revegetation, terracing, construction of aeration structures, and other improvements, the stream was restored. The natural functions of the stream would then cool and reaerate the water to convert the ammonia. Restoration of Boulder Creek would also improve wildlife habitat, particularly fisheries.

Source: Barnett, J., Greenways Coordinator, City of Boulder. 1990. Personal communication.

Fort Collins

A laboratory study was conducted by the Crops Research Laboratory in Fort Collins using a rainfall simulator to evaluate how buffer zone length and vegetation height influence runoff and sediment yield. Results showed not only that sediment was filtered from the runoff by vegetation, but also that most sediment was deposited upslope from the vegetated buffer strips as a sediment wedge. The sediment wedge developed outside the vegetation zone and then progressed into the vegetation as time passed.

Source: Pearce, R., M.J. Trlica, W.C. Leiniger, J.L. Smith, and G.W. Frasier. 1996. *Efficiency of Grass Buffer Strip Length and Vegetation Height on Sediment Filtration in Laboratory Rainfall Simulations*. USDA National Agricultural Library.

Landowning Colorado Style

The booklet offers information about natural and man-made laws in Colorado. Riparian area and wetland functions along with regulatory policies are discussed.

Source: U.S. Environmental Protection Agency (USEPA). No date. *Landowning Colorado Style*. Environmental Protection Agency, Washington, DC.

Shop Creek Pond

The Shop Creek Pond/wetland system was evaluated to determine ability to remove suspended solids and phosphorus species from stormwater runoff. Suspended solid removals for 66 storms averaged 78% in Shop Creek Pond and 36% in the wetlands. Total phosphorus removals for the same storm events averaged 47% in Shop Creek Pond and 10% in the wetland. The Shop Creek Pond/wetland system was capable of removing about 52% of the total phosphorus load entering the system.

Source: Kunkel, J.R., T.D. Steele, B. Urbonas, and J. Carlson. 1992. Chemical-Constituent Load Removal Efficiency of an Urban Detention Pond/Wetlands System in the Denver Metropolitan Area, Colorado. In *Proceedings of Environmental Engineering: Saving a Threatened Resource in Search of Solutions*, Baltimore, Maryland, August 2-6, 1992.

Connecticut

Barn Island

Impoundment of the Barn Island tidal marsh in the 1940s for waterfowl management following ditching for mosquito control and harvesting of salt meadow hay greatly impacted and altered habitat in the system. Prior to restoration efforts the impoundment consisted primarily of phragmites and narrow-leafed cattails. Several attempts at restoring salt marsh vegetation to the site have been made with varying degrees of success. The restoration has proceeded significantly toward restoring salt marsh communities following reestablishment of tidal influx.

Source: Myers, J. 1996. The ongoing salt marsh restoration at Stonington, Connecticut. In *Restoration and Reclamation Review*. University of Minnesota, Department of Horticultural Science, St. Paul, MN.

Coastal Embayments

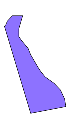
In 1991 the Connecticut Department of Environmental Protection requested a study be conducted by Coastal America to identify salt marshes that have been degraded as a result of tidal flow restrictions caused by the placement of transportation facilities. This study provided an initial assessment of all degraded salt marshes between New Haven and the Connecticut-Rhode Island border. Ten sites were selected for further study, and six were found to be experiencing degradation as a result of tidal flow restrictions. As a result, the Connecticut congressional delegation drafted legislation to provide for a comprehensive examination of degraded coastal wetlands.

Source: Coastal America Partnership. 1997. *Wetlands Protection and Restoration*. Coastal America, Washington, DC.

Wetland Protection

Connecticut requires a permit for dredging or filling activities in tidal and inland wetlands. Permit applications for new projects are reviewed for impacts on water quality, water circulation, aquatic life, and wetlands. Soil erosion and sediment controls are also required for construction adjacent to wetlands, thereby reducing sediment impacts in wetlands from development in adjacent upland areas. Local authorities frequently incorporate mandatory setbacks from wetlands into zoning regulations to provide added protection against effects from upland areas on wetlands.

Source: *Connecticut CZARA Program*. 1996. Connecticut Department of Environmental Protection, Hartford, CT.



Delaware

PSE&G's Estuary Enhancement Program:

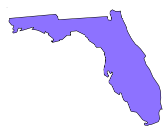
The Public Service Electric & Gas Co. (PSE&G) is conducting a restoration program under the New Jersey Department of Environmental Protection and the Delaware Department of Natural Resources and Environmental Control. Of the land slated for restoration, 12,500 acres are in New Jersey and 8,000 are in Delaware. Nearly 17,000 acres will be restored as salt marshes, making this the largest endeavor of its kind. PSE&G purchased land and made agreements with landowners to gain access to land.

Source: Richman, M. 1996. Utility restores salt marshes in large wetlands enhancement program. *Water Environment Federation* 1(1, June).

Wetlands Rehabilitation Program

The Northern Delaware Wetlands Rehabilitation Program was established by the Department of Natural Resources and Environmental Control to bring together civic and business leaders, scientists, resource managers, and property owners to develop strategies to restore close to 10,000 acres of wetlands in 31 distinct sites along the Christina and Delaware rivers in New Castle County. The program seeks to improve water quality; increase wildlife populations; control nuisance plants, mosquitoes, and flooding; reduce shoreline erosion; and improve recreational and educational opportunities in designated marshes.

Source: Delaware Department of Natural Resources and Environmental Control. 1998. *Wetlands Rehabilitation Program*. Delaware Department of Natural Resources and Environmental Control, Dover, DE.



Florida

Agrico Swamp

This evaluation of the success of restoring phosphate mined lands involved comparisons between natural and reclaimed sites over a 4-year period. Species richness, percent cover, and the survival and growth of vegetation were measured. Restored sites were determined to improve water quality to levels consistent with state water quality standards.

Source: U.S. Geological Survey (USGS), Northern Prairie Science Center. 1997a. *Riparian Ecosystem Creation and Restoration: A Literature Summary*. *Case Studies: Agrico Swamp*. U.S. Geological Survey, Reston, VA.

Banana Lake

The Banana Lake project was conducted as compensation for impacts on wetlands from a highway construction project. Objectives of the restoration project included improving the surface water quality, eliminating localized flooding, restoring pre-mining drainage and functions of the headwater system, and restoring a hardwood wetland. The restored wetland was shown to reduce nitrate, ammonia, Kjeldahl nitrogen, total nitrogen, orthophosphate, and total phosphorus in comparison to adjacent unrestored wetlands.

Source: Powers, R.M., and J.F. Spence. 1989. Headwater Restoration: The Key Is Integrated Project Goals. In *Proceedings of Wetlands: Concerns and Successes*, ed. D.W. Fisk, Tampa, Florida, September 17-22, 1989, pp. 269-279. TPS 89-3. American Water Resources Association, Bethesda, MD.

Buffer Zone Guidelines

The East Central Florida Regional Planning District has developed guidelines for determining buffer zones for water, wetlands, and wildlife.

Source: Brown, M.T., J. Schaefer, and K. Brandt. 1990. *Buffer Zones for Water, Wetlands, and Wildlife in East Central Florida*. Publication no. 89-07 and Florida Agricultural Experiment Station Journal Series no. T-00061. Center for Wetlands, University of Florida, Gainesville, FL.

Emerson Point Park

The Emerson Point Park restoration project is part of a larger estuary watershed restoration program through the Tampa Bay National Estuary Program. Emerson Point is one of 26 habitat restoration and enhancement projects. In 1995 Manatee County began planning the restoration project. A $1.5 million budget was secured through the integral financial commitment of local, regional, state, and federal agencies and several nonprofit and corporate donators. So far, $475,000 of $828,000 budgeted for restoration has been spent. The project has helped increase community awareness and appreciation of the Tampa Bay environment.

Source: International City/County Management Association and National Association of Counties (ICMA and NACO). 1999. *Protecting Wetlands, Managing Watersheds...Local Government Case Studies.* International City/County Management Association and National Association of Counties, Washington, DC.

Kissimmee Prairie Watershed

Through the efforts of the Florida Department of Environmental Protection's Division of Recreation and Parks, Florida's Conservation and Recreation Lands Program, the South Florida Water Management District, the National Audubon Society, and the Nature Conservancy, 48,000 acres in the 100,000-acre Kissimmee Prairie Watershed were acquired. The Kissimmee Prairie Watershed is an area of more than 100,000 acres in northern Okeechobee and southern Osceola counties. Habitats in the watershed consist of wet and dry prairie, pine flatwoods, scrub, oak hammock, marsh, and hardwood swamp, as well as native and improved rangeland. The watershed, therefore, provides prime habitat for several federally listed threatened and endangered birds.

Source: International City/County Management Association and National Association of Counties (ICMA and NACO). 1999. *Protecting Wetlands, Managing Watersheds...Local Government Case Studies.* International City/County Management Association and National Association of Counties, Washington, DC.

Kissimmee River

Total phosphorus and total nitrogen mass balance equations were calculated for Boney Marsh, a subtropical constructed freshwater wetland in the floodplain of the Kissimmee River in South Florida. River water was diverted through the marsh for 9 years. Nutrient retention was influenced primarily by nutrient loading rates. The Boney Marsh mean annual total phosphorus removal efficiency was 72%. Total phosphorus removal efficiencies were consistently higher than total nitrogen removal efficiencies at all times. Unlike wetlands in temperate latitudes, Boney Marsh was a net positive sink for total phosphorus year-round but not for total nitrogen.

Source: Moustafa, M.D., T.D. Fontaine, and M.J. Chimney. 1995. The Response of a Freshwater Wetland to Long-term Low-level Nutrient Loads. In *National Interagency Workshop on Wetlands*, USACE Waterways Experiment Station, New Orleans, LA, April 5-7, 1997.

Lake Jackson

A sediment filtration plant and artificial wetland were constructed to remove suspended solids and nutrients from stormwater runoff prior to discharge into Lake Jackson. Water samples collected during storm events were analyzed for a wide range of particulate and dissolved parameters including suspended solids and various nitrogen and phosphorus species. Results from the first year of study indicated that under normal operating conditions, the facility was capable of removing about 95% of the suspended solid load. All other parameters measured showed reductions of from 35% to 90%.

Source: Tuovila, B.J., T.H. Johengen, P.A. LaRock, J.B. Outland, D.H. Esry, and M. Franklin. 1987. An Evaluation of the Lake Jackson (Florida) Filter System and Artificial Marsh on Nutrient and Particulate Removal from Stormwater Runoff. In *Aquatic Plants for Water Treatment and Resource Recovery*. University of Arizona, Tucson, AZ.

Orange County

The efficiency of a detention pond and wetland temporary storage system in reducing constituent loads in runoff was determined in a study conducted in an urban area of west Orlando. Regression efficiencies, which relate the amount of constituent load into the wetland versus the amount exported, were used to quantify the removal effectiveness. The detention pond generally reduced suspended constituent loads. The pond had regression efficiencies of 65% for suspended solids, 41% for suspended lead, 37% for suspended zinc, 17% for suspended nitrogen, and 21% for suspended phosphorus. The wetland was generally effective in reducing both suspended and dissolved constituent loads. Regression efficiencies for suspended constituents were 66% for solids, 75% for lead, 50% for zinc, 30% for nitrogen, and 19% for phosphorus. Regression efficiencies for dissolved constituents were 38% for solids, 54% for lead, 75% for zinc, 13% for nitrogen, and 0% for phosphorus. The detention pond/wetland system achieved appreciable reduction of loads for most constituents. System regression efficiencies were 55% for total solids, 83% for total lead, 70% for total zinc, 36% for total nitrogen, and 43% for total phosphorus.

Source: Martin E.H., and J.L. Smoot. 1986. *Constituent Load Changes in Urban Stormwater Runoff Routed Through a Detention Pond-Wetlands System in Central Florida*. Prepared in cooperation with the Florida Department of Transportation. USGS Water Resources Investigation Report 85-4310.

Orlando

An urban stormwater treatment system consisting of a detention pond and a wetland was constructed to receive runoff from a four-lane roadway and adjacent areas. Water quality monitoring at the pond inlet, pond outlet, and wetland outlet was conducted to determine the effectiveness of the pond, the wetland, and the system in treating stormwater runoff. The detention pond reduced suspended constituent concentrations and loads of solids, lead, and zinc. The wetland was found to be more effective at reducing constituent concentrations and loads than the detention pond. By utilizing two treatment units in series, a variety of physical and biological processes acted to improve water quality. The system achieved appreciable reductions in the loads of solids, lead, zinc, and, to a somewhat lesser degree, loads of nutrients. Total solids, lead, and zinc efficiencies ranged between 55% and 83%. Total nitrogen and phosphorus efficiencies were 36% and 43%, respectively.

Source: Martin, E.H. 1988. Effectiveness of an urban runoff detention pond-wetlands system. *Journal of Environmental Engineering* 114(4).

Palm Beach Gardens

A system of man-made wetlands (36 ha) and a natural wetland retention impoundment (120 ha) were used to treat stormwater runoff from a residential/golf course development (947 ha). The wetland system was designed to improve water quality, restore destroyed wetlands, provide habitat for fish and wildlife, and add natural aesthetics. All water quality parameters monitored were improved by the wetland treatment system. The wetland system removed 71% of nitrite, 68% of turbidity, 62% of total phosphate, and 50% of total suspended solids. Water discharged from the development met state potable water standards.

Source: Blackburn, R.D., P.L. Pimentel, and G.E. French. 1986. *Treatment of Stormwater Runoff Using Aquatic Plants: The Use of Wetlands for Controlling Stormwater Pollution,* ed. E.W. Strecker, J.M. Kersnar, and E.D. Driscoll. Woodward-Clyde Consultants, Portland, Oregon. Prepared for U.S. EPA, Region 5, Water Division, Watershed Management Unit. EPA/600 February 1992.

Tampa

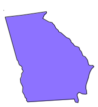
A wet detention pond built as part of a parking lot expansion in Tampa was studied to assess its ability to remove pollutants from urban runoff. The pond, which has a wetland vegetation coverage of 90%, was measured for pollutant removal efficiencies from flows generated by 18 storm events over the summer of 1989. Measurements taken at pond inflow and outflow points showed reductions of 44% for ammonia nitrogen, 75% for nitrate and nitrite, 56% for orthophosphate, 47% for total phosphorus, and 71% for total suspended solids. Organic nitrogen was not removed.

Source: Rushton, B.T., and C.W. Dye. 1990. Tampa Office Wet Detention Stormwater Treatment. In *Annual Report for Stormwater Research Program Fiscal Year 1989-1990*, pp. 39-74. Southwest Florida Water Management District, Brooksville, FL.

Wetland Protection

Florida requires a permit for dredging or filling activities in waters of the state, including wetlands. Permit applications are reviewed for impacts on water quality, habitat, and the functions of wetlands as NPS pollution filters. Stormwater regulations require the placement of BMPs to reduce or eliminate pollutants entering wetlands from upland developments. Further protection of wetlands and riparian areas is achieved through the Surface Water Improvement and Management Program, which identifies point and nonpoint sources of water pollution in individual watersheds and develops strategies for restoration and protection of river corridors and wetland systems with the goal of bringing all sources of surface water pollution into compliance with state water quality standards.

Source: *Florida Coastal Nonpoint Source Pollution Control Program.* 1995. Florida Coastal Management Program, Tallahassee, FL.



Georgia

Little River

A study was conducted on riparian forests located adjacent to agricultural uplands to test their ability to intercept and utilize nutrients (nitrogen, phosphorus, potassium, calcium) in agricultural runoff. Tissue nutrient concentrations, nutrient accretion rates, and production rates of woody plants on the sites were compared to control sites. Data from the study provide evidence that young (bloom state) riparian forests within agricultural ecosystems absorb nutrients lost from agricultural uplands.

Source: Fail, J.L., Jr., B.L. Haines, and R.L. Todd. No date. Riparian forest communities and their role in nutrient conservation in an agricultural watershed. *American Journal of Alternative Agriculture* II(3):114-120.

Tifton

A mixed hardwood riparian forest located in an agricultural watershed was shown to be effective in retaining nitrogen (67%), phosphorus (25%), calcium (42%), and magnesium (22%). Nitrogen was removed from subsurface water by plant uptake and microbial processes. Riparian land use was also shown to affect the nutrient removal characteristics of the riparian area. Forested areas were more effective in nutrient removal than pasture areas, which were more effective than croplands.

Source: Lowrance, R.R., R.L. Todd, and L.E. Asmussen. 1983. Waterborne Nutrient Budgets for the Riparian Zone of an Agricultural Watershed. *Agriculture, Ecosystems and Environment* 10:371-384.

Nutrient Cycling in an Agricultural Watershed

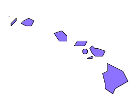
Processes within a riparian area apparently converted primarily inorganic nitrogen (76% nitrate, 6% ammonia, 18% organic nitrogen) into primarily organic nitrogen (10% nitrate, 14% ammonia, 76% organic nitrogen).

Source: Lowrance, R.R., R.L. Todd, and L.E. Asmussen. 1984. Nutrient cycling in an agricultural watershed: Phreatic movement. *Journal of Environmental Quality* 13(1):22-27.

Riparian Restoration

The study evaluated the effectiveness and feasibility of restoring a riparian wetland and using it as a bioremediation site for nutrients moving downslope from an animal waste application site. Short-term effectiveness of the restored wetland in enhancing water quality was monitored. Water sampling design and procedures are presented in detail.

Source: Vellidis, G., R. Lowrance, M.C. Smith and R.K. Hubbard. 1993. Methods to assess the water quality impact of a restored riparian wetland. *Journal of Soil and Water Conservation* 48(3):223(8).

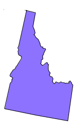


Hawaii

Hamakau Wetlands

The Hamakau Wetlands restoration project, funded through the National Coastal Wetlands Conservation Grant Program, was completed in the spring of 1995. The project was designed to restore a 22.7-acre wetland in Honolulu County that had been donated to the state by Ducks Unlimited. The parcel was donated to Ducks Unlimited by a private landowner, the Kaneohe Ranch. The wetland is connected to the Kawainiu Marsh, which at 800 acres is the largest wetland in Hawaii. An important goal of this project was to restore habitat to benefit endangered birds. Critical to the restoration of the wetlands was removal of nonnative plants and animals species. In addition to the direct benefits to wildlife, the Hamakua Wetlands is important as a model for the multi-partner approach to wetland conservation projects in Hawaii. Finally, its high profile in the urban setting of the city of Kailua in Honolulu County provides excellent public education opportunities on the importance of conserving and restoring wetlands.

Source: U.S. Fish and Wildlife Service (USFWS). 1998a. *Case Studies—U.S. Fish and Wildlife Service*. U.S. Department of Interior, Fish and Wildlife Service, Washington, DC.

