# EPA Region 5
# Wetlands Supplement: Incorporating Wetlands into Watershed Planning

March 2012

# Photograph Sources

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Clockwise starting in the upper left:

1. R. Hagerty. 2001. U.S. Fish and Wildlife Service. Horicon National Wildlife Refuge. Wetland sunrise; water and reeds in foreground with plant growth in background. (Wisconsin)
2. R. Hagerty. 2003. U.S. Fish and Wildlife Service. A close-up view of a whooping crane photographed at the International Crane Foundation in Baraboo, Wisconsin. Endangered species.
3. J. Hollingsworth and K. Hollingsworth. 2008. U.S. Fish and Wildlife Service. Hooded Merganser brood, Seney National Wildlife Refuge, Michigan.
4. U.S. Fish and Wildlife Service. 2008. Thirty-acre wetland restoration in Rice County, Minnesota.
5. D. Becker. 2010. U.S. Geological Survey. Floodwaters at Moorhead, Minnesota.
6. U.S. Fish and Wildlife Service. 2009. Three men using equipment to take core samples at Roxanna Marsh, Grand Calumet River, in Hammond, Indiana, as part of a wetland restoration effort and damage assessment process.

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# Acronyms and Abbreviations

The following acronyms and abbreviations are used in the Supplement. Refer back to this list when you need clarification.

AFA......................................Alternative Futures Analysis
AOC.....................................Area of Concern
AVGWLF...............................ArcView-enabled General Watershed Loading Function model
AWHA..................................Avian Habitat Assessment model
CARL ...................................Conservation and Recreation Lands (dataset)
CFR .....................................*Code of Federal Regulations*
CGI ......................................Center for Geographic Information (Michigan)
CSOs...................................combined sewer overflows
CWA ....................................Clean Water Act
DEM.....................................digital elevation model
DFIRM .................................Digital Flood Insurance Rate Map (FEMA)
DLG .....................................digital line graph
DOI DRG ..............................Department of the Interior, U.S. Digital Raster Graphic
FEMA...................................Federal Emergency Management Agency (Homeland Security)
FQI.......................................Floristic Quality Index
GIS ......................................geographic information system
GLIN ....................................Great Lakes Information Network
GSL .....................................Great Salt Lake
HGM ....................................hydrogeomorphic
IFMAP…………………………..Integrated Forest, Monitoring, Assessment, and Prescription
IWWR ..................................Interagency Workgroup on Wetland Restoration
LLWFA.................................landscape-level wetland functional assessment
MDEQ..................................Michigan Department of Environmental Quality
MNFI....................................Michigan Natural Features Inventory
NAPP...................................National Aerial Photographic Program (USGS)
NCSU…………………………..North Carolina State University
n.d……………………………...no date
NHD.....................................National Hydrography Dataset (USGS and EPA)
NHPCS ................................Natural Heritage Priority Conservation Sites (Virginia)
NMFS ..................................National Marine Fisheries Service (NOAA)
NOAA ..................................National Oceanic and Atmospheric Administration
NRC.....................................National Research Council
NRCS ..................................Natural Resources Conservation Service (USDA)
NWI......................................National Wetlands Inventory
NWIPlus...............................National Wetlands Inventory, enhanced version
PCBs ...................................polychlorinated biphenyls
ppm......................................parts per million
PPRW ..................................Paw Paw River Watershed

QC ........................................Quality Control
RIBITS ..................................Regional Internet Bank Information Tracking System
SSO ......................................Storm Sewer Overflows
SSURGO ..............................Soil Survey Geographic Database (NRCS)
SWCD...................................Soil and Water Conservation Districts
SWMPC ................................Southwest Michigan Planning Commission
USACE .................................U.S. Army Corps of Engineers
USDA....................................U.S. Department of Agriculture
USEPA .................................U.S. Environmental Protection Agency
USFWS.................................U.S. Fish and Wildlife Service (DOI)
USGS ...................................U.S. Geological Survey (DOI)
VaNLA ..................................Virginia Natural Landscape Assessment
VDCR ...................................Virginia Department of Conservation and Recreation
VDEQ ...................................Virginia Department of Environmental Quality
VDOT....................................Virginia Department of Transportation
VNHP....................................Virginia Natural Heritage Program
VWRC...................................Virginia Wetland Restoration Catalog
W–PAWF ..............................Watershed-based Preliminary Assessment of Wetland Functions
WWTP ..................................wastewater treatment plant

# 1. Introduction

## 1.1 What Is the Purpose of This Supplement?

The purpose of this Supplement is to encourage the inclusion of proactive wetland management into watershed plans because wetlands play an integral role in the healthy functioning of the watershed. This Supplement promotes using a watershed approach that not only protects existing freshwater wetlands but also maximizes opportunities to use restored, enhanced, and created freshwater wetlands to address watershed problems such as habitat loss, hydrological alteration, and water quality impairments. The primary audiences for the Supplement are members and staff of watershed organizations and local/state agencies.