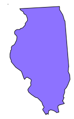


Idaho

Teton River Basin

The National Wildlife Refuge System has provided funding for the acquisition of 1,000 acres of wetland habitat in Teton County. The site, which consists of several wetlands and associated uplands, provides migratory, nesting, feeding, and resting habitat for waterfowl, raptors, shorebirds, and wading birds, as well as several rare, threatened, and endangered plant and animal species. The project will be managed by the Teton Valley Land Trust.

Source: U.S. Fish and Wildlife Service (USFWS). 1998e. Wetlands Projects Approved for 19 States. Fish and Wildlife Service News List Server. Listed April 30, 1998. U.S. Department of Interior, Fish and Wildlife Service, Washington, DC.



Illinois

Des Plaines River

The Des Plaines River Wetlands Demonstration Project was designed to improve water quality in the river through the use of constructed wetlands. Four wetlands were constructed to improve water quality affected by agricultural and urban runoff. The four wetlands were found to reduce total suspended solids by 86% to 90%, nitrogen by 61% to 92%, and phosphorus by 65% to 78%.

Source: U.S. Environmental Protection Agency (USEPA). 1993a. *Constructed Wetlands for Wastewater Treatment and Wildlife Habitat.* EPA832-R-93-005. USEPA, Office of Wastewater Management, Washington, DC.

East St. Louis

The East St. Louis Action Research Project evaluated the economics of wetland development in areas where wetlands had formerly been located to improve surface water quality, to create recreational spaces, to create habitat, and to alleviate flooding. Many benefit assumptions were made to estimate the amount of benefit that can be derived from the reintroduction of a wetland. This analysis took into account only the money that the wetland would bring in by people using it for recreation and education. Lodging will be provided in the wetlands and is included in the cost and benefit analysis. The total recreational benefit comes to $371,350 per year. The true benefits of the wetland will be seen by the surrounding area and its various populations. The indirect monetary benefits of wetlands were not estimated for East St. Louis. However, the following list is being considered in addition to the direct benefits from recreation alone.

- It is likely that the residents get their water supply from these wetlands, as opposed to ground wells. Wetlands recharge the water table over time by trapping and holding snowmelt and rainfall. The benefits from increased water will be felt by farms bordering the wetland, which may discover increased yields.

- The large size of this wetland will provide flood protection to large areas lower in the drainage basin, increasing property values.
- The wetlands and their surrounding vegetation will help to capture and filter runoff water of pesticide residue, nutrients from crop fertilizer, animal waste, and organic matter. After this occurs, the particles can be converted to less harmful forms or remain buried, helping to improve water quality. This puts less demand on treatment facilities.

  Source: Sperl, R., A. Davis, and B. Scheidecker. 1996. Wetland Development: Economic Evaluation. *East St. Louis Action Research Project*. University of Illinois at Urbana-Champaign, Champaign, IL.

Embarras River

Studies were conducted on forested and grassed VFS in central Illinois. It was found that both types of VFS reduced nitrate-nitrogen concentrations up to 90% in shallow ground water. On an annual basis, the forested VFS was more effective at reducing nitrate-N than the grass VFS, but it was less efficient at retaining total and dissolved phosphorus.

Source: Osborne, L.L., and D.A. Kovacic. 1993. Riparian vegetated buffer strips in water quality restoration and stream management. *Freshwater Biology* 29:243-258.

Iroquois County

Iroquois County, Illinois, is using the Natural Resources Conservation Service's (NRCS) Conservation Reserve Program (CRP) to establish VFS along the many miles of creeks, streams, rivers, and drainage ditches throughout the county. An NRCS district representative helps farmers register for the program, which has provided about $26,000 worth of switchgrass seed to the participants. The VFS will remove chemicals and sediment and lead to improved water quality. NRCS is also working to obtain easements for those areas currently enrolled in the program, so that the land does not return to production after the CRP contract ends. In addition, the Illinois Department of Natural Resources, through its Conservation 2000 fund, is acquiring easements on key floodplains, many of which are in or adjacent to continuous CRP buffers.

Source: Natural Resources Conservation Service (NRCS). 2000c. *Illinois-Water Quality, Flood Protection, State Program*. U.S. Department of Agriculture, Washington, DC.

Prairie Wolf Slough Restoration Project

The Prairie Wolf Slough Restoration Project was an Urban Resources Partnership-funded program that involved 13 different local, private, state, and federal agencies. There was a desire among partners to demonstrate wetland restoration techniques and the benefit of wetlands in urban and suburban areas. The restored wetlands were shown to help improve water quality and control stormwater flooding. During storm events in 1996, the site flooded and stored water that would normally have moved downstream.

Source: Urban Resources Partnership. 1997. Prairie Wolf Slough—A Chicago Wetland/Prairie Restoration Project. In *WHC 1997 Wildlands Conference "Beyond-the-Case-Study" Workshops*. United Nations Educational, Scientific, and Cultural Organization, World Heritage Committee, Paris, France.

Agricultural Watersheds

Small streams in agricultural watersheds in Illinois were shown to have water temperature problems following the removal of trees. Loss of shade increased water temperatures by 10 to 15 degrees Fahrenheit. Slight increases in water temperature over 60 degrees caused a significant increase in phosphorus release from sediments.

Source: Karr, J.R., and I.J. Schlosser. 1977. *Impact of Nearstream Vegetation and Stream Morphology on Water Quality and Stream Biota. Ecological Research Series*. EPA-600/3-77-097. U.S. Environmental Protection Agency, Washington, DC.

Heron Pond

A riparian forested wetland adjacent to the Cache River in southern Illinois was studied to determine its ability to serve as a nutrient and sediment trap. The 30-ha alluvial cypress wetland, dominated by bald cypress and water tupelo, was estimated to retain about 0.4% of the total annual phosphorus flux of the river and approximately 3% of the sediments passing through the system.

Source: U.S. Environmental Protection Agency (USEPA). 1993b. *Created and Natural Wetlands for Controlling Nonpoint Source Pollution*. Office of

Research and Development and Office of Wetlands, Oceans, and Watersheds. CRC Press Inc., Boca Raton, FL.

Meredosia Wetland Complex Project

In March 1998 the Migratory Bird Conservation Commission, as authorized under the North American Wetlands Conservation Act, approved $524,556 in funding for the Meredosia Wetland Complex Project in Brown, Cass, and Morgan counties. This act is non-regulatory and calls for voluntary partnerships to develop and implement the projects. Partners will acquire 1,160 acres (a $2 million value) of farmland from John Hancock Mutual Life Insurance Company as part of a larger project that is protecting and restoring areas along the Illinois River. Restoration of this property could provide a significant increase in waterfowl hunting, birdwatching, and nature exploration.

Source: U.S. Fish and Wildlife Service (USFWS). 1998c. *Illinois.* U.S. Department of Interior, Fish and Wildlife Service, Washington, DC.

Wetland Assessment

The synoptic assessment approach is being applied to develop maps for use in ranking riparian wetlands for restoration according to their potential for water quality improvements. The approach is being used to identify areas where wetland restoration would provide the greatest benefit from reduced nitrogen levels to human water supply and to non-degraded fish communities.

Source: USEPA. 1992a. A Synoptic Approach to Cumulative Impact Assessment - A Proposed Methodology. EPE/600/R-92/167.

Wetlands Conservation Strategy

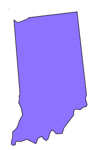
The Illinois Wetland Conservation Strategy is a comprehensive plan to guide the development and implementation of Illinois's wetland programs and protection initiatives. It is an organizational tool used to identify opportunities for making programs work better. The goal of the Illinois Wetland Conservation Strategy is to ensure that there will be no net loss of wetlands or their functions in Illinois.

Source: Baum, S. 1995. *Illinois Wetland Strategy*. Illinois Natural History Survey, Champagne, IL.

University of Illinois

Four vegetative filters were installed on feedlots in central and northern Illinois. Two configurations were used: channelized flow and overland flow. Filters removed as much as 95% of nutrients and oxygen-demanding materials from the applied runoff on a weight basis and 80% on a concentration basis. Removal was directly related to two variables: flow distance and contact time with the filter. Channelized flow with greater flow depths required either greater contact time or longer flow distance than shallow overland flow to achieve the same level of treatment.

Source: Dickey, E.C., and D.H. Vanderholm. 1981. Vegetative filter treatment of livestock feedlot runoff. *Journal of Environmental Quality* 10(3):279-284.



Indiana

Center for Alternative Agricultural Systems

Purdue University Center for Alternative Agricultural Systems began a study in 1990 to determine the feasibility of offsetting the costs of converting productive land into VFS by planting certain tree and shrub species. Pussy willow, red twigged dogwood, and corkscrew willows were planted as wind breaks in buffer strips. Two years after planting, researchers sold harvested branches to florists for gains equivalent to $5,500 per acre. Erosion from the test fields was dramatically reduced, and corn stubbles and soil that would normally have washed into ditches and drain tiles were trapped by the shrubs.

Sources: Perkins, A. 1997. 4a Indiana. Perdue University, West Lafayette, IN.

Purdue Agriculture Experiment Station. 1997. *Purdue Makes Money Grow on Filter-Strip Bushes*. Purdue University, West Lafayette, IN.

Kosciusko County

A 1-acre wetland was constructed downstream of a dairy farm and monitored to determine the water quality effects of the system on surface water runoff from the dairy. The effects of the wetland on water quality were determined by monitoring the chemical composition of the surface water, nutrient load, and plant and animal dynamics. Significant reductions were seen in fecal coliform, phosphates, total phosphorus, ammonia, suspended solids, total nitrogen, and conductivity. Year-round routine operation and maintenance were determined to be required for successful treatment.

Source: U.S. Environmental Protection Agency (USEPA). 1997d. *The Water Monitor*. EPA 841-N-97-005.U.S. Environmental Protection Agency, Office of Wetlands, Oceans and Watersheds. August-September 1997.

Purdue University

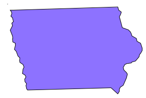
A project was conducted to develop a VSF system with familiar native herbaceous and tree species that would not inhibit tree establishment and growth, would provide beneficial wildlife habitat, and would provide necessary erosion control. Three VSF plots composed of mixed native weeds and grasses, ladino clover, and orchard grass were established with seedlings of oak, walnut, and ash. VSF cover, wildlife, and erosion control were monitored monthly throughout a 4-year period. The native species control plot performed better than the planted clover and orchard grass plots. Wildlife habitat use and browsing statistics indicated an increase in biodiversity due to VSF use. Tree planting within the VSF system was shown to diversify land use objectives to include hardwood production and wildlife habitat enhancement without restricting tree growth or VSF effectiveness in meeting water quality improvement objectives.

Source: Gillespie, A.R., B.K. Miller, and K.D. Johnson. 1995. *Effects of Ground Cover on Tree Survival and Growth in Filter Strips of the Cornbelt Region of the Midwestern US.* Texas A&M Blackland Research Center.

Southern Lake Michigan

A $1 million grant through the National Wildlife Refuge System will be used to help purchase more than 1,200 acres of critical habitat for migrating waterfowl, raptors, shorebirds, and neotropical birds in Lake, Porter, and LaPorte counties along southern Lake Michigan.

Source: U.S. Fish and Wildlife Service (USFWS). 1998e. Wetlands Projects Approved for 19 States. Fish and Wildlife Service News List Server. Listed April 30, 1998. U.S. Department of Interior, Fish and Wildlife Service, Washington, DC.



Iowa

Allamakee County

Since the Conservation Reserve Program was initiated in Allamakee County, 1,700 acres of continuous land have been enrolled. In addition, buffers on 40 miles of stream have been enrolled. One contract is on Vernon and Sandra Gavles' dairy farm, which has 44 acres in the CRP. A state-owned, stocked trout stream runs across their property. Practically the entire corridor they own is in buffers, with 29.2 acres of woody riparian zone and 14.6 acres of grass filter. The CRP rent is approximately $150/acre for a total of $6,600. The Gavles have also installed 6,870 feet of exclusionary fencing to keep their cattle out of the stream. All of these efforts will help protect and improve water quality. Without the 50 percent cost share, they would not have been able to make these changes.

Source: Natural Resources Conservation Service (NRCS). 2000a. *Iowa Conservation Reserve Program (CRP), Bottomland*. U.S. Department of Agriculture, Washington, DC.

Iowa River Corridor Project

The Iowa River Corridor Project uses a voluntary approach to wetland restoration, gives landowners economic alternatives for frequently flooded farmland, and is intended to improve water quality and wildlife habitat. It is sponsored by the Iowa Natural Resources Conservation Service. The farmers can choose to continue farming as they have, sell an easement and have a wetland restored, sell an easement and title to the FWS, or try some alternative farming practices.

Source: Zinkand, D. 1996. Wetlands restoration project to look like giant buffer strip. *Iowa Farmer Today.* Iowa Farmer Today Publications, Cedar Rapids, IA.

Iowa State University

Studies at Iowa State University have shown that vegetated buffer strips are 35% to 40% effective in reducing runoff volumes. Vegetated buffer strips removed, on average, 26% to 50% of the atrazine, metolachlor, and cyanazine from runoff from test fields. Heavier rainfall meant a lower percentage reduction in runoff. Plots with a 15-to-1 drainage area-to-buffer strip area ratio had an average 40% runoff reduction, while plots with a 30-to-1 ratio had a 35% reduction.

Source: Wood, G. 1997. BMPs make the grade. *Farm Journal*, February.

Middle Raccoon Watershed Partnership

Farmers in Carroll County, Iowa, have been encouraged to participate in CRP to reduce soil erosion, improve water quality, enhance wildlife habitat, and improve the aesthetic qualities of their farms. By the third year of the CRP program, the 420-square mile Middle Raccoon watershed outside Des Moines, Iowa, had about 75 miles of stream buffers averaging approximately 100 feet wide. Also, four constructed wetlands have been installed on farms in the watershed through an EPA and Iowa Department of Natural Resources Section 319 grant.

The city of Des Moines, Iowa, may also join the collaborative watershed protection effort in the Middle Raccoon watershed. Since the city receives its drinking water from the Raccoon River, it is investigating the impact of the stream buffers on water quality in the Raccoon River. The CEO and General Manager of the Water Works Department, L.D. McMullen, is researching whether the stream buffers have made enough difference in the water quality to avoid having to alter or expand the city's water treatment system. He stated that currently it costs $1,000 per day to run the system's nitrate reducer after a severe rainstorm and hopefully the installation of stream buffers will enable the city to save that money.

Sources: Natural Resources Conservation Service (NRCS). No date. *Iowa–Middle Raccoon Watershed Partnership, Conservation Reserve Program (CRP), City of Des Moines drinking water*. U.S. Department of Agriculture, Washington, DC.

Raccoon River Watershed Project. 1999. *Partner Initiatives of the Raccoon River Watershed Project: Constructed Wetland Project.* Raccoon River Watershed Project, Urbandale, IA.

Wetland Restoration Program

The Wetland Science and Watershed Science Institutes, in cooperation with the Social Sciences Institute, the Natural Resources Conservation Service (Iowa State Office), and the USFWS, are implementing a watershed-scale wetland restoration project in Winnebago County, Iowa. Winnebago County is in the heart of the southern prairie pothole region, and all of the wetlands in the project watershed have been impacted to some degree by agricultural drainage. The overall purpose of this project is to determine where wetland restoration would create the greatest benefits and give deference to those wetlands in the Wetland Restoration Program sign-up. Landowners with wetlands identified for restoration are being given assurance that their lands would be accepted into the program.

Source: U.S. Geological Survey (USGS). 1998. *Watershed Scale Wetland Restoration.* U.S. Geological Survey, Reston, VA.

Kansas

Johnson County Streamway Park System

Leaders in Johnson County, Kansas, expected to spend $120 million on stormwater control projects. Instead, voters passed a $600,000 levy to develop a county-wide streamway park system. Development of a greenways network along streambeds will address some of the county's flooding problems, as well as provide a valuable recreation resource. This greenway network will save Johnson County over $119 million if it is implemented, and no additional stormwater controls are necessary.

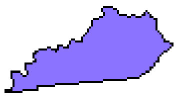
Source: International City/County Management Association and National Association of Counties (ICMA and NACO). 1999. *Protecting Wetlands, Managing Watersheds...Local Government Case Studies.* International City/County Management Association and National Association of Counties, Washington, DC.

Water Quality Assessment

Every 3 years, Kansas assesses water quality conditions in seven state or federally owned wetlands covering 25,069 acres. Data collected at these wetlands are compared against baseline wetland conditions. The data will be used to define standards to protect wetlands.

Source: U.S. Environmental Protection Agency (USEPA). 1995b. *National Water Quality Inventory: 1994 Report to Congress*. EPA841-R-95-005. U.S.

Environmental Protection Agency, Office of Water, Washington, DC.



Kentucky

Reference Reach Monitoring Program

Kentucky has added several wetlands to its reference reach monitoring program to characterize general wetland conditions in each of the physiographic regions of the state. The assessments will be used to develop designated uses and biological criteria for wetlands.

Source: U.S. Environmental Protection Agency (USEPA). 1995b. *National Water Quality Inventory: 1994 Report to Congress*. EPA841-R-95-005. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Louisiana

Atchafalaya Basin

Overflow areas in the Atchafalaya Basin had large areal net exports of total nitrogen (predominantly organic nitrogen) and dissolved organic carbon but acted as a sink for phosphorus. Ammonia levels increased dramatically during the summer. The Atchafalaya Basin floodway acted as a sink for total organic carbon mainly through reductions in particulate organic carbon.

Source: Lambou, V.W. 1985. Aquatic Organic Carbon and Nutrient Fluxes, Water Quality, and Aquatic Productivity in the Atchafalaya Basin, Louisiana. In *Proceedings of Riparian Ecosystems and Their Management: Reconciling Conflicting Issues*, Tucson, Arizona, April16-18, 1985, pp. 180-185. GTR RM-120. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Barataria-Terrebonne Estuary

Several economic studies have shown that the value of Barataria-Terrebonne Estuarine System (BTES) wetlands for tertiary wastewater treatment ranges from $82 to $157 per acre for municipal wastewater. The value for industrial wastewater is as high as $4,626 per acre. The costs to replace wetlands in the BTES area ranges from $368 to $2,204, depending on the type of creation. For dredged material placement, the costs range from $502 to $1,250; for uncontrolled sediment diversion, $368; and for controlled sediment diversion, $1,004 to $2,204. In addition to the commercial activity that is dependent on the estuary, the resource provides area residents and visitors with a number of valuable non-market services, such as recreational opportunities. The most significant activities are fishing, hunting, swimming, and boating. The economic benefits were estimated to be between $3.3 million and $1 billion per year for these activities. Estimates were also developed for recreational benefits per acre of wetland within the study area. Fishing was the highest-valued activity at between $96 and $1,213 per acre of wetland.

Source: Barataria-Terrebonne National Estuary Program. No date. Economic Value Assessment of the Barataria-Terrebonne Estuarine System. Published Research Report 26. Nicholls State University Campus, Thibodaux, LA.

Coastal Wetlands

Louisiana's coastal swamps constitute about 40% of the entire coastal wetland resources of the U.S. (Bergstrom et al., 1990). These wetlands are of great importance for the recreational, commercial harvest, and ecological service benefits they provide. A case study involved an attempt to value several of the key direct and indirect uses of Louisiana's coastal wetlands within a total valuation framework (Farber and Costanza, 1987; Costanza et al., 1989). Since the population of the region has been growing rapidly, the researchers incorporated a 1.3% annual increase into their benefit estimates to take this into account.

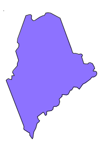
The estimated value of commercial fisheries in the coastal wetlands of Louisiana is between $317 and $846 per acre. The value for trapping is estimated to be between $151 and $401 per acre. The value placed on recreation in these wetlands is between $46 and $181 per acre. The highest value is found in stormwater protection, estimated to be between $1,915 and $7,549 per acre. These values were obtained from Costanza et al. (1989) and are in 1983 dollars, shown for both an 8 percent and 3 percent discount rate.

Source: Costanza, R., S.C. Farber, and J. Maxwell. 1989. Valuation and management of wetland ecosystems. Ecological Economics 1: 335-361.

Marsh Terracing

In response to critical coastal land loss, this pilot project was launched to test a technique for restoring wetlands in an area where sediment inflow is minimal. Bay bottom terracing uses existing sediment to form a baffle system of ridges or “terraces” at marsh elevation, after sedimentation. Data analyzed from aerial photography, on-site surveys, and readings from satellite-linked data collection platforms have shown that the technique was a success and that the marsh is coming back strongly. The terraces were quickly and completely vegetated, shoreline retreat was reversed, and annual primary productivity was increased.

Source: U.S. Environmental Protection Agency (USEPA). 1994a. *Innovations in Coastal Protection: Searching for Uncommon Solutions to Common Problems*. EPA 842-F-94-002. U.S. Environmental Protection Agency, Office of Water, Washington, DC.



Maine

St. Agatha

A constructed wetland-pond treatment system was installed on Long Lake to test its effectiveness in removing phosphorus and sediments from agricultural runoff. The 1-acre treatment system, which consists of an initial sedimentation basin, a grass filter strip, a constructed wetland, and a deep detention pond, removed 92% of total phosphorus and 95% of total suspended solids over a 150-day study period.

Source: Jolley, J.W. 1990. The Efficiency of Constructed Wetlands-Pond Systems in the Reduction of Phosphorus and Sediment Discharges from Agricultural Watersheds. Thesis in Civil Engineering, University of Maine.

Long Lake

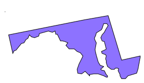
Agricultural runoff was determined to be the largest pollutant source to Long Lake. The NRCS designed treatment systems called Nutrient/Sediment Control Systems to improve the quality of runoff entering the lake. Four systems, consisting of sediment basins, grass filters, constructed wetlands, and pond components, were installed in the Long Lake watershed. The system approach incorporated design ideas based on the ecology of wetlands, in addition to design parameters already reported in the literature on the individual performance of ponds, filter strips, and wetlands. Monitoring data for 1989 and 1990 showed annual removal efficiencies of 82% to 91% for total phosphorus, 96% to 97% for total suspended solids, and 92% to 94% for volatile suspended solids. Monitoring for both years ended in mid-November when the systems froze over. Although the annual removals were good, seasonal removals varied considerably, with spring (April to May) flows exporting more phosphorus and sediment from the system than was imported.

Source: Moshiri, G.A. 1993. *Constructed Wetlands for Water Quality Improvement*. CRC Press, Inc., Boca Raton, FL.

Wetland Conservation Plan

The State Planning Office, in cooperation with other state agencies and a diverse task force, is developing a State Wetland Conservation Plan (WCP). The plan will include an inventory and assessment of state wetland resources, implementation of a conservation strategy, recommendations for regulatory changes, and a monitoring program.

Source: *Maine Coastal Nonpoint Source Control Program*. 1996. Maine State Planning Office, Coastal Program, Augusta, ME.



Maryland

Anacostia Restoration Plan

In Maryland and the District of Columbia, a basinwide plan for the restoration of the Anacostia River and associated tributaries considered in detail the impacts of wetland creation and riparian plantings within the watershed.

Source: USACE. 1990. *Anacostia River Basin Reconnaissance Study*. U.S. Army Corps of Engineers, Baltimore District; Baltimore, MD.

Chesapeake Bay

Simulated rainfall and bare plots were used to determine the effectiveness of 4.6- and 9.2-meter-long

VFS in removing nutrients and sediments from agricultural runoff. Total suspended solids, total nitrogen, and total phosphorus in surface runoff were reduced by 66%, 0%, and 27%, respectively, by the 4.6-meter VFS. Nutrient removals appeared to be greater with longer filters but decreased as the number of runoff events increased.

Source: Magette, W.L., R.B. Brinsfield, R.E. Palmer, and J.D. Wood. 1989. Nutrient and sediment removal by VFSs. *Transactions of the American Society of Agricultural Engineers* 32(2):663-667.

Chesapeake Bay

Riparian forest buffers have been used to treat stormwater in the Chesapeake Bay watershed. According to a study found in the *Chesapeake Bay Riparian Handbook*, the costs of engineered stormwater BMPs that incorporate natural systems, such as grassed swales and bioretention areas, is less expensive than the construction of storm drain systems. These engineered stormwater BMPs cost $500 to $10,000 per acre.

Sources: Palone, R.S. and A.H. Todd (eds). 1998. *Chesapeake Bay Riparian Handbook: A Guide for Establishing and Maintaining Riparian Forest Buffers*, NA-TP-02-97. U.S. Department of Agriculture, Forest Service, Washington, DC.

U.S. Environmental Protection Agency (USEPA). 1997b. *Protecting Wetlands: Tools for Local Governments in the Chesapeake Bay Region.* EPA 903-R-97-008. Prepared for Chesapeake Bay Program by U.S. Environmental Protection Agency, Washington, DC.

Forest Buffer Legislation

Baltimore County, Maryland, has adopted legislation to protect the water quality of streams, wetlands, and floodplains. The legislation requires forest buffers for any activity that is causing or contributing to pollution, including NPS pollution, of the waters of the state. Baltimore County has also developed management requirements for the forest buffers, including those located in wetlands and floodplains, that specify limitations on alteration of the natural conditions of these resources. The provisions call for public and private improvements to forest buffers to abate and prevent water pollution, erosion and sedimentation of stream channels, and degradation of aquatic and riparian habitat.

Source: Chesapeake Bay Program. 1997a. *Chesapeake Bay Watershed Riparian Buffer/Local Case Studies.* U.S. Environmental Protection Agency, Chesapeake Bay Program, Annapolis, MD.

GIS

Since the early 1980s, Prince George's County has been using GIS technologies. The Department of Environmental Resources found GIS to be the most cost-effective means to continue its flood management and water quality programs. In 1992 the county completed a 15-year effort modeling the watershed, covering approximately 85% of the county. Recognizing the need to update the data, the county determined that it could cost $4 million by traditional methods. As an alternative, the county developed Geo-STORM, a flood management model, and WPS, a water quality model. These models automatically perform much of the necessary data analysis and provide alternative solutions. The final part of the program was a Wetland Banking System using GIS. The total cost of this program was $450,000 and is part of the county's stormwater management funding, provided through ad valorem taxes, surplus, interest income, permit fees, a fee-in-lieu program, and miscellaneous budgeting items.

Source: International City/County Management Association and National Association of Counties (ICMA and NACO). 1999. *Protecting Wetlands, Managing Watersheds...Local Government Case Studies.* International City/County Management Association and National Association of Counties, Washington, DC.

Nontidal Wetlands Protection Act

Maryland's Nontidal Wetlands Protection Act encourages development of comprehensive watershed plans for addressing wetlands protection, mitigation, and restoration issues in conjunction with water supply issues.

Source: State of Maryland. 1989. Maryland Code, Annotated. Natural Resources. Nontidal Wetlands Protection Act Sections 8-1201–8-1211.

Rhode River 1

A case study focusing on the hydrology and belowground processing of nitrate and sulfate was conducted on a riparian forested wetland. Nitrate and sulfate entered the wetland from cropland ground water drainage and from direct precipitation. Data collected over a 3-year period showed that an average of 86% of nitrate and 25% of sulfate inputs were removed in the wetland. Annual removal of nitrates varied from 87% in the first year to 84% in the second year, and sulfate removal varied from 13% in the second year to 43% in the third year. Nitrate removal was always highest in the fall (average of 96%) when input fluxes were lowest and lowest in the winter (average of 81%) when input fluxes were highest.

Source: Correll, D.L., and D.E. Weller. 1989. Factors Limiting Processes in Freshwater: An Agricultural Primary Stream Riparian Forest. In *Freshwater Wetlands and Wildlife*, ed. R.R. Sharitz and J.W. Gibbons, pp. 9-23. U.S. Department of Energy, Office of Science and DOE Symposium Series no. 61. Technology Information, Oak Ridge, TN.

Rhode River 2

A riparian deciduous hardwood forest in the Rhode River watershed was shown to remove over 80% of nitrate and total phosphorus in overland flows and about 85% of the nitrate in shallow ground water drainage from cropland.

Source: Correll D.L., T.E. Jordan, and D.E. Weller. 1992. Nutrient flux in a landscape: Effects of coastal land Use and terrestrial community mosaic on nutrient transport to coastal waters. *Estuaries* 15(4, December):431-442.

Riparian Forest Buffer Demonstration Sites

A restoration effort in the Chapel Point State Park, located in the town of Marbury, has been made possible by funds from the Maryland Greenways Program. Excess sediment from erosion of agricultural land is of primary concern. The main objectives of the restoration effort are improved water quality and establishment of forested buffer strips along the Port Tobacco River. Riparian forest buffer demonstration sites have already been established along the Port Tobacco River in the Chapel Point State Park.

Source: Chesapeake Bay Program. 1998. *Riparian Forest Buffer Demonstration Sites: Chapel Point State Park, MD*. U.S. Environmental Protection Agency, Chesapeake Bay Program, Annapolis, MD.

Sligo Creek

Wet Ponds were constructed to filter stormwater entering Sligo Creek, a tributary to the Anacostia River. The Sligo Creek watershed is highly urbanized, which has resulted in the creek's poor water quality and limited habitat. Before the stormwater ponds were constructed, there were only three species of fish and no amphibians living in the creek. The Wheaton Branch stormwater detention pond project is one of 12 stormwater projects. It captures runoff from a commercial area and filters it through a retrofitted and expanded three-celled extended detention wet pond. Hand stones were placed to stabilize the channel. In 1993 vernal ponds were dug to help repopulate fish and amphibians.

Source: Chesapeake Bay Program. 1997a. *Chesapeake Bay Watershed Riparian Buffer/Local Case Studies*. U.S. Environmental Protection Agency, Chesapeake Bay Program, Annapolis, MD.

In the Maryland Department of Transportation, the Environmental Programs Division (EPD) is responsible for the preparation of plans, specifications, and estimates for wetland mitigation and stream restoration projects; ensuring compliance with all applicable environmental regulations; and ensuring that all natural, cultural, and socioeconomic commitments made during the planning phase are met during final design of all SHA capital projects.

Source: Jacobs, Susan M., Maryland Department of Transportation. No date. Personal communication.

Wye Island

Changes in nitrate concentrations in ground water between an agricultural field planted in tall fescue (*Festuca arundinacea*) and riparian zones vegetated by leguminous or nonleguminous trees were measured to determine the effectiveness of riparian vegetation management practices. Analysis of shallow ground water samples indicated that nitrate concentrations beneath nonleguminous riparian trees decreased toward the shoreline, and removal of the trees resulted in increased nitrate concentrations. Nitrate concentrations did not decrease below leguminous trees, and removal of the trees resulted in decreased ground water nitrate concentrations.

Source: James, B.R., B.B. Bagley, and P.H. Gallagher. 1990. Riparian Zone Vegetation Effects on Nitrate Concentrations in Shallow Groundwater. Submitted for publication in the *Proceedings of the 1990 Chesapeake Bay Research Conference*. University of Maryland, Soil Chemistry Laboratory, College Park, MD.

Rhode River Subwatershed

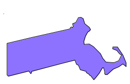
Phosphorus export from a riparian forest was shown to be nearly evenly divided between surface runoff (59%) and ground water flow (41%) for a total phosphorus removal of 80%. The mean annual concentration of dissolved total phosphorus changed little in surface runoff. Most of the concentration changes occurred during the first 19 meters of the riparian forest for both dissolved and particulate pollutants. Dissolved nitrogen compounds in surface runoff also declined. Total reductions of 79% for nitrate, 73% for ammonium nitrate, and 62% for organic nitrate were observed. Changes in mean annual ground water concentrations decreased significantly (90% to 98%), while ammonium nitrate concentrations increased by more than threefold. Again, most of the nitrate loss occurred in the first 19 meters of the riparian forest. It appears that the major pathway of nitrogen loss from the forest was in subsurface flow (75% of the total nitrate) with a total removal efficiency of 89% for total nitrate.

Source: Peterjohn, W.T., and D.L. Correll. 1984. Nutrient dynamics in an agricultural watershed: Observations on the role of a riparian forest. *Ecology* 65(5):1466-1475.

Wetlands Assistance Guide

The *Private Landowner's Wetland Assistance Guide* is a comprehensive guide to federal, state, and private/nonprofit programs offering technical and/or financial assistance to private wetland owners within the state of Maryland.

Source: State of Maryland. 1992. *Private Landowner's Wetlands Assistance Guide: Voluntary Options for Wetlands Stewardship in Maryland*. U.S. Environmental Protection Agency, Region 3, Philadelphia, PA.



Massachusetts

Cape Cod Coastal Embayments

In 1990 the Massachusetts Department of Environmental Protection initiated a $100,000 study to examine the potential restoration of 500 to 1000 acres of salt marsh cut off from tidal influence by transportation infrastructure. It is anticipated that, by designing culverts to provide tidal flows that more closely approximate natural conditions and by constructing larger channels in and around transportation facilities, the productivity of these marshes will be restored.

Source: Coastal America Partnership. 1997. *Wetlands Protection and Restoration*. Coastal America, Washington, DC.

Natural Storage in the Charles River Valley

The Charles River basin drains approximately 307 square miles in the Boston, Massachusetts, area. It is the most densely populated river watershed in New England. Severe flooding in 1955 due to Hurricane Diane caused more than $5 million in damages to the watershed. The USACE studied the area to identify a solution for future flooding. In 1984 the USACE unveiled a plan entitled "The Charles River Natural Valley Storage Project." Instead of structural controls, the project relied mainly on preserving wetlands. The plan identified 6,930 acres of land in 17 existing wetlands within the river basin as essential and stated that they would be protected. Protection is a result of purchasing the land outright or purchasing easements, which prevent current and future owners from interfering with natural water storage. A portion of the land protected is uplands and fringe wetlands.

The USACE decided on the measures in the Charles River Natural Valley Storage Project because "wetlands provide a prudent and least-cost solution to future flooding." By preserving the wetlands, costly structural controls were avoided. Purchasing the land and easements had cost $10 million, only 10 percent of the estimated $100 million cost of constructing a dam for the same purpose. The USACE also estimated that in 1987 an additional $3.2 million in damages was prevented by controlling severe spring flooding in the land purchased as part of the Charles River Natural Valley Storage Project. It has been further estimated that the city of Boston has realized annual savings of $17 million in flood damage from the project.

In addition to maintaining the natural hydrology of the area, the preservation of the wetlands also benefits the aesthetic and ecological quality of the floodplain. Further benefits are seen in the local property values. Statistical analysis in the Charles River Natural Valley Storage Project area has confirmed a 1.5 percent premium added to the property values of homes next to the wetlands. Realtors in the area have also noted an undeniable advantage to selling the land adjacent to the wetlands.

Sources: National Audubon Society. No date b. *What's a Wetland Worth?* National Audubon Society, New York, NY.

Natural Resources Defense Council (NRDC). 1999. *Reports: Stormwater Strategies—Community Responses to Runoff Pollution*. Natural Resource Defense Council, New York, NY.

Wetland Protection

Massachusetts requires a permit for activities involving dredge-and-fill, or other alterations, within a wetland area or within a 100-foot buffer zone around a wetland area. The Wetlands Protection Act (Massachusetts General Laws Chapter 131, Section 40) provides jurisdiction for activities outside wetland areas and their buffer zones once a wetland has been altered as a result of an activity. Regulations have explicit criteria for the protection of water quality and aquatic habitat functions of wetlands, which are addressed in the review of permit applications. The Commonwealth's Stormwater Initiative also helps to protect wetlands by requiring the best practical method of treatment of new stormwater discharges to wetlands. Other practices to protect wetland functions, such as acquisition efforts, local bylaws, and increased buffer zones, are achieved through planning processes at the town meeting level.

Source: *Massachusetts Coastal Nonpoint Pollution Control Plan*. 1995. Massachusetts Office of Coastal Zone Management, Boston, MA.

Michigan

Peterson Wetland Restoration

The project successfully restored 14 ha of wetlands drained by a county tax ditch. Project goals included restoration of the 14-ha wetland, reduction of siltation and water volume entering the county drain and the Looking Glass River, increased flood storage, improved water quality, and creation of habitat for wetland wildlife. Wetland vegetation, waterfowl usage, and water retention increased. Because of the increase in water retention, the restored wetland now provides excellent wildlife habitat in addition to reducing sedimentation, erosion, and flooding. Water quality and siltation data are not available due to the absence of an adequate monitoring and assessment program.

Source: Eitniear, T. 1995. Peterson Wetland Restoration Project. In *Methods of Modifying Habitat to Benefit the Great Lakes Ecosystem,* ed .J.R.M. Kelso and J.H. Hartig, pp. 282-286 CISTI Occas. Paper No.1. Natural Research Council of Canada, Research Press, Ottawa, ON, Canada.

Grand Traverse Bay Watershed Initiative

The Grand Traverse Bay Watershed Initiative in Michigan represents an effort on the part of local organizations and agencies to manage resources in a five-county area in the state's lower peninsula. The program considers wetlands, riparian areas, and other environmental issues related to water quality within the bay watershed in a manner that balances economic growth with environmental protection.

Source: Wright, C. 1997. Grand Traverse Bay Watershed Initiative. Traverse City, MI.

Landowner's Guide

Living with Michigan's Wetlands is a comprehensive guide designed to help landowners understand wetlands, their benefits, basic techniques and options for wetland management, and the economic benefits of various protection methods. Wetland regulatory policies affecting landowners and sources for information and assistance are included. The document also provides information to help landowners make decisions regarding protection of wetlands and other natural resources while meeting economic needs and personal goals.

Source: U.S. Environmental Protection Agency (USEPA). 1996-1997. *Living with Michigan's Wetlands: A Landowner's Guide.* U.S. Environmental Protection Agency, Washington, DC.

Meadows Golf Club

The Meadows Golf Club, which finished its first year of operation in 1994, was designed to model sound environmental practices. Wetlands located on the course are used as biological filters. In addition, vegetated buffer zones, established around sensitive wetland areas, aid in reducing nutrient runoff into the waterways. Water quality monitoring indicates a steady decline in the amount of nitrates, phosphates, suspended and dissolved solids, and ammonia exported from golf course wetlands.

Source: U.S. Environmental Protection Agency (USEPA). 1995c. *Nonpoint Source News-Notes*. August/September, issue no. 42. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Michigan Wildlife Habitat Foundation

The Michigan Wildlife Habitat Foundation (MWHF) is focused on restoring and improving wildlife habitat, and it has an active program for wetland restoration on private lands. The landowner must provide a match of at least $100 per acre and must sign an agreement that land uses on the site will not change for 10 years. The remaining restoration costs are covered by MWHF.

Source: Michigan Wildlife Habitat Foundation. 1997. *Saginaw Bay Watershed: A Strategy for Wetland Restoration*. Consortium for International Earth Science Information Network.

Wetland Protection

Michigan has implemented the Clean Water Act §404 Program since 1984. Water quality impacts are considered in the permit review process, and §404 permits are not issued for activities that would result in a violation of state water quality standards. The Goemaere-Anderson Wetland Protection Act, the Inland Lakes and Streams Act, and the Great Lakes Submerged Lands Act are also used to protect wetlands and riparian areas from the effects of new activities.

Source: *Michigan Coastal Nonpoint Source Program*. 1996. Michigan Department of Environmental Quality, Lansing, MI.

Watershed Initiative Program

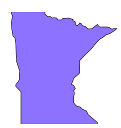
Michigan's Watershed Initiatives program implements management measures to protect nonpoint source functions within wetlands and riparian areas. Existing conditions within the wetlands, as well as the effects of activities upstream in the watershed, are addressed. This is accomplished on a targeted basis through the Watershed Initiatives, which identify priority areas for wetland protection and restoration in selected watersheds. The state utilizes funds and technical assistance provided through Clean Water Act §319 and Coastal Zone Management Act grants to encourage local governments and communities to implement best management practices on a watershed basis for wetland protection and restoration.

Source: *Michigan Coastal Nonpoint Source Program*. 1996. Michigan Department of Environmental Quality, Lansing, MI.

Wetland Acquisition

Michigan's wetland protection approach is supplemented by a program of state acquisition of wetlands, state encouragement of wetland easements, state designation of Environmental Areas to protect coastal wetlands and adjacent uplands, and encouragement of private wetland acquisition efforts. Instruments such as tax reversion and land exchange are used to maximize acquisition efforts.

Source: *Michigan Coastal Nonpoint Source Program*. 1996. Michigan Department of Environmental Quality, Lansing, MI.



Minnesota

Clear Lake

Clear Lake, a 257-ha body of water in south central Minnesota, is a heavily used recreational area. The lake has become eutrophic because of inflow of nutrient-rich runoff from the adjacent city of Waseca. In 1981, 50% of the hydraulic load and 55% of the phosphorus load to the lake was diverted into a 21.4-ha marsh system. Between 1981 and 1986, the wetland reduced the annual phosphorus load to Clear Lake by 39%. In 1986 construction was completed on a second marsh system designed to filter urban and agricultural runoff carrying 20% of the phosphorus load into the lake.

Source: Barten, J.M. 1987. Stormwater runoff treatment in a wetland filter: Effects on the water quality of Clear Lake. *Lake and Reservoir Management* 3:297-305.

Conservation Reserve Enhancement Program

In February 1998 Minnesota and the Federal Government approved the Minnesota River Conservation Reserve Enhancement Program (CREP). CREP will combine state funds with the federal Conservation

Reserve Program to restore 190,000 acres of floodplain marshes and forests around the Minnesota River.

Source: Environmental Defense Fund. 1998. EDF Praises Minnesota River Conservation Reserve Enhancement Program. News release, February 19, 1998.

Economic Efficiency of Wetland Mitigation in Minnesota's Red River Valley

The economic efficiency of wetland mitigation in Minnesota's Red River Valley was examined using the Minnesota Routine Assessment Method on 10 wetland case studies to rate the functions of impacted and replacement wetlands. Secondary sources were used to assign dollar values to wetland functions of impacted and replacement wetlands. Estimated annual social values ranged from $207 to $1,027 per acre for impacted wetlands and from $268 to $927 per acre for replacement wetlands. The social values of replacement wetlands exceeded the social values of impacted wetlands in seven cases. Values of replacement wetlands were 1.8 to 4 times greater than the values of impacted wetlands due to 2-to-1 replacement ratios.

Source: Detenbeck, N.E., C.A. Johnson, and G.J. Niemi. 1993. Wetland effects of lake water quality in the Minneapolis/St. Paul metropolitan area. *Landscape Ecology* 8:39-61.

Fish Lake

An urban lake in the Minneapolis-St. Paul area was found to retain sediment and nutrient loads in runoff routed through the wetland. Comparison of annual loads entering and leaving the wetland showed the retention of incoming loads in the wetland was 97% of nonvolatile suspended solids, 76% of volatile suspended solids, 48% of total phosphorus, 4% of dissolved phosphorus, 3% of dissolved nitrite plus nitrate nitrogen, 1% of total ammonia nitrogen, and 47% of total organic nitrogen.

Source: Brown, R.G. 1985. Effects of an urban wetland on sediment and nutrient loads in runoff. *Wetlands*, 4(1):147-158.

Lake McCarrons

A combined detention/wetland stormwater treatment facility was constructed upstream of Lake McCarrons to decrease phosphorus loads in stormwater entering the lake and to restore a degraded wetland. Nutrient removal effectiveness of the pond was determined based on mass inflows and outflows from rainfall and snowmelt events summed over the entire period of the study. Samples were analyzed for a wide range of particulate and dissolved constituents including suspended solids and various nitrogen and phosphorus species. Removal of total suspended solids was greater that 90%, total phosphorus was reduced by over 78%, and total nitrogen was reduced by greater than 74%. The goal to reduce the total phosphorus load to the lake by 75% was achieved.

Source: Oberts, G.L., and R.A. Osgood. 1991. Water-quality effectiveness of a detention/wetland treatment system and its effect on an urban lake. *Environmental Management* 15(1):131-138.

The Minnesota Department of Natural Resources

The Minnesota Department of Natural Resources computed the average cost to replace an acre-foot of floodwater storage to be $300. In other words, if development eliminates 1-acre of wetland that naturally stores a 12-inch depth of water during a storm, it would cost the public $300 to replace the water storage. The cost to replace 5,000 acres of wetlands lost annually in Minnesota would be $1.5 million.

Source: Floodplain Management Association. 1994. Economic benefits of wetlands. *FMA News: The Newsletter of the Floodplain Management Association* (July).

Minnesota USGS

The USGS conducted a study to determine the effectiveness of two VSF for reducing chemical loads in feedlot runoff and to investigate how infiltration from the VSF affects ground water. Water samples were analyzed for concentrations of nitrate, ammonium, organic nitrogen, phosphorus, chloride, sulfate, fecal coliforms, and chemical oxygen demand. Ground water samples were analyzed for dissolved oxygen, pH, specific conductance, and temperature. A report is being prepared that will summarize the discharge and chemical data collected, information about the effectiveness of VSF for treating feedlot runoff, and information about the impacts of infiltration from VSF on ground water.

Source: U.S. Geological Survey (USGS). 1997b. Summary of Project MN14702: Effectiveness of

Vegetated Filter Strips for Remediating Feedlot Runoff in Minnesota. U.S. Geological Survey, Reston, VA.

Reference Wetlands Project

Minnesota initiated the Reference Wetlands Project to develop a basis for assessing the biological and chemical health of wetlands. The assessment of 32 relatively undisturbed and three disturbed wetlands will be used to provide a basis for determining use support status and will help the state determine if restored wetlands can achieve conditions comparable to natural wetlands.

Source: U.S. Environmental Protection Agency (USEPA). 1995b. *National Water Quality Inventory: 1994 Report to Congress*. EPA841-R-95-005. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Stevens County

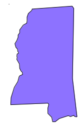
Vegetated buffer strips were evaluated to determine pollution control efficiencies for feedlot runoff. Buffer strips were planted in corn, sorghum, sudan grass, or oats. Runoff and total solids transported from the feedlot were reduced by 67% and 79%, respectively. Total nitrogen was reduced by an average of 84% and total phosphorus by an average of 83%.

Source: Young, R.A., T. Huntrods, and W. Anderson. 1980. Effectiveness of vegetated buffer strips in controlling pollution and feedlot runoff. *Journal of Environmental Quality* 9(3):483-487.

Wetland Conservation Plan

The Conservation Plan was developed to improve management and conservation of wetlands. The plan was designed to use existing wetland policies as a starting point to improve policies and enhance information for decision making. The plan addresses regional differences in the state based on their ecology and general landscape, watershed features, major land use patterns, and wetland characteristics.

Source: Minnesota Department of Natural Resources. 1997. *Minnesota Wetland Conservation Plan, Version 1.0.* Minnesota Department of Natural Resources, St. Paul, MN.



Mississippi

Coastal Preserves

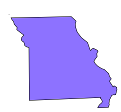
The Mississippi Department of Marine Resources will acquire 2,500 acres of Grand Bay savannah and coastal marshes within the Grand Bay Bioreserve in the Grand Bay/Bangs Lake area of Jackson County. Only 3% of the rare and biologically significant coastal savannah remains. It is the largest and least disturbed wet pine savannah in the nation. The area includes estuarine, marsh, and scrub shrub wetlands. The preserve is one of Mississippi's three largest estuarine wetland ecosystems and is a vital nursery area for estuarine and marine fish and shellfish species.

Source: U.S. Fish and Wildlife Service (USFWS). 1998b. *1998 Coastal Wetlands Conservation Grant*. U.S. Department of Interior, Fish and Wildlife Service, Washington, DC.

Pearl River Basin

The synoptic assessment approach is being used in the Pearl River Basin to provide information on cumulative impacts for use in the 404 permit review process. The assessment approach evaluates wetland losses from conversion and the effects of the losses on hydrologic function.

Source: U.S. Environmental Protection Agency (USEPA). 1992a. *A Synoptic Approach to Cumulative Impact Assessment: A Proposed Methodology.* EPE/600/R-92/167. U.S. Environmental Protection Agency, Washington, DC.



Missouri

Missouri Department of Conservation

The Ralph and Martha Perry Memorial Conservation Area Wetlands Restoration program created 737 acres of wetlands in three counties located along the Blackwater River. The project will enable the Missouri Department of Conservation to better manage the habitat by controlling the flow of water to and from the land in ways that simulate natural processes. This is one of only 24 projects nationwide that received funding in 1995 from the North American Wetlands Conservation Council.

Source: Missouri Department of Conservation. 1998. *Ralph and Martha Perry Memorial Conservation Area.* Missouri Department of Conservation, Jefferson City, MO.

Bay Island, Hannibal

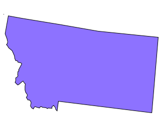
Sedimentation resulting from high flow levels in the Upper Mississippi River has resulted in deterioration and loss of riverine forested wetland habitat. Restoration of wetland functions in the Bay Island Complex included construction of low-level levees, water level management, and planting of mast tree species. Water level management during critical times of the year provides valuable resting and feeding habitat for migratory waterfowl and wintering bald eagles. Shorebirds, furbearers, and other wildlife species also benefit from restoration of prime wetland habitat. Planting of mast tree species provides important food resources for wood ducks and adds diversity to the bottomland hardwood forest that currently exists in the area.

Source: USACE, Great Lakes Regional Headquarters. 1997. *Environmental Management Program: Bay Island Wetland Habitat Rehabilitation and Enhancement*. USACE, Great Lakes Regional Headquarters, Chicago, IL.

Operation Green Stripe

Through Operation Green Stripe, Future Farmers of America (FFA) chapters recruit farmers to establish vegetative buffers between their fields and surface water supplies. Cooperating agriculture retailers provide free grass seed for the strips, and Monsanto provides educational grants to FFA chapters based on the number of farmers the students recruit.

Source: Monsanto. 1997. *Operation Green Stripe*. Monsanto, St. Louis, MO.



Montana

Pine Butte Swamp

The Nature Conservancy's Pine Butte Swamp Preserve is an 18,000-acre area consisting of a large fen, native foothills prairie, and rocky ledges of limber pine and creeping juniper. The preserve includes the largest wetland complex along the Rocky Mountain Front and represents the grizzly bear's last stronghold on the plains. Studies have been completed on the area's hydrology, vegetation, and wildlife, and the Conservancy has developed a long-range management plan for the fen, the grizzly bear, and the surrounding foothill prairie. Cooperative efforts with local agencies and neighboring landowners enhance the integrity of the ecosystem.

Source: The Nature Conservancy. 1998c. *Pine Butte Swamp Preserve.* The Nature Conservancy, Arlington, VA.

Ronan Spring Creek

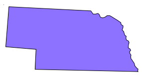
Located in northwestern Montana, about 50 miles north of Missoula, Ronan Spring Creek is only 4 miles long. It is a tributary to Crow Creek, which flows to the Flathead River and eventually drains into the Columbia River. Farming practices, urbanization, and grazing activities had led Ronan Spring Creek to be 200 feet wide but only a few inches deep. In 1996 the Confederated Salish and Kootenai Tribes, Bill Edelman (who owns the creek), and the NRCS began to contact neighbors along the creek, local groups, and state and federal natural resource agencies to create a large partnership. Money for the restoration effort was provided through a grant by the state Fish, Wildlife and Parks Department's Future Fisheries program, the Ronan State Bank, and Pheasants Forever. Approximately $5,000 was used for shrubs. Harriman Trout Farms donated fish, and the Confederated Salish and Kootenai Tribes offered staff time and expertise. In the end, the creek was restored to 8 feet wide and 4 feet deep, which will help to bring back fish habitat and backwaters for waterfowl.

Source: Natural Resources Conservation Service (NRCS). 2000b. *Erosion Control, Water Management, Local Partnerships, Wildlife Habitat*. U.S. Department of Agriculture, Washington, DC.

Stream Management Guide

The *Stream Management Guide for Landowners, Managers, and Stream Users* provides helpful background information for landowners and managers, resource professionals, state and local decision makers, recreationists, and others interested in streams. The document discusses the characteristics of streams and restoration of degraded streams and riparian areas, and it presents examples of stream and riparian area problems that might be encountered.

Source: Montana Department of Environmental Quality. 1995. *The Stream Management Guide for Landowners, Managers and Stream Users*. Color World, Bozeman, MT.



Nebraska

Heron Haven Wetland Restoration

Monitoring of water quality is being conducted (as of 1997) on this highly urbanized wetland to determine the appropriate best management practices to be applied in restoration efforts. Restoration efforts are being directed at protecting the wetland from NPS impacts and improving water quality and habitat characteristics. Quarterly monitoring was begun in December 1995, and some impacts of urban runoff to the wetland have been assessed. A report on restoration efforts to date is being prepared for the project.

Source: University of Nebraska–Lincoln. 1997a. *Heron Haven Wetland Restoration Project*. Water Center Environmental Programs Unit. University of Nebraska, Lincoln, NE.

Ithica

A series of studies and demonstrations are being conducted at the Agricultural Research and Development Center near Ithica to develop and demonstrate regionally relevant VFS designs in large-scale riparian plots, compare and demonstrate the efficacy of several VFS designs with different vegetation compositions and widths, and to evaluate the overall contribution of riparian VFS in NPS abatement on a realistic subwatershed scale. The overall aim of the program is to better define the most effective VFS for the Midwest and promote their use as BMPs in Nebraska.

Source: University of Nebraska–Lincoln. 1997b. Riparian Buffer Strips (RBS). Water Center Environmental Programs Unit. University of Nebraska, Lincoln, NE.

Private Lands Wetlands Initiative Program

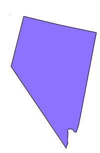
The Nebraska Game and Parks Commission (NGPC) funds a two component program that provides for wetland development and financial incentives to participate in the water bank program. The intent of the program is to pay for the landowner’s actual costs for restoring, enhancing, or creating shallow wetlands and adjacent upland habitat for the benefit of waterfowl and other wildlife. The NGPC will reimburse the landowner for 100% of the costs. It will also provide landowners a one-time lump sum incentive for enrolling existing wetlands in the USDA’s Water Bank Program or for extending their existing contract.

Source: Nebraska Game and Parks Commission. 1997. *Programs for Restoring, Creating, and Enhancing Wetlands on Private Lands in Nebraska*. Nebraska Game and Parks Commission, Lincoln, NE.

Tiburon Golf Course

The Wehrspann Lake Watershed Project has organized several Water Quality Opens at a local golf course in Omaha. Participants enjoy 18 holes of golf while learning about measures the golf course is taking to preserve water quality on the course and other steps being taken to preserve water quality and habitat elsewhere in the watershed. A unique educational feature of the tournament lies in the fact that people from all walks of life are brought together in a casual environment that is conducive to learning about nonpoint source pollution. The tournaments also help to stimulate discussions between the golfers and the golf course managers about management practices, such as the nonpoint source treatment functions of wetlands.

Source: U.S. Environmental Protection Agency (USEPA). 1998a. *Top Ten Watershed Lessons Learned.* EPA 840-F-97-001. U.S. Environmental Protection Agency, Office of Water, Washington, DC.



Nevada

Lake Tahoe

A 3-year study in Lake Tahoe of nitrate removal in an undisturbed headwater watershed showed that riparian forests and wetlands were capable of removing over 99% of the incoming nitrate nitrogen. Wetlands and riparian areas in the watershed appeared to be capable of “cleaning up” nitrate-containing waters with a very high degree of efficiency and for providing a major value as natural pollution controls for sensitive waters.

Source: Rhodes, J., C.M. Skau, D. Greenlee, and D. Brown. 1985. Quantification of Nitrate Uptake by Riparian Forests and Wetlands in an Undisturbed Headwaters Watershed. In *Proceedings of Riparian Ecosystems and Their Management: Reconciling Conflicting Issues*, Tucson, Arizona, April 16-18,1985, pp. 175-179. GTR RM-120. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Walker River Paiute Tribe

The purpose of the Walker River Paiute Riparian Management Plan (Walker River Paiute Tribe) is to protect and improve riparian areas and water quality on the reservation.

Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

New Hampshire

Wetland Water Quality Standards

In New Hampshire, monitoring of a variety of parameters at five wetlands throughout the state will provide baseline data for developing specific wetland water quality standards.

Source: U.S. Environmental Protection Agency (USEPA). 1995b. *National Water Quality Inventory: 1994 Report to Congress*. EPA841-R-95-005. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

New Jersey

Agricultural Experiment Station

The New Jersey Agricultural Experiment Station has developed a five-zone model for determining buffer widths for the protection of surface waters from NPS pollution.

Source: Nieswand, G.H., B.B. Chavooshian, R.M. Hordon, T. Shelton, S. Blarr, and B. Brodeur. 1989. *Buffer Strips to Protect Water Supply Reservoirs and Surface Water Intakes: A Model and Recommendations.* Prepared for the New Jersey Department of Environmental Protection by Cook College Department of Environmental Resources.

Freshwater Protection Act Rules

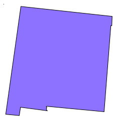
The Freshwater Protection Act Rules (New Jersey Administrative Code 7:7A) require ecological transition areas adjacent to wetlands of exceptional or intermediate value. Wetlands of ordinary resource value, which constitute approximately 5% of the state, do not require buffers. The standard width of the transition area for wetlands of exceptional value is 150 feet, and for freshwater wetlands of intermediate value, it is 50 feet. Wetlands of exceptional value include those which discharge into FW-1 or FW-2 trout waters or their tributaries (FW-1 and FW-2 are water quality rankings for fresh surface waters in New Jersey) or those which provide habitat for threatened or endangered species. Freshwater wetlands of ordinary resource value are those which do not exhibit the characteristics above, are isolated wetlands that are more than 50% surrounded by development, and are less than 5,000 square feet in size, including, but not limited to drainage ditches, swales, and detention facilities. Freshwater wetlands of intermediate value include those which are not defined as either exceptional or ordinary. Activities within buffers are limited based on the determined wetland value and guidelines established at New Jersey Administrative Code 7:7A-6.2.

Source: New Jersey Department of Environmental Protection and Energy. 1992. *Freshwater Wetlands Protection Act Rules, New Jersey Administrative Code 7:7A*. New Jersey Department of Environmental Protection, Trenton, NJ.

Green Acres Program

The New Jersey Green Acres Program provides funding for state, county, municipal, and nonprofit organization acquisition of open lands, including wetlands, for the purpose of conservation. The program also provides funding for the development of recreational facilities that offer public access and use of wetlands and riparian areas.

Source: *New Jersey Coastal Nonpoint Pollution Control Program*. 1995. New Jersey Department of Environmental Protection, Trenton, NJ.



New Mexico

Partners Project

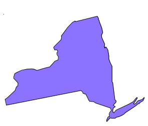
Kimberly de Castro of Santa Fe, a participant in the U.S. Fish and Wildlife Service's Partners for Fish and Wildlife Program, received the Environmental Law Institute's National Wetlands Award in the Land Stewardship and Development category. The award recognizes her commitment to habitat restoration and her devotion to educating youth about having respect for the land. Ms. de Castro dedicated her entire 50-acre property to wildlife, restoring two wetlands and planting more than 5,000 plants. The restored land has also become an outdoor learning center. Since 1987, Partners for Fish and Wildlife has funded more than 17,900 landowner agreements and helped restore 397,000 acres of wetlands and 1,400 miles of riparian and in-stream habitat.

> Source: U.S. Fish and Wildlife Service (USFWS). 1998d. New Mexico Partners Project Wins National Wetlands Award. Press release, April 22, 1998. U.S. Department of Interior, Fish and Wildlife Service, Washington, DC.

Riparian Preserve

The Gila Riparian Preserve protects a prime example of Southwest riparian habitat along the Gila River, New Mexico's last major free-flowing river. Regular flooding facilitates the germination of seedlings in beds created by high river flows.

> Source: The Nature Conservancy. 1997. *Gila Riparian Preserve*. The Nature Conservancy, Arlington, VA.



New York

Audubon Golf Course Program

The Audubon Society of New York State teamed with the U.S. Golf Association to establish the Audubon Cooperative Sanctuary Program for Golf Courses. Objectives include enhancement of wildlife habitat and protection of natural resources on golf courses. Active participation in conservation programs by golf course superintendents, course officials, golfers, and the public is encouraged. Participants in the program develop a plan of action to enhance habitat and improve management practices. A course may become certified in the following areas: environmental planning, wildlife and habitat management, public involvement, integrated pest management, water conservation, and water quality management. More than 1900 golf courses nationwide have joined the program since its inception.

> Source: U.S. Golf Association. 1998. *An Overview of U.S. Golf Association Environmental Research*. U.S. Golf association, Far Hills, NJ.

Buffalo River and Cazenovia Creek Model

The Buffalo River and Cazenovia Creek Model Wetlands and Watershed Stewardship Program is part of the Erie County Department of Environment and Planning's program to assist municipalities with planning issues at a watershed level. The project was first proposed in 1997 as a demonstration project, which was very successful and cost-effective. It aims to create a heightened sense of community awareness and encourages environmental stewardship for three new natural parks along the Buffalo River. It also provides an educational work experience and real job training for youth. The project cost $10,450 and was supplemented by a grant from EPA and the U.S. Department of Labor. NACO provided funding to implement and document the program. The county estimates that other counties that wish to implement a similar project should expect a cost of $10,000 to $15,000.

> Source: International City/County Management Association and National Association of Counties (ICMA and NACO). 1999. *Protecting Wetlands, Managing Watersheds...Local Government Case Studies.* International City/County Management Association and National Association of Counties, Washington, DC.

Monroe County Wetland Education Program

Through a $20,000 grant from EPA, $5,000 of in-kind services from the county Health Department, and at least $4,000 of in-kind services from the Environmental Management Council, Monroe County hired an intern to advance wetland education efforts in schools and with public officials. The wetland education activities were developed by the intern and other county staff. This effort focuses on watersheds in

Monroe County, but participants from adjoining municipalities that share common watersheds with Monroe County have participated in the wetland workshops.

Source: International City/County Management Association and National Association of Counties (ICMA and NACO). 1999. *Protecting Wetlands, Managing Watersheds...Local Government Case Studies.* International City/County Management Association and National Association of Counties, Washington, DC.

The Salt Marsh Restoration Team (SMRT)

The SMRT has received the American Rivers 1997 Urban Hometown River Award, a GOLD award for Special Achievement in Scientific/Engineering Breakthrough. SMRT is restoring and enhancing a critical salt marsh on the western shore of Staten Island and on the islands of Arthur Kill and Kill Van Kull that were damaged by a 567,000-gallon oil spill. The restoration focused on restoring smooth cordgrass. Cordgrass stabilizes the shoreline against the massive erosion that is occurring in the absence of the plant community, replaces lost habitat, and accelerates the rate of reduction for petroleum contaminants left from the spill. SMRT has successfully restored over 1.25 miles of shoreline, amounting to over 6 acres of hand-planted nursery-grown grasses. Rapid erosion of shoreline has been halted in this area.

Source: American Rivers. 1998. American Rivers 1997 Urban Hometown River Award. American Rivers, Washington, DC.

Skaneateles Lake

Chris and Rick Fesko own a 1,200-acre farm on the hillside east of Skaneateles Lake. With the help of the Onondaga Soil and Water Conservation District and the Skaneateles Lake Watershed Agricultural Program, the Feskos plan to add more BMPs to those already existing on their property. The costs for these new efforts are estimated at $150,000, which will be contributed by the Feskos, NRCS, Farm Service Agency, EPA, New York State, and the city of Syracuse.

Source: Natural Resources Conservation Service (NRCS). 2000b. *Erosion Control, Water Management, Local Partnerships, Wildlife Habitat*. U.S. Department of Agriculture, Washington, DC.

Staten Island Bluebelt Project

Staten Island is the least populated and least developed of New York City's five boroughs. In the 1970s, the city zoned 672 acres as "Open Space Network," an undevelopable, environmentally sensitive area. In the 1980s, the state began regulating freshwater and tidal wetlands, which allowed for more wetland protection on Staten Island. In the 1990s, the DEP started the storm sewer construction and maintenance system in South Richmond, Staten Island. The system uses existing, natural drainage systems (including streams, ponds, and wetlands) as the main part of the stormwater system. The system covers 11 watersheds consisting of 6,000 acres. Additions to the system will include constructed wetlands, settling ponds, and sand filters (NRDC, 1999). Freshwater and tidal wetlands on Staten Island were acquired for use as stormwater treatment systems. Beginning in the 1970s, the New York State Department of Environmental Conservation delineated rivers and wetlands of important nonpoint source abatement functions. A cost/benefit study indicated that the Bluebelt project saves about $50 million over the conventional trunk sewer line approach! Constructed wetlands might be incorporated into the Bluebelt System (Gumb, D., et al., 1996). The Bluebelt is 265.5 acres.

Sources: Gumb, D., J. Vokral, R. Smith, S. Mehrotra. 1996. Staten Island Bluebelt Project: New York City's Watershed Approach with Multiple Benefits. In *Watershed '96 Proceedings.* U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Natural Resources Defense Council (NRDC). 1999. *Reports: Stormwater Strategies—Community Responses to Runoff Pollution*. Natural Resource Defense Council, New York, NY.

Wetland Protection

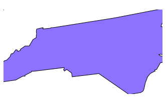
New York requires permits for activities within a tidal or nontidal wetland or regulated adjacent area, generally extending a distance of 100 to 300 feet landward from the wetland boundary. New York also establishes cooperative agreements with local governments and municipal governments for the purpose of preserving, maintaining, or enhancing wetlands. The State Environmental Quality Review evaluates impacts on wetlands and riparian areas from activities outside the wetland or regulated adjacent area.

Source: *New York Coastal Nonpoint Program Submission*. 1995. New York Department of Environmental Conservation, Albany, NY.

Wetland Regulation Guidebook

The purpose of the guidebook is to provide planners, developers, and the public with an introduction to the scope and application of existing laws and regulations that directly or indirectly affect wetlands in New York.

Source: Trust for Public Land. 1999. *Economic Benefits of Open Space Bibliography: Infrastructure Savings*. Trust for Public land, San Francisco, CA.



North Carolina

Atlantic White Cedar Wetland Restoration

The purpose of the restoration project was to restore wetland hydrology on 392 acres and plant Atlantic White Cedars on 25 acres of cleared, ditched, and drained wetlands to revitalize wildlife and water quality attributes. The time frame for completing restoration work was limited due to planting requirements. The project was completed in 3 months.

Source: Gantt, L.K. 1994. *Atlantic White Cedar Wetlands Restoration Cookbook of Innovations in Coastal Protection.* U.S. Environmental Protection Agency, Office of Wetlands, Oceans and Watershed, Washington, DC.

Coastal Plain vs. Piedmont

The effectiveness of VFS and riparian buffers for trapping sediment and nutrients was compared for two sites in North Carolina, one in the Piedmont Physiographic Province and the other in the Coastal Plain. Runoff, sediment, and chemical analyses were completed on a number of storm events at each site. At both test sites, the grass strips filtered in excess of 50% of the sediment from the agricultural source areas. The riparian strips were less consistent at reducing sediment yields. Chemical filtration of agricultural runoff by the grass and riparian buffers also occurred. Sediment-bound constituents were shown to be reduced to a greater degree than soluble nutrients, such as orthophosphorus.

Source: Parsons, J.E., J.W. Gilliam, R. Munoz-Carpena, R.B. Daniels, and T.A. Dillaha. 1994. Nutrient and Sediment Removal by Grass and Riparian Buffers. In *Proceedings of the Second Environmentally Sound Agriculture Conference*, Orlando, FL, April 20-22, 1994.

Pamlico River

The chemistry of porewaters and soils was compared using a low-organic-matter created intertidal marsh and an adjacent high-organic-matter natural intertidal marsh. Five years after emergent vegetation had established in the created wetland, the conversion from upland porewater and soil properties to natural wetland characteristics was incomplete. Results of the study indicate that wetlands created on upland sites initially may not duplicate the hydrologic and nutrient cycling functions characteristic of natural wetland systems. It is likely to take many more years before the created wetland soils become reduced and soil and porewater nutrient reservoirs develop to produce hydrologic and nutrient cycling attributes comparable to natural wetlands.

Source: Craft, C.B., E.D. Seneca, and S.W. Broome. 1991. Porewater chemistry of natural and created marsh soils. Journal of Experimental Marine Biology and Ecology 152(2):187(14).

Riparian Buffer Width Study

Riparian forests are effective as sediment, nitrogen, and phosphorus filters. Four watersheds in two research projects on the Coastal Plain were studied. The optimal width of a riparian forest for effective filtering is based on the contributing area, slope, and cultural practices on adjacent lands. Riparian strips as narrow as 16 meters were effective in removing nitrate.

Source: Cooper, J.R., J.W. Gilliam, and T.C. Jacobs. 1986. Riparian Areas as a Control of Nonpoint Pollutants. In *Watershed Research Perspectives*, ed. D. Correll, pp. 166-192. Smithsonian Institution Press, Washington, DC.

Streamside Rules for Nuese River

Modified rules protecting existing 50-foot riparian buffers along the Nuese River became effective January 22,1998. The riparian rule makes it illegal to remove existing forest vegetation within 30 feet of the bank, and it requires maintenance of dense vegetative cover for an additional 20 feet. Landowners are required to keep trees and plants healthy and to promptly repair any eroded channels.

Source: North Carolina Department of Environment and Natural Resources. 1998. News release, January 27, 1998. North Carolina Department of Environment and Natural Resources, Raleigh, NC.

Beaver Dam Creek Watershed

Nitrate concentrations in shallow ground waters beneath cultivated fields and in the drainage waters from those fields were examined to determine the fate of nitrogen lost to drainage waters. Studies indicated that a substantial part of the nitrogen in the drainage water was denitrified in the buffer strip. Buffer strips of less than 16 meters were effective for nitrogen reduction before drainage waters reached the stream. Subsurface nitrate leaving agricultural fields was reduced by 93% on average after passing through a forested buffer.

Source: Jacobs, T.C., and J.W. Gilliam. 1985. Riparian losses of nitrate from agricultural drainage waters. *Journal of Environmental Quality* 14(4):472-478.

Cypress Creek 1

A riparian forest was shown to be a sink for phosphate from cultivated fields. Over a 20-year period the riparian forest provided a sink for about 50% of the phosphate in runoff from adjacent croplands.

Source: Cooper, J.R., and J.W. Gilliam. 1987. Phosphorus redistribution from cultivated fields into riparian areas. *Soil Science Society of America Journal* 51(6):1600-1604.

Cypress Creek 2

Riparian areas adjacent to agricultural fields were examined to determine sediment accumulation over a 20-year period. The areal extent and thickness of sediment were described using ^{137}Cesium data and soil sediment morphology. Sediment delivery estimates for the Coastal Plain watershed indicated that 84% to 90% of the sediment removed from the cultivated fields remained in the watershed.

Source: Cooper, J.R., J.W. Gilliam, R.B. Daniels, and W.P. Robarge. 1987. Riparian areas as filters for agriculture sediment. *Soil Science Society of America Journal* 51(6):417-420.

North Dakota

Red River Riparian Area

The objectives of this research project were to identify and demonstrate BMPs by restoring riparian areas and subsequently reducing NPS pollution and to transfer this technology to producers and natural resource professionals throughout North Dakota.

Source: University of North Dakota. 1997. *Red River Riparian Demonstration Project*. Energy and Environmental Research Center. University of North Dakota, Fargo, ND.

Spring Creek Wetland

Two wetlands constructed on USACE reservoirs were monitored for their ability to remove NPS pollutants from stormwater runoff and possibly improve reservoir water quality. The two sites were the Spring Creek wetland, a 23-acre emergent marsh constructed in 1991 on Bowman Reservoir near Bowman, North Dakota, and a 5-acre wetland constructed in 1992 as part of a larger wetland complex on Range Creek, a major tributary of Ray Roberts Reservoir near Dallas, Texas. Sampling focused on storm events with less emphasis on base low flows. Samples were analyzed for suspended sediments, nutrients, and selected herbicides. Results from the two sites varied, but overall, the wetlands removed suspended sediments from inflows while being less effective at removing dissolved NPS pollutants. The Spring Creek wetland was capable of removing approximately 40% of total phosphorus. Neither wetland was effective at removing nitrogen or herbicide.

Source: Downer, C.W., and T.E. Myers. 1995. Constructed Wetlands for Sediment Control and Non-Point Source Pollution Abatement at US Army Corps of Engineers Project: Ray Roberts Lake, Dallas, Texas, and Bowman Haley Reservoir, Bowman, North Dakota. In *National Interagency Workshop on Wetlands*, USACE Waterways Experiment Station, New Orleans, LA, April 5-7, 1997.

Ohio

Conservation Easement Purchase

The Ohio EPA recently awarded a low-interest SRF loan to The Nature Conservancy to foster creek bank conservation. The Nature Conservancy received the $110,000 loan to purchase a 154-acre permanent conservation easement along Brush Creek in Adams County, Ohio. Ohio EPA's water quality standards classify this section of Brush Creek as almost achieving the exceptional warm water aquatic habitat classification. The creek is a significant statewide water resource and is known to contain four endangered aquatic species, including the club shell mussel. Conservation easements allow owners to voluntarily place permanent restrictions on how their property will be used and are an effective way to protect the quality of streams and their adjacent areas.

Source: U.S. Environmental Protection Agency (USEPA). 1998b. *Wetlands Projects Funded by the Clean Water State Revolving Fund (CW-SRF)*. U.S. Environmental Protection Agency, Office of Wastewater, Washington, DC.

Metzger Marsh Coastal Wetland Restoration Project

The Metzger Marsh Coastal Wetland Restoration Project, undertaken through the North American Waterfowl Management Plan, seeks to restore emergent wetland vegetation while permitting open access between the wetland and Lake Erie. This approach has not been successful in the past along Lake Erie, but innovative methods are being implemented to try to maximize coastal wetland values and functions.

Source: Tori, G. No date. Project 21. Metzger Marsh Coastal Wetland Restoration Project. *In Methods of Modifying Habitat to Benefit the Great Lakes Ecosystem.* Canada Institute for Scientific and Technical Information, Ottowa, ON. Occasional paper no. 1.

Ohio State University Extension Service

The Ohio State University Extension Service calculated the costs associated with creating VSFs on agricultural land. One of the costs they found was for tree planting and maintenance. The planting of seedlings in a VSF adds about $0.45/seedling to the total installation cost. Mowing once per month during May through September of the first 2 years only of the VSF adds $7/acre for each mowing operation. VSFs provide both economic and noneconomic benefits to the farmer, landowner, and surrounding areas. VSFs can cause a reduction in ditch maintenance costs that are assessed to landowners. In 1985 Ohio had 4,615 miles of open ditch under county maintenance programs. The costs of ditch maintenance in those counties with 50 miles or more of maintained ditch averaged $328/mile/year. The total estimated costs would exceed $1.5 million per year.

Since the VSF is an edge-of-the-field best management practice, which reduces the potential for sediment movement into water resources, most of the economic pollution control benefits occur off the farm. Based on a 1987 estimate, sediment added an extra $0.32/ton to water treatment costs. When considering all the communities in Ohio, a 25 percent reduction in the amount of sediment entering surface water supplies would save $2.7 million per year in water treatment costs.

Source: Leeds, R.D., L. Forster, and L.C. Brown. 1993. *Vegetative Filter Strip Economics*. Ohio State University Extension, Columbus, OH.

Ohio Wetlands

The Ohio Wetlands guide provides useful information on wetland status, type, and function. The effects of land use on wetlands and their protection and conservation are also presented.

Source: National Audubon Society. 1995. *Ohio Wetlands*. National Audubon Society, New York, NY.

Protecting Darby Creek

Recently, the Ohio SRF provided a low-interest loan to a homebuilder to construct a variety of preventive nonpoint source measures to protect the Darby Creek, which is one of the highest quality watersheds in the state. The project includes a wide variety of structural and nonstructural best management practices intended to protect approximately 1.5 miles of this high-quality watershed from potential runoff from a new housing development. The project includes construction of sediment and stormwater retention lakes, grassed waterways for stormwater treatment, restoration of the wooded stream corridor, and the establishment of emergent wetland habitat. Additionally, the project includes a 200-acre conservation easement to protect the most environmentally sensitive areas. The conservation easement contains conditions, covenants, deed restrictions, and regulations that protect the entire area. The project also contains an environmental education component for homeowners and housing contractors. This $575,000 project is part of the Nonpoint Source Program (Clean Water Act §319).

Source: U.S. Environmental Protection Agency (USEPA). 1998b. *Wetlands Projects Funded by the Clean Water State Revolving Fund (CW-SRF)*. U.S. Environmental Protection Agency, Office of Wastewater, Washington, DC.

Oklahoma

Hackberry Flat

More than 4,000 acres of wetlands and associated uplands in Tillman County will be acquired as migration, wintering, and breeding habitat for waterfowl and other migratory birds. A grant of $900,000 through the National Wildlife Refuge System and partner contributions of $2.4 million will fund the project, which also contributes to the habitat goals of the North American Waterfowl Management Plan's Playa Lakes Joint Venture. The project area is in the direct migration route of whooping cranes and provides habitat for bald eagles, thousands of ducks and geese, and sandhill cranes.

Source: U.S. Fish and Wildlife Service (USFWS). 1998e. Wetlands Projects Approved for 19 States. Fish and Wildlife Service News List Server. Listed April 30, 1998. U.S. Department of Interior, Fish and Wildlife Service, Washington, DC.

Wetlands Conservation Award

James Pielsticker, a civic leader in Tulsa who owns land along the Deep Fork River in Chandler, was awarded the Fish and Wildlife Service's Regional Wetlands Conservation Award for his work to restore and enhance wetlands on 310 acres of his property and his efforts to promote wetland conservation across Oklahoma. The restored wetlands are now managed to benefit waterfowl and other wetland-dependent wildlife, such as wintering bald eagles and migratory songbirds. Water quality has also improved with the reduced sedimentation and decreased erosion. Pielsticker participated in the Fish and Wildlife's Partners for Wildlife and has contributed over $150,000 to restoring wetland habitat on his property along the Deep Fork River floodplain.

Source: Langer E., and H. Stuart. 1997. James Pielsticker Wins Regional Wetlands Conservation Award From U.S. Fish and Wildlife Service. U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC.

Oregon

Bear Creek

Bear Creek, located in central Oregon, has been undergoing a constant transformation for more than 20 years. During 1977, it was reported that streambanks were eroding and sedimentation levels in Bear Creek were elevated during high water flows. To reverse this condition, grazing was reduced in the area, and during the early 1980s, grazing was stopped. In an attempt to promote willow growth along Bear Creek, existing juniper trees were also felled. By the mid 1980s, a new grazing regime was instituted to preserve newly emerging stream-bank vegetation. The surrounding pasture was divided into three units, and livestock were grazed in late winter and early spring. By this point, the stream channel had narrowed and approximately 1.5 feet of sediment was trapped in the floodplain by vegetation. A flood during the summer of 1987 threatened the stability of the stream, but within one month streamside vegetation reestablished and stabilized the floodplain.

Forage amounts for grazing livestock increased to 5 times the original amount grazed in the area by 1989. This led to local cost savings of $10,000 annually for hay production by local livestock operators. By the mid 1990s, Bear Creek was experiencing minimal damage from occasional flooding because of well-established riparian vegetation. The overall health of the creek was also improving as rainbow trout and beaver returned to the creek. In addition, forage levels increased from 200 pounds/acre to 2,000 pounds/acre, and the area now stores 4 million gallons of water per mile compared to 1977's 500,000 gallons per mile.

Sources: Bureau of Land Management (BLM). No date. *Problems and Solutions: A Riparian Improvement Example*. Bureau of Land Management, Washington, DC.

Salmon River Salt Marsh

Progress in the restoration of the Salmon River Salt Marsh was assessed by examining changes in the plant species, plant communities, elevation of the site, the role of salinity and soil texture, width and depth of creek cross sections, and estimated aboveground net primary production. Restoration goals were determined to be met in the sense that the restored salt marsh now consists of typical Pacific Northwest salt marsh communities; tidal exchanges are complete; creeks now provide habitat for juvenile fish; and the marsh is highly productive. The goal of returning the diked salt marsh to its original high salt marsh condition was not met. Based on study results, guidelines were developed to aid wetland managers in restoration projects.

Source: Frenkel, R.E., and J.C. Morlan. 1991. Can we restore our salt marshes? Lessons from the Salmon River, Oregon. *Northwest Environment Journal* 7:119-135.

Tulatin River, Washington County

A graduate student at Oregon State University studied two tributaries of the Tulatin River. His studies showed that riparian restoration on a widespread scale could result in savings of more than $1 million annually in reduced river dredging and water treatment costs. The costs of restoring 19.7 miles of Gale Creek and 26.1 miles of Dairy Creek, two tributaries of the Tulatin, were estimated at $660,000, or $2 per person in Washington County.

Source: Environmental News Network (ENN). 1996. *Riparian restoration is cost-effective, study shows*. ENN, Sun Valley, ID.

West Eugene Wetlands Project

The West Eugene Wetlands Project is a cooperative partnership between the Bureau of Land Management, the City of Eugene, and Lane County, Oregon, to acquire and manage the last wetlands in the Willamette Valley.

Source: Bureau of Land Management (BLM). 1997. *Environmental Education*. Bureau of Land Management, Eugene, OR.

Wetland Mitigation Bank

The West Eugene Wetland Mitigation Bank was established by the city of Eugene, Public Works Engineering Division, Water Resources Team. Its goal is to provide a mechanisms to fund wetland mitigation projects and to carry out the West Eugene Wetlands Plan. It might also serve other community needs. Funds for mitigation are derived from credit sales. The mitigation bank currently charges $30,000 per mitigation credit, of which 83 percent was spent on the development, design, planning, and construction of the credit. The remaining charge is for the management of the mitigation site and the mandated operation and management period.

Source: Bureau of Land Management (BLM). 1997. *Environmental Education*. Bureau of Land Management, Eugene, OR.

Wetlands Conservation Guide

The Oregon Wetlands Conservation Guide is a comprehensive guide to federal, state, and private/nonprofit programs offering technical and/or financial assistance to private wetland owners in the state of Oregon. It is also an appropriate resource guide for management of public lands (parks, open space, wildlife refuges, recreation areas).

Source: Oregon Wetlands Conservation Alliance. No date. *The Oregon Wetlands Conservation Guide: Voluntary Wetlands Stewardship Options for Oregon's Private Landowners*. Oregon Wetlands Conservation Alliance, Portland, OR.

Wetland Conservation Plan

Local jurisdictions are authorized to develop WCPs. The plans enable decisions on wetland use to be made through the planning process, rather than on a case-by-case basis. The WCPs provide a basis for characterizing wetlands and adjacent uplands over a large area and to evaluate the effects of land use activities on wetlands.

Source: Oregon Administrative Rules. 1994. *Chapter 141, Division of State Lands, Division 86, Wetland Conservation Plan*.

Wetlands Construction

Oregon has taken advantage of its SRF for many wetland projects. In the town of Lakeview, city of Woodburn SRF is funding a project to expand and upgrade a lagoon wastewater treatment system. Included in this project is the construction of a wetland to improve the natural treatment system. The SRF funded the construction of a wetland in the city of Mount Angel to polish effluent from another lagoon treatment system. The city of Woodburn used the SRF to fund the construction of a wastewater treatment system using a poplar plantation for phytoremediation. Although this is not a constructed wetland, it is a project that expanded and improved a natural treatment system. In addition, the cities of Florence and Ashland plan to use constructed wetlands in future SRF funded projects.

Source: U.S. Environmental Protection Agency (USEPA). 1998b. *Wetlands Projects Funded by the Clean Water State Revolving Fund (CW-SRF)*. U.S. Environmental Protection Agency, Office of Wastewater, Washington, DC.

Pennsylvania

DEP

The Pennsylvania Department of Environmental Protection, through several partnerships, has restored more than 100 miles of tributary habitat. This amounts to 3,728.1 acres of wetlands, representing a net gain of 3,107.4 acres. Funding was provided by section 319 money to initiate *Pennsylvania's Stream ReLeaf—A Plan for Restoring and Conserving Buffers Along Pennsylvania Streams* and the *Forest Buffer Toolkit*, a "how-to" manual.

Source: Pennsylvania Department of Environmental Protection. No date. Coastal Zone Management Program. Pennsylvania Department of Environmental Protection, Harrisburg, PA.

East Goshen

Wetlands destroyed throughout East Goshen, Pennsylvania to make room for rapid development in the town resulted in septic system overflows. Residents' yards were polluted with wastewater, and the town was forced to install a $1.5 million sewer system. The town also expects to expand the system in the future.

Source: National Audubon Society. No date a. *Wetlands Horror Stories*. National Audubon Society, New York, NY.

The Pike Run Restoration Project

The Pike Run restoration project demonstrates the effectiveness of including habitat restoration techniques in a watershed treatment program. Forty wetland acres were restored as a result of cooperative efforts among landowners, government agencies, and conservation groups. The main source of funding for the project came from an EPA section 319 grant administered by the Pennsylvania Department of Environmental Protection, Division of Watershed Conservation. The project is a partnership venture of the USFWS Partners for Wildlife Program, the Pennsylvania Game Commission, the USDA Natural Resources Conservation Service and Pasture Systems and Watershed Management Research Laboratory, Ducks Unlimited, National Fish and Wildlife Foundation, California University of Pennsylvania, Pheasants Forever, the Audubon Society of Western Pennsylvania, and interested landowners.

Source: Environmental Protection Agency. *Polluted Runoff (Nonpoint Source Pollution): Partners in Wildlife- The Pike Run Watershed Restoration Project.* <http://www.epa.gov/owow/NPS/Section319II/PA.html> Accessed January 2003.

Wetland Restoration/Creation Site Registry

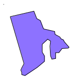
Under the Pennsylvania Department of Environmental Protection's Wetland Restoration/Creation Site Registry Program, interested property owners register the number of acres they have available for wetland creation. A developer with requirements to mitigate for wetland impacts then pays the cost of restoration or creation of new wetlands on the property at no cost to the landowner. The developer is also responsible for monitoring the success of the project. So far, 39 landowners have registered 240 acres in the program (as of 1997).

Source: Pennsylvania Department of Environmental Protection. 1997b. *Wetland Restoration: A Lasting Tribute for Earth Day*. Pennsylvania Department of Environmental Protection, Harrisburg, PA.

Wetland Replacement Project

The Pennsylvania Department of Environmental Protection, in cooperation with the USFWS, Ducks Unlimited, and the Lake Naomi Club, will create 7.5 acres of wetlands from an abandoned sand and gravel mine on the club's property in Monroe County. The Wetland Replacement Fund provides permit applicants with more options for replacing small wetlands that are unavoidably lost. Wetlands can thus be created on a larger scale and in better areas.

Source: Pennsylvania Department of Environmental Protection. 1997a. *Monroe County's Wetlands Protection*. Pennsylvania Department of Environmental Protection, Harrisburg, PA.



Rhode Island

Galilee Bird Sanctuary

In 1992 the Rhode Island Division of Fish, Wildlife and Estuary Resources requested the USACE to act as the federal lead in the restoration of tidal flows into a portion of the salt marsh at the Galilee Bird Sanctuary, Narragansett. Up to one-half of the sanctuary qualifies for salt marsh restoration under the authority of section 1135 of the Water Resources Development Act of 1986. The remaining half will be restored under the authority of the state. Two acres will consist of intertidal habitat within tidal channels, 24 acres will be fully restored to salt marsh, and 8 acres will be partially restored to salt marsh. This will be done by re-excavating natural channels and installing twin box culverts beneath the escape road to improve tidal exchange.

Source: Coastal America Partnership. 1997. *Wetlands Protection and Restoration.* Coastal America, Washington, DC.

Kingston 1

A study was conducted to evaluate the removal of ground water nitrate in and adjacent to wetlands located within three different riparian forests. Removal rates were found to be in excess of 80% within wetlands during both the growing and dormant seasons. Removal rates within transition zones were less than 36% during the growing season and ranged between 50% and 78% in the dormant season. Test results show that both wetlands and transition zones between wetlands and uplands can be important sinks for ground water nitrate.

Source: Simmons, R.C., A.J. Gold, and P.M. Groffman. 1992. Nitrate dynamics in riparian forests: Groundwater studies. *Journal of Environmental Quality* 21:659-665. ISSN: 0047-2425.

Kingston 2

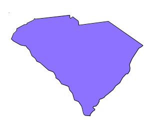
Denitrification was measured in a riparian forest with upland wetland transition zones and red maple wetlands on two sides of a stream. Upland use on one side of the stream was high-density, unsewered residential development, and upland on the other side was undeveloped. The developed and undeveloped sites were compared to determine removal efficiencies. Nitrate removal efficiencies for the developed site were determined to be 59% from ground water.

Source: Hanson, G.C., P.M. Groffman, and A.J. Gold. 1994. Denitrification in riparian wetlands receiving high and low groundwater nitrate inputs. *Journal of Environmental Quality* 23:917-922.

Wetland Protection

The Division of Freshwater Wetlands Rules and Regulations Governing the Administration and Enforcement of the Freshwater Wetlands Act regulates all projects that might alter freshwater wetlands, including activities in close proximity to a freshwater wetland that might impact the natural character or functions of a wetland, including nonpoint source functions. Projects in close proximity to a wetland require a permit if changes result in the flow of surface runoff into or away from a wetland, or if modifications in water quality would change its natural character.

Source: *Rhode Island Coastal Nonpoint Pollution Control Program*. 1995. Rhode Island Department of Environmental Management, Providence, RI.



South Carolina

Congaree Swamp

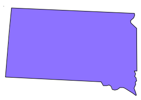
The Congaree Bottomland Hardwood Swamp has been determined to provide valuable water quality functions, such as removing and stabilizing sediment, nutrients, and toxic contaminants. It was determined that the total cost of constructing, operating, and maintaining a tertiary treatment plant to perform the same functions would be $5 million.

The National Audubon Society estimates that the cost to replace the pollution prevention role of all of the Congaree Bottomland Hardwood Swamp in South

Carolina with a water treatment facility would be $5 million.

Sources: National Audubon Society. No date b. *What's a Wetland Worth?* National Audubon Society, New York, NY.

USEPA. 1995b. *National Water Quality Inventory: 1994 Report to Congress*. EPA841-R-95-005. USEPA, Office of Water, Washington, D.C.

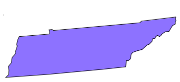


South Dakota

Constructed Wetlands for Wastewater Treatment

Five communities in South Dakota have received SRF loans for wetland projects. The communities of Clear Lake, Huron, Lake Cochrane, Pickeral Lake, and Richmond Lake have used SRF loans to construct wetlands as part of improvements to a publicly owned treatment works. Constructed wetlands are a complex of saturated substrates, emergent and subemergent vegetation, animal life, and water that simulates natural wetlands for various benefits. In these cases, the wetlands follow a lagoon treatment system to further reduce pollutant levels in the wastewater prior to discharge. User charges are being used to repay the loans, which total about $7.5 million for all five communities. These projects are all eligible under the Nonpoint Source Program (Clean Water Act §319).

Source: U.S. Environmental Protection Agency (USEPA). 1998b. *Wetlands Projects Funded by the Clean Water State Revolving Fund (CW-SRF)*. U.S. Environmental Protection Agency, Office of Wastewater, Washington, DC.



Tennessee

Riparian Restoration Guide

The *Riparian Restoration and Streamside Erosion Control Handbook* was prepared in response to a need by landowners to prevent erosion of private lands and to rehabilitate damaged streamside or riparian zones. The document presents successful techniques for planting, bank armoring, in-stream structures, and soil bioengineering, which have been used by others to stabilize streambanks and restore riparian and aquatic resources.

Source: Hoffman J.T., Green D.L., and Eager D. 1998. *Riparian Restoration and Streamside Erosion Control Handbook*. Tennessee Department of Agriculture, Nashville, TN.

Rivers and Wetlands Program

The Rivers and Wetlands Program assesses the conditions and trends of rivers and wetlands in Tennessee and uses the information to assist in the restoration and conservation of aquatic resources. The mission of the Rivers Program is to characterize the biological, aesthetic, recreational, and cultural resources of the rivers of Tennessee. The mission of the Wetlands Program is to identify wetlands across Tennessee for conservation and restoration, assist in the development of a strategy for the best use of wetland resources, assist in the implementation of the State Wetlands Conservation Strategy, and educate the public and private sectors about the importance of wetlands. The program was established in 1995 through an EPA Wetlands Planning Grant.

Source: Tennessee Department of Environment and Conservation. 1998. *Tennessee Rivers and Wetlands Program*. Tennessee Department of Environment and Conservation, Nashville, TN.

Wetland Conservation Grant

The Division of Natural Heritage of the Tennessee Department of Environment and Conservation has received a $208,207 grant from EPA's Wetland State Partnership Grant Program to continue funding for the Division's Wetlands Program through June of 1999. The grant will be used to encourage property owners to voluntarily enroll wetlands in state and federal wetland conservation and assistance programs; to work with state, county, and local governments to avoid or minimize impacts to wetlands; and to encourage voluntary wetlands conservation. The grant will also be used to provide information about wetland values and protection to all 95 Tennessee counties.

Source: Tennessee Department of Environment and Conservation. 1997. Environment and Conservation Receives an EPA Grant. Tennessee Department of Environment and Conservation, Nashville, TN.

Texas

Austin

A study was conducted to measure the efficiency of VFS for removing constituents in highway runoff. Efficiency was determined by measuring concentrations of pollutants in samples of the runoff directly off the road and after the runoff passed through the VSF. Two VSF were monitored (U.S. 183 and Walnut Creek) to investigate the potential for variation in performance between VFS.

> Source: Walsh, P.M., Barrett, M.E., Malina, J.F., Jr., and Charbeneau, R.J. 1997. *Use of Vegetative Controls for Treatment of Highway Runoff.* Center for Research in Water Resources. CRWR Online Report 97-5. University of Texas, Center for Research in Water Resources, Austin, TX.

Galveston Bay Foundation

A cooperative effort between volunteers and local, state, and federal agencies was organized by the Galveston Bay Foundation to restore coastal marshes primarily through the planting of smooth cordgrass. Approximately 200 volunteers participated in 16 plantings at 6 sites and created over 20,000 square feet of marsh. The large number of volunteers is a reflection of the growing awareness of the need to restore the ecological balance in Galveston Bay.

> Source: Shead, L. 1997. *Restoration and Construction of Coastal Wetlands*. U.S. Environmental Protection Agency, Washington, DC.

Ingleside

Underutilized public property is being converted into a multiuse coastal biofilter and wildlife habitat. Best management practices implemented at the site include a VSF, enlargement of a mitigated wetland for filtering runoff, soil enhancement, xeriscaping, and the use of solid waste disposal material and dredge material to improve the effectiveness of the biofilter. The project includes an education component targeting high school and adult populations. The site is being monitored to evaluate the effectiveness of the best management practices.

> Source: U.S. Environmental Protection Agency (USEPA). 1997a. Personal communication from Laura J. Talbot to Wetlands Strategies and State Programs Branch, U.S. Environmental Protection Agency.

Refugio

A wetland is being constructed (as of 1997) in Lions/ Shelby Park in the city of Refugio. Stormwater runoff from urban and rangeland sources will be directed to the constructed wetland for treatment. A strong public outreach program is intended to complement the project for maximum effectiveness and demonstration.

> Source: U.S. Environmental Protection Agency (USEPA). 1997a. Personal communication from Laura J. Talbot to Wetlands Strategies and State Programs Branch, U.S. Environmental Protection Agency.

Texas Agricultural Experiment Station

A study was conducted to determine the effectiveness of permanent grass and winter wheat strips in trapping herbicides. Study sites were located in nine watersheds. In each watershed, three 30-foot wide buffer strips of grass, winter wheat, and corn were established. Atrazine, cyanazine, and metolachlor were applied as preemergent herbicides. Runoff was measured and sampled during rainfall events to determine the amount and quality of water leaving each field. Results show that 15- and 30-foot-wide filter strips of coastal Bermuda grass were effective at intercepting herbicides and that the filter strips reduced runoff volume by 60%. Herbicide levels in both wheat and grass filter strips were shown to be significantly lower than those in areas that were planted completely in corn.

> Source: Hoffman, D., and T. Gerik. 1995. Limiting Herbicide Runoff with Vegetative Filter Strips. In *Proceeding of the 1995 Water for Texas Conference*, TWRI, College Station, TX.

Wetlands Assistance Guide

Texas Parks and Wildlife has developed the *Wetlands Assistance Guide for Landowners* to assist landowners in protecting wetlands and riparian areas according to their different needs within the context of broader conservation goals. The document provides a comprehensive guide to federal, state, and private programs offering technical and/or financial assistance to private wetland owners within the state of Texas.

Source: Texas Parks and Wildlife. 1995. *Wetlands Assistance Guide for Landowners. State Wetlands Conservation Plan*. Texas Parks and Wildlife, Austin, TX.

Wetland Habitat Alliance of Texas

The Wetland Habitat Alliance of Texas (WHAT) is an organization dedicated to preserving Texas wetlands by raising public awareness and appreciation of wetlands and funding projects to manage wetland waters; protect, enhance, and restore natural wetlands; and create wetlands on nonwetland sites. The cooperator and WHAT agree to a proposed project, and the NRCS verifies the operable conditions before the project is approved. Interested landowners can receive up to 100% financial assistance for a 10-year minimum agreement.

Source: Texas Parks and Wildlife. 1995. *Wetlands Assistance Guide for Landowners. State Wetlands Conservation Plan*. Texas Parks and Wildlife, Austin, TX.

Wetlands Conservation Plan

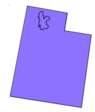
The Conservation Plan focuses on nonregulatory, voluntary approaches to conserving Texas's wetlands. Wetland issues addressed in the plan fall into five general categories: education, economic incentives, statewide and regional conservation, assessment and evaluation, and coordination and funding. Because of the extensive size and physiography of the state, a regional approach is used to best characterize the diverse wetlands needs and resources of Texas.

Source: Texas Parks and Wildlife. 1997a. *Texas Wetlands Conservation Plan*. Texas Parks and Wildlife, Austin, TX.

Wetlands Restoration Site Registry

Texas Parks and Wildlife received a $60,000 grant from EPA to develop a voluntary registry for public and private lands available for mitigation or registration. The program will function to link those who do not own land but who need or want to do wetland restoration with property owners who have similar goals. The purpose of the registry is to identify potential sites for wetland restoration, but there is no guarantee that all registered sites will be restored.

Source: Texas Parks and Wildlife. 1997. *Texas Wetlands Plan Update*. Vol. 2, issue 2. Texas Parks and Wildlife, Austin, TX.



Utah

Decker Lake

The Decker Lake Wetlands Preserve Foundation is a nonprofit group dedicated to preserving its namesake lake as an educational resource and natural preserve. The group is hoping to create a preserve surrounding the 35-acre, West Valley City lake that includes trails, an education center, and wildlife observation areas, thus creating a retreat in the center of the urban valley.

Source: Decker Lake Project. 1998. *Decker Lake Wetlands Preserve Foundation.* Salt Lake City, UT.

Matheson Preserve

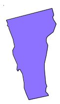
The Scott M. Matheson Wetlands Preserve is managed by the Nature Conservancy and the Utah Division of Wildlife Resources (UDWR) to ensure the lasting protection of a spectacular desert wetland system and its associated biological diversity. Studies are being conducted in hydrology and ground salinity to develop an understanding of how the wetland system functions. Surveys are being conducted for sensitive species, such as the northern leopard frog, and to identify invasive plant species that pose a threat to native vegetation communities. Birds are also monitored to assess their resting, breeding, and foraging habits. With this information, the Conservancy and UDWR can better design conservation strategies to maintain the wetland and its plant and animal residents. The Conservancy hopes to demonstrate cooperative private land management efforts and educate children and other visitors about wetlands and broader conservation issues on the Colorado Plateau.

Source: The Nature Conservancy. 1998a. *Matheson Wetland Preserve.* The Nature Conservancy, Arlington, VA.

Wetlands Workbook

Utah's *Guide to Proper Wetland Management and Development* is a workbook that targets decision makers, land managers, planners, and private citizens and is intended to aid these groups in proper wetland management. The document provides guidelines for wetland identification, discusses wetland functions, and provides guidelines for responsible development. Wetland permitting requirements and a list of available technical and agency resources is provided.

Source: Lock, Patricia A., Division of Wildlife Resources. 1993. Personal communication.



Vermont

Charlotte

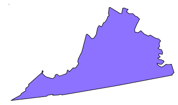
A VSF constructed to treat milkhouse wastewater from a dairy farm was evaluated to determine its effectiveness in reducing phosphorus and nitrogen concentrations as well as exports in surface and subsurface flow. The strip significantly reduces solids, phosphorus, and nitrogen on a concentration basis, and it retained 95% solids, 89% phosphorus, and 92% nitrogen on a mass basis. Retention was greatest during the growing season and poorest during periods of snowmelt. Concentrations in subsurface outputs were greater than those in surface runoff.

Source: Schwer, C.B., and J.C. Clausen. 1989. Vegetative filter treatment of dairy milkhouse wastewater. *Journal of Environmental Quality* 18:446-451.

Lake Champlain Basin

The Lake Champlain Basin Watersheds National Monitoring Program is designed to implement and evaluate the effectiveness of livestock exclusion, riparian revegetation, and grazing management in reducing the concentrations and loads of nutrients, bacteria, and sediment from agricultural sources. Monitoring will continue over at least a 6-year period, including a 2-year calibration period prior to best management practice implementation, 1 year during land management implementation, and at least 3 years after best management practice implementation.

Source: U.S. Environmental Protection Agency (USEPA). 1995d. *Section 319 National Monitoring Program: An Overview.* U.S. Environmental Protection Agency, Washington, DC.



Virginia

Blacksburg

VFS were used to remove sediment, nitrate, and phosphate from a confined livestock area. Removal efficiencies were evaluated under varying flow characteristics and filter strip lengths. Results indicated that the VSF were effective for the removal of sediment and other suspended solids if the feedlot runoff was shallow and uniform. Sediment removal decreased with time as sediment accumulated in the filters. Total nitrogen and phosphorus were not removed as effectively as sediment, and the filter strips were not effective in removing soluble nitrogen and phosphorus.

Source: Dillaha, T.A., J.H. Sherrard, D. Lee, S. Mosttaghimi, and V.O. Shanholtz. 1988. Evaluation of vegetative filter strips as a best management practice for feed lots. *Journal of Water Pollution Control Federation* 60(7):1231-1238.

Comprehensive Plan Policy

Fairfax County, Virginia, adopted a comprehensive plan policy in 1982 to protect water quality and sensitive lands along watercourses from encroachment. The *environmental quality corridor (EQC)* policy established a "sensitive lands EQC" that provides for all presently mapped 100-year floodplains (and those mapped during the subsequent development process); all floodplain soils or soils with high water table, poor bearing strength, or other severe development constraints; wetlands adjacent to the streams; and steep slopes (defined as 15 percent or greater) adjacent to the floodplains, soils, or wetlands. Where the floodplains, soils, and wetlands cover only a narrow area, a minimum buffer width of 50 feet plus a factor of 4 times the percent slope is provided. The policy has resulted in protection of substantial portions of Fairfax County stream valleys. However, because it is only a policy rather than an ordinance, it can be implemented in an enforceable manner only on land uses that must be found to be in conformance with the county's comprehensive plan.

Source: Fairfax County, Virginia, Board of Supervisors. 1982. Occoquan Basin Study: Amendments to the Comprehensive Plan Adopted by the Board of

Supervisors June 15, 1982. Fairfax County Office of Comprehensive Planning, Fairfax, VA.

Culpeper County

A study concluded that for every dollar of tax revenue collected from residential land uses in Culpeper County in 1987, $1.25 was spent on county services. For every dollar collected from industrial/commercial or farm/forest/open space lands, only $0.19 was spent on services.

Source: Vance, T., and A.B. Larson. February 1988. Fiscal Impact of Major Land Uses in Culpeper County, Virginia. Piedmont Environmental Council, VA.

Henrico County's Environmental Program

Henrico County, which lies within the Chesapeake Bay Watershed, was dominated by agricultural activity until the 1940s and is now growing at a steady rate. Because of the many wetlands in the county, the Environmental Division of the Department of Public Works is developing a stormwater management program that will offer additional protection to water resources, including wetlands. The goal of this project is to strike a balance between the need to protect stream systems not yet degraded and the desire to restore those that have been impacted by development. This proposed program would help increase the overall effectiveness of the county's future Stormwater Management Program, protect and restore stream systems in the county, and protect and establish forested buffers.

Source: International City/County Management Association and National Association of Counties (ICMA and NACO). 1999. *Protecting Wetlands, Managing Watersheds...Local Government Case Studies.* International City/County Management Association and National Association of Counties, Washington, DC.

Prices Fork Research Farm

Rainfall simulation was used to evaluate the effectiveness of 9.1 and 4.6 meter-long VFS for the removal of sediment, nitrogen, and phosphorus from cropland runoff. The 9.1 and 4.6 meter long VFS under shallow uniform flow conditions removed an average of 84% and 70% of the incoming suspended solids, 79% and 61% of the incoming phosphorus, and 73% and 54% of the incoming nitrogen, respectively. Soluble nutrients in effluent were sometimes greater than the incoming soluble nutrient load.

Source: Dillaha, T.A., R.B. Renear, S. Mostaghimi, and D. Lee. 1989a. Vegetative filter strips for agricultural nonpoint source pollution control. *Transactions of the American Society of Agricultural Engineers* 32(2):513-519.

Riparian Restoration Demonstration

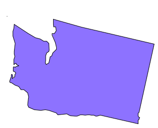
The Riparian Restoration Demonstration and Education Project Committee was established in 1994 to provide technical training and support for riparian restoration. In 1997, as part of the program, the Virginia Department of Conservation and Recreation conducted hands-on riparian restoration seminars at six locations across the Commonwealth. The seminars were designed to present restoration techniques for both rural and urban settings.

Source: Northern Virginia Soil and Water Conservation District. 1997. *Conservation Currents* 25(1, September/October) and 25(2, November/December).

VFS Effectiveness Study

VFS of varying ages were inspected and evaluated throughout rural Virginia through site visits and mail surveys. Results of the study indicate that many VFS performed poorly because of poor design and maintenance. It was determined that in order to make VFS more efficient, one or more of the following should be included in the design or management: a stone trench to spread water effectively; careful shaping of VFS to ensure sheet flow; inspection for, and repair of, damage following major storm events; and removal of any accumulated sediment.

Source: Dillaha, T.A., J.H. Sherrard, and D. Lee. 1989b. Long-term effectiveness of vegetative filter strips. *Water Environment and Technology* (November 1989):419-421.



Washington

City of Bellevue

Estimates of the cost of artificially replacing wetland functions with engineering solutions are enormous and such projects are, in many case, impossible. The city of Bellevue, Washington, conducted a study which showed that it would be 8 times more expensive to build an artificial stormwater system than to use the natural stormwater control system provided by wetlands. The flood peaks in watersheds with extensively destroyed or degraded wetlands are substantially higher than those in healthy watersheds. Higher flood levels cause greater individual property damage and impose massive costs on taxpayers.

Source: National Audubon Society. No date c. *Why Are Wetlands Important?* National Audubon Society, New York, NY.

Synoptic Assessment Approach

The synoptic assessment approach was applied to provide information on future risk of valued habitat loss and to identify habitat areas for protection as part of the development of a State WCP. The assessment tool was used to evaluate wetland functions, make regional comparisons, and identify significant impacts on wetland resources.

Source: U.S. Environmental Protection Agency (USEPA). 1992a. *A Synoptic Approach to Cumulative Impact Assessment: A Proposed Methodology.* EPE/600/R-92/167. U.S. Environmental Protection Agency, Washington, DC.

Thurston County

A study is being conducted to determine the pollutant removal effectiveness of VFS constructed along roadsides in treating stormwater runoff from highways. Water quality data from the study will be used to assist the Washington State Department of Transportation in developing design criteria for inclusion in its highway runoff manual. Three 20-foot-wide, 10-foot-long VFS located in three different soil types will be evaluated in the study. Removal rates for total suspended solids, zinc, copper, lead, cadmium, total petroleum hydrocarbons, nitrate-nitrite, total phosphorus, soluble reactive phosphorus, and toxics will be measured.

Source: Yonge, D. 1996. *Vegetative Filter Strip Monitoring and Assessment.* Washington State Department of Transportation. Olympia, WA.

Wetland Reconstruction

The City of Des Moines, Washington, is using SRF to purchase and reconstruct a badly degraded wetland area and to construct a sediment trap/pond facility. This project is allowing the city to meet two goals it constantly struggles to achieve: flood protection and wetland preservation and enhancement. Area stormwater will enter one of two sediment traps by way of the surrounding reconstructed wetlands. The wetlands serve the dual purpose of providing flood protection by collecting stormwater runoff and acting as a preliminary filter by removing suspended solids. The majority of sediment and any heavy metal removal will occur while the water is in the sediment traps. The water will then leave the traps through artificial inlets that lead to Barnes Creek, which eventually enters Puget Sound. This $222,500 project is part of the National Estuary Program (Clean Water Act §320).

Source: U.S. Environmental Protection Agency (USEPA). 1998b. *Wetlands Projects Funded by the Clean Water State Revolving Fund (CW-SRF)*. U.S. Environmental Protection Agency, Office of Wastewater, Washington, DC.

Wetlands Regulatory Program

The Washington State Department of Ecology has instituted a regulatory program to counteract encroachment into wetlands due to compliance with infrastructure-related development standards. Local governments in the Puget Sound basin have authority to require more stringent controls to protect water quality where minimum setback requirements do not provide adequate protection of water quality-sensitive areas such as wetlands.

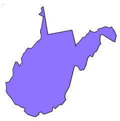
Source: Washington State Department of Ecology. 1992. *Stormwater Program Guidance Manual for the Puget Sound Basin*. Washington State Department of Ecology, Olympia, WA.

Winona Wetlands Purchase

The city of Port Townsend, Washington, was able to meet both stormwater management objectives and a wetlands preservation goal by obtaining funding from Washington's SRF to purchase an area known as the Winona Wetlands. These wetlands act as a critical stormwater basin for the area and provide valuable wildlife habitat. Potential development of the area not only threatened the wetlands but would also result in stormwater management problems. By purchasing the wetlands, the city was able to protect a natural stormwater management system as well as a wildlife refuge. The city purchased 6.5 acres in Phase I and is currently planning to borrow additional SRF for a

Phase II purchase of 9 acres. This $400,000 project is part of the National Estuary Program (Clean Water Act §320) for the Puget Sound estuary. A portion of the city's stormwater utility fee paid by households is being used to repay the Washington SRF.

Source: U.S. Environmental Protection Agency (USEPA). 1998c. *Winona Wetlands Purchase*. U.S. Environmental Protection Agency, Office of Wastewater Management, Washington, DC.

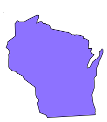


West Virginia

Riparian Task Force

The Hampshire County Riparian Task Force was established in 1992. The task force, which is composed of landowners and 12 local organizations, has dedicated itself to educating the public about the important role that forested riparian buffers play in maintaining water quality. An important part of the task force's message is that individual actions and personal choices can have both good and bad effects on the region's water resources. Committed to reaching as large an audience as possible, the task force developed an educational strategy that targets both children and adults. The task force has developed educational materials and demonstration sites to promote the importance of protecting water quality in the Potomac River Basin.

Source: Chesapeake Bay Program. 1997b. *Riparian Buffer Case Study.* U.S. Environmental Protection Agency, Chesapeake Bay Program, Annapolis, MD.



Wisconsin

State Water Quality Standards

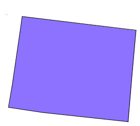
The state of Wisconsin has adopted specific wetlands water quality standards designed to protect the sediment and nutrient filtration or storage function of wetlands. The standards prohibit addition of those substances that would "otherwise adversely impact the quality of other waters of the State" beyond natural conditions of the affected wetland. In addition, the state has adopted criteria protecting the hydrologic conditions in wetlands to prevent significant adverse impacts on water currents, erosion or sedimentation patterns, and the chemical and nutrient regimes of the wetland. Wisconsin has also adopted a sequenced decision-making process for projects potentially affecting wetlands that considers the wetland dependency of a project; practicable alternatives; and the direct, indirect, and cumulative impacts of the project.

Source: Wisconsin Department of Natural Resources. 1991. Water Quality Standards for Wetlands—Natural Resources Chapter 103. *Register*, July 1991, No. 427.

Wisconsin Department of Natural Resources, Oneida Indian Reservation

The Duck, Apple, and Ashwaubenon (DAA) Priority Watershed Project is a 10-year project to reduce runoff and improve water quality and aquatic habitat within the 265-square-mile watershed of Lake Michigan. In 1997 the Wisconsin Land and Water Conservation Board approved the $21.8 million DAA Nonpoint Source Control Plan to improve water quality and quantity and the economy and quality of life in northeastern Wisconsin. The Priority Watershed Project is a watershed-based program that addresses all nonpoint sources of pollution and provides a coordinating framework for environmental management that focuses on public and private efforts to address the highest priority problems within hydrologically defined geographic areas. The goal of the program is to reduce phosphorus and total suspended solids by 50 percent or more.

Source: International City/County Management Association and National Association of Counties (ICMA and NACO). 1999. *Protecting Wetlands, Managing Watersheds...Local Government Case Studies.* International City/County Management Association and National Association of Counties, Washington, DC.



Wyoming

Green River

The Green River drains 12,000 square miles of western Wyoming and northern Utah and incorporates a diverse spectrum of geology, topography, soils, and climate. Land use is predominantly range and forest. A multiple regression model was used to associate various riparian and nonriparian basin attributes (geologic substrate, land use, channel slopes, etc.) with previous measurements of phosphorus, nitrate, and dissolved solids.

Source: Fannin, T.E., M. Parker, and T.J. Maret. 1985. Multiple Regression Analysis for Evaluating Non-point Source Contributions to Water Quality in the Green River, Wyoming. In *Proceedings of Riparian Ecosystems and Their Management: Reconciling Conflicting Issues*, Tucson, Arizona, April 16-18,1985, pp. 201-205. GTR RM-120. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Washington, DC

Anacostia River Watershed

Intergovernmental agencies that include the District of Columbia, Montgomery County, Prince George's County, and the State of Maryland collaborated and organized efforts to restore the Anacostia River and tributaries. Over 98 percent of the tidal wetlands and nearly 75 percent of the freshwater wetlands within the watershed were destroyed prior to the start of the project. Restoration activities were facilitated by the Metropolitan Council of Governments through administrative and technical support. The project was funded through annual contributions from Anacostia residents.

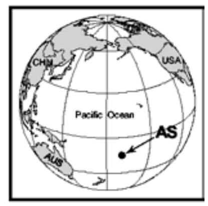
Source: U.S. Environmental Protection Agency. *Polluted Runoff (Nonpoint Source Pollution): Anacostia River Watershed District of Columbia.* <www.epa.gov/OWOW/NPS/Ecology/chap6ana.html>. Accessed January 2003.

Kenilworth Marsh: A Classic Wetland Restoration Success Story in The Nation's Capitol

The USACE in consultation with several federal and local agencies restored more than 30 acres of emergent wetland in a reconstructed freshwater tidal marsh in Washington, DC's Anacostia River. Restoration of the marsh involved using dredge materials from the Anacostia River and planting about 350,000 plants comprising of 16 local, native species. An EPA section 319 grant administered by the District of Columbia was used to support the monitoring effort of the restored marsh. The lessons learned from using dredged materials were used to build similar wetlands in nearby marshes.

Source: U.S. Environmental Protection Agency (USEPA), Office of Research and Development. 2002. *Kenilworth Marsh: A Classic Wetland Restoration Success Story in The Nation's Capitol.*

TERRITORIES

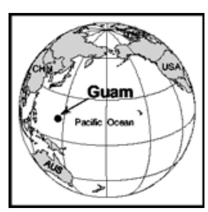


American Samoa

Coastal Management Program

The American Samoa Coastal Management Program Administrative Rules require the establishment of buffer zones of 25 to 50 feet between wetlands and development. Special Management Plans, which provide additional protection to wetlands, have been established for Pago Pago Harbor and the pala, or wetland, areas around the villages of Leone and Nu'uuli. In addition, American Samoa, has developed a Comprehensive Wetlands Management Plan for the islands of Tutuila, Aunu'u, American Samoa, and Manu'a that documents the status of wetlands and suggests strategies to protect remaining wetlands.

Source: *American Samoa Coastal Nonpoint Source Pollution Program.* 1995. American Samoa Environmental Protection Agency, American Samoa.



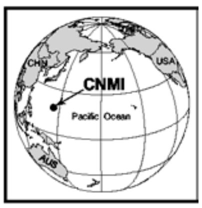
Guam

Wetland Protection

The Guam Environmental Protection Agency includes NPS evaluations of all wetlands in or adjacent to projects under their review. The *Guam Nonpoint*

Source Management Plan states that the Guam Environmental Protection Agency will include in their formal review standards specific evaluations for NPS control potential of existing and constructed wetlands. The agency will also review projects adjacent to wetlands for their impact on wetlands.

Source: *Guam Nonpoint Source Pollution Management Plan*. 1996. Guam Environmental Protection Agency, Tiyan, Guam.



Commonwealth of the Northern Marianas Islands

Tinian Magpo Watershed and Wetland Protection Plan

The Division of Coastal Resources Management and the Division of Environmental Quality applied for and received a grant from EPA to prepare the *Tinian Magpo Watershed and Wetland Protection Plan*. The plan includes rationale for development and descriptions of the environment, previous and ongoing investigations, federal and commonwealth agencies regulating wetlands, and water resources. The final plan includes detailed descriptions of the Magpo watershed and the Magpo wetland. The plan also identifies problems and concerns within the Magpo watershed and wetland and provides recommendations for solutions.

Source: Baldwin G.W. 1995. Tinian Magpo Watershed and Wetland Protection Plan. Prepared for Division of Coastal Resources Management, Department of Lands and Natural Resources, Saipan, MP; Division of Environmental Quality, Department of Public Works, Saipan, MP; U.S. Environmental Protection Agency, Washington, DC.

Puerto Rico

Los Manchos Mangrove Restoration

The $1.6 million Los Manchos Mangrove Restoration Project lies within the Los Manchos Mangrove Forest. It involves the restoration of tidal flushing to approximately 1,000 acres of mangrove forest along the eastern coast of Puerto Rico, at the U.S. Naval Station, Roosevelt Roads. Construction phasing of the project includes the demolition of existing causeways, construction of a new causeway with bridges to allow greater tidal flow and saltwater exchange, and the clearing of damaged or fallen mangroves. New mangroves will be planted in areas that were severely damaged.

Source: Coastal America Partnership. 1997. *Wetlands Protection and Restoration.* Coastal America, Washington, DC.

Mangrove Protection in Puerto Rico

In Puerto Rico protection of mangroves receives priority attention. In 1974 the Environmental Quality Board adopted Resolution 74-21 to protect mangrove wetlands. The resolution states a need to preserve, protect, and when possible restore mangroves; minimize changes in the quantity or quality of water in mangroves; protect mangroves from adverse effects of dredging or the placement of dredge spoils; and promote environmental measures for the protection of mangroves.

Source: *Puerto Rico Coastal Nonpoint Pollution Control Plan*. 1995. Draft. Department of Natural Resources, Puerta de Tierra, PR.

Virgin Islands

GIS Assessment

The U.S. Virgin Islands Department of Planning and Natural Resources is developing a wetland geographic information system (GIS). The system will be used to evaluate wetland management needs and priorities. Data in the GIS wetlands database will be used to ascertain historic losses of salt ponds. This data will also be used to formulate salt pond protection measures, e.g., establishment of specific salt pond boundaries and setbacks, and creation of guidelines for the maintenance and restoration of ponds.

Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

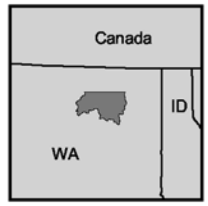
TRIBES

Bad River Band of Chippewa Indians

Wetlands Conservation Plan/Outreach

The Bad River Band of Lake Superior Chippewa Indians is serving as a wetlands information center for Wisconsin tribes. The Bad River Band is focusing on learning various wetland programs and on the development of a tribal Wetlands Conservation Plan (WCP) for their reservation. The WCP addresses the threats to the Kakagon/Bad River Sloughs ecosystem. In conjunction with this plan, the tribe is working with federal agencies to provide outreach services and help other Wisconsin tribes develop WCP.

Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.



Colville Confederated Tribes

Owhi Lake

Owhi Lake, Washington, has the most important resident fishery within the Colville Confederated Tribes reservation. The tribes have restored riparian areas and limited livestock access to Owhi Creek and Lake in an effort to reduce phosphorus levels. Tribal activities included the fencing of Owhi Lake and creation of livestock enclosures to restrict the use of pastures along the creek. School children worked with tribal technicians; they planted riparian vegetation and helped put medium organic debris in the creek, using only local materials.

Source: U.S. Environmental Protection Agency (USEPA). 1997c. *Section 319 Success Stories: Volume II.* U.S. Environmental Protection Agency, Washington, DC.

Confederated Salish and Kootenai Tribes of the Flathead Reservation

Watershed Demonstration Project

The tribe is conducting a Watershed Demonstration Project for the Bitterroot watershed. Criteria are being developed by the Flathead Tribes to inventory wetland resources and to identify wetlands that have incurred detrimental impacts. Outreach activities are being undertaken with stakeholders to determine what measures could be taken to restore and enhance the use of wetland resources.

Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Confederated Tribes of the Umatilla Indian Reservation

Wetland Community Park

There are plans to create a community park between two wetland areas near Oregon housing projects and the Umatilla Indian Reservation tribal government campus. The 3.5-acre park, among the cottonwoods of Mission Highway, would provide traditional amenities in addition to a platform that extends into the wetlands to accommodate viewing, with information to educate the public on the value of wetlands and wetland protection.

Source: Plans Developed for Wetland Community Park. *Confederated Umatilla Journal,* Feb. 19, 1998, p. 9.

Umatilla River Watershed

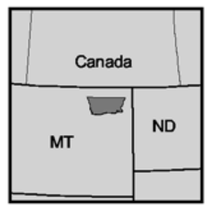
A variety of land uses on the Umatilla Indian Reservation and in the surrounding Umatilla River watershed (in north-central Oregon) result in nonpoint source pollution. Erosion has led to the loss of wetlands and riparian vegetation along the river. The tribes hope to restore these areas by improving livestock and crop management practices. Objectives include increased riparian shade and bank storage to improve productivity and survival of coldwater fisheries habitat; rotational grazing and wider use of upland pastures; improved crop management; increased riparian vegetation and the possible introduction of beaver to provide natural habitat structural improvements; increased in-stream structure and channel diversity; and implementation of a proactive approach to private land grazing and agricultural management.

Source: U.S. Environmental Protection Agency (USEPA). 1997c. *Section 319 Success Stories: Volume II.* U.S. Environmental Protection Agency, Washington, DC.

Watershed Protection

The tribes are conducting a watershed protection approach demonstration project in the Umatilla Basin. Building on last year's grant, they are developing a watershed protection program and multilevel-government integrated watershed management plan.

Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.



Fort Peck Assiniboine and Sioux Tribes

Managed Grazing

The demonstration of a managed grazing system is under way as part of a riparian restoration and water quality protection plan for the Fort Peck Reservation in northeastern Montana. The system is located in the Little Porcupine Creek watershed. Little Porcupine Creek has lost almost all integrity because of uncontrolled grazing, which has stripped the banks and the riparian corridor of vegetation. The stream also serves as the only livestock watering source for the range. The goal of the project is to restore the riparian zone from a severely impaired to a moderately impaired biological condition.

Source: U.S. Environmental Protection Agency (USEPA). 1997c. *Section 319 Success Stories: Volume II.* U.S. Environmental Protection Agency, Washington, DC.

The Grand Portage Reservation

The Grand Portage Reservation received an EPA grant for $50,000 in 1995 to develop a Wetland Protection and Conservation Ordinance for the reservation that includes regulatory and nonregulatory approaches to wetland protection. The draft ordinance was developed, and sections of land on the reservation that were most at risk from development were the focus of the wetland evaluations conducted in conjunction with the development of the ordinance. According to Janice Cheng, EPA Region Wetlands Division, the tribe did not use other outside funding sources besides EPA for the development of the ordinance, but the tribe did provide a 25 percent match to the grant funds. Ms. Cheng stated that other tribes in EPA Region 5 have received similar grants for developing wetland protection ordinances. The cost of developing the ordinances has varied from approximately $50,000 to $100,000. The length of time involved in their development has also ranged from slightly less than 1 year to more than 2 years. The variation in cost and duration of the projects depends largely on the amount of background wetland information that is available for the reservation.

Source: Cheng, Janice, USEPA, Region 5. January 18, 2000. Personal communication.

Hopi Tribe

Wetlands Conservation Project

The Hopi Tribe is preparing the *Hopi Wetland Conservation Plan* for protecting and conserving wetlands on the Hopi Reservation. In addition, the tribe is completing a watershed protection demonstration project for the Blue Canyon area of the reservation, a unique riparian area that is currently being considered for a National or Tribal Park. An important objective is to develop a plan that provides adequate protection but still allows for economic development by the tribe. The emphasis is on establishing goals that provide direct protection of the wetland resources.

Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Hualapai Tribe

Spencer Creek

Spencer Creek is the largest perennial stream on the Hualapai Indian Reservation in Arizona. The creek, nearby wetlands, and native vegetation are plagued by fecal contamination resulting from burro overgrazing. A 3-day restoration project involves helicopter crews that will haul fence panels down to Indian Gardens to make a temporary holding pen, net all burros, and transport them by helicopter to the holding pen for relocation to other areas. The Hualapai Department of Natural Resources hopes to prevent the buildup of buro populations to allow woody riparian vegetation, now lost to overgrazing, to reestablish. Removal of the burros will improve wetland plants and water quality throughout the Spencer Creek drainage.

Source: U.S. Environmental Protection Agency (USEPA). 1997c. *Section 319 Success Stories: Volume II.* U.S. Environmental Protection Agency, Washington, DC.

Inter-Tribal Council of Michigan

Wetlands Outreach

The Inter-Tribal Council of Michigan (MITC) is providing wetlands technical assistance to the Bay Mills Indian Community and expanding this assistance to all Michigan tribes. This project is fulfilling the need for outreach and education specific to the 404 program. MITC is determining the specific needs of each tribe and is working with the federal agencies to provide technical information and wetland management assistance. MITC's goal is to eventually develop wetland management strategies for all the Michigan tribes that request their assistance. The strategies include the identification, preservation, and management of wetlands on reservations.

Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Miccosukee Tribe of Indians of Florida

Wetland Water Quality Standards

The Miccosukee Tribe has vested interests in approximately 2.1 million acres in South Florida, and the vast majority of this acreage is wetlands. The tribe is collecting and analyzing water samples at 20 sites, including eight wetland reference sites on the Miccosukee Tribe's federal reservations. The tribe is using this information to develop wetland water quality standards and to assess and monitor the ecological integrity of the tribe's wetlands with development of potential indicators.

Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Narragansett Indian Tribe

Wetlands Protection Program

The tribe is developing a program for the protection of tribal wetlands, including development of zoning by-laws, a conservation and recreation plan, and biological criteria/wetland water quality standards. In addition, the tribe is developing educational and training opportunities for tribal members and staff involved in the administration of their newly developed wetland protection program.

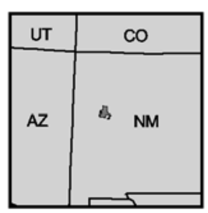
Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Nez Perce Tribe

Wetland Conservation Program

The tribe is developing and implementing a watershed protection approach demonstration project in the Lapwai Creek Watershed and a comprehensive WCP for the reservation.

Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

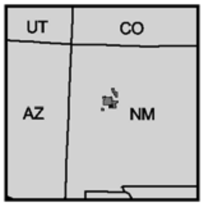


Pueblo of Acoma

Wetlands Protection Program

The tribe is developing a comprehensive plan for wetland areas on the reservation as an ongoing project with other tribal programs such as range management, forestry, fish and wildlife, and various agricultural and recreational programs. By developing a Wetlands Protection Plan, these areas can be incorporated into an overall tribal lands management program.

Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.



Pueblo of Laguna

Wetlands Program

The tribe is developing a program to manage and conserve its wetlands as they relate to other resources. The elements of the wetland program are being incorporated into the overall Integrated Resources Management Plan. The objectives are to establish a Wetlands Section within the pueblo's Natural Resources Department, to gather data for a WCP, to develop a WCP, to develop water quality standards, to improve wetlands potential through watershed improvement projects, and to gain public input on a WCP.

Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Red Lake Band of Chippewa Indians

Red Lake Farm

The Red Lake Band of Chippewa Indians will manage more than 1,200 acres of wetlands and other habitats, including a portion of the Kiwosay Wildlife Area in Minnesota. A $177,000 grant through the National Wildlife Refuge System, along with $338,000 from partners, will be used to help restore nesting habitat as well as wild rice and small grain food plots, which are a food source for migrating and breeding waterfowl.

Source: U.S. Fish and Wildlife Service (USFWS). 1998e. Wetlands Projects Approved for 19 States. Fish and Wildlife Service News List Server. Listed April 30, 1998. U.S. Department of Interior, Fish and Wildlife Service, Washington, DC.

Wetlands Outreach

The Red Lake Band is developing expertise in both regulatory and advanced planning aspects of the wetland program and providing wetland outreach to the tribes of Minnesota. They are providing technical assistance in wetland delineation, wetlands regulations, and eventually, assistance in the development of individual tribal wetland ordinances or WCP. They are also upgrading their existing computer equipment to accommodate an expanded geographic information system. They are gathering information on current needs of the Minnesota tribes and are working with the federal agencies on training in policy issues.

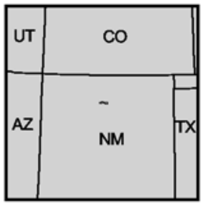
Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Rincon San Luiseno Band of Mission Indians

Wetlands Protection Plan

In 1992 the Rincon San Luiseno Band initiated work to develop a wetland management program for the reservation lands along the San Luis Rey River. The Rincon are defining short- and long-term data requirements to assess water and wetland quality on the reservation. Data include quantitative information on chemical, physical, and biological parameters. Permanent sampling and monitoring stations are being defined on the reservation, along with data collection requirements and protocols.

Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

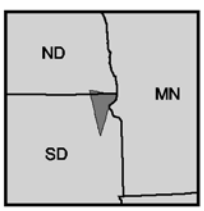


Santa Clara Pueblo

Wetlands Project:

The tribe is developing a comprehensive wetland monitoring and assessment plan for the pueblo, finalizing a draft Wetlands Management Plan, and developing a pollution prevention strategy for remediation of the pueblo's wetlands.

Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.



Sisseton-Wahpeton Dakota Nation

Wetlands Conservation Plan

The nation is developing a Tribal WCP. They are undertaking activities to protect, restore, and maintain wetland resources on the reservation. With the assistance of the Natural Resources Conservation Service and USFWS, they are using existing wetland data to inventory wetland resources and identify priority wetlands on the reservation.

Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Warm Springs Tribe

Wetlands Conservation Plan

The tribe is inventorying existing wetlands, identifying functions and values, refining tribal monitoring and enforcement programs, and consolidating existing tribal laws affecting wetlands. These activities will provide the basis for the development of a wetlands conservation programs for the reservation.

Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.