A **watershed** is the area of land that contributes runoff to or drains to a lake, river, stream, wetland, estuary or bay (USEPA 2008a).

**Wetlands** are the link between land and water. They are transition zones where the flow of water, the cycling of nutrients, and the energy of the sun meet to produce a unique ecosystem characterized by hydrology, soils, and vegetation, making these areas very important features of a watershed (USEPA 2004). (See chapter 2 for a regulatory definition of wetlands.)

A **watershed approach** is an analytical process that considers the abundance, locations, and conditions of aquatic resources in a watershed. It further considers how those attributes support landscape functions and attainment of watershed goals (Sumner 2004). Rather than identifying and protecting individual water resources, a watershed approach involves developing a framework for management of an area defined by drainage rather than political or land ownership boundaries (USEPA 2005).

**Watershed plans** are analytic frameworks for protecting and restoring water quality and quantity for various societal purposes. Ideally, they result from implementation of the watershed approach. Plans may focus on watersheds within political or land ownership boundaries for strategic or practical purposes.

This document is a Supplement to the U.S. Environmental Protection Agency's (EPA) Watershed Planning Handbook.[1] It conveys information on recently developed approaches and tools for assessing wetland functions and conditions, the results of which assist decision makers in determining where in a watershed existing and former wetlands can best be restored or enhanced, or where wetlands can be created to optimize their functions in support of water quality and other watershed management plan goals. The Supplement also discusses wetland restoration, enhancement, and creation techniques and reviews the considerations involved in deciding how best to undertake a wetlands project.

EPA's Watershed Planning Handbook and other scientific resources emphasize the importance of the watershed as a *management unit* in which elements and processes operate over different spatial and temporal scales. The literature also emphasizes the importance of planning and implementing projects aimed at protecting or restoring water quality (or meeting similar goals) within the context of the watershed.

[1] USEPA, *Handbook for Developing Watershed Plans to Restore and Protect Our Waters,* EPA 841B08002 (U.S. Environmental Protection Agency, Washington, D.C., March 2008). http://water.epa.gov/polwaste/nps/handbook_index.cfm

> [T]he integrity of aquatic ecosystems is tightly linked to the watersheds of which they are part. There is a direct relationship between land cover, key watershed processes, and the condition of aquatic ecosystems. Healthy, functioning watersheds provide the ecological infrastructure that anchors water quality restoration efforts. Components of a healthy watershed can include intact and functioning headwaters, wetlands, floodplains and riparian corridors, instream habitat and biotic refugia, biological communities, green infrastructure, natural disturbance regimes, sediment transport, and hydrology expected for its location (USEPA 2011c).

The Supplement assumes readers have some background in use of the watershed approach and in watershed planning and have previously developed or are in the process of developing watershed plans. If additional information is required in these areas, consult EPA's Watershed Planning Handbook and other similar federal, state, and local guides.

Including wetlands in a watershed management plan might entail costs beyond what a watershed group has budgeted for targeting a specific watershed goal. Planners should keep in mind that the goals and objectives they have established for their respective watersheds will dictate which model elements suggested in this Supplement will be useful for inclusion in the organization's watershed plan. EPA encourages watershed groups to employ all recommended elements yet recognize that time, effort, and budgetary constraints can limit the group's implementation of all model elements. These factors can also limit the considerations a group might give to detailed planning, implementation, and monitoring tasks. The intent of this Supplement is to share methodologies for considering and identifying wetland functions. It is also to encourage restoration, enhancement, or creation of wetland functions to help watershed groups achieve their respective watershed management plan goals

## 1.2 Why Include Wetlands in Watershed Planning?

### 1.2.1 Wetland Functions and Values

It is important to include wetlands in watershed plans because of the important role they play in ecosystem function and watershed dynamics. Wetlands are a product of and have an influence on watershed hydrology and water quality. Wetlands contribute to healthy watersheds by influencing important ecological processes. They recycle nutrients, filter certain pollutants, play a role in climatic processes by absorbing and storing elements such as carbon and sulfur, recharge groundwater, and provide energy production and habitat for fish and wildlife. Wetlands also provide goods and services that

**Wetland Functions versus Wetland Values**

***Wetland Functions***
Wetland functions relate to a process or series of processes (the physical, biological, chemical, and geologic interactions) that take place within a wetland. Major wetland functions include those that change the water regime in a watershed (hydrologic function), improve water quality (biochemical function), and provide habitat for plants and animals (food web and habitat functions).

***Wetland Values***
Values are generally associated with goods and services that society recognizes. Wetlands can have ecological, economic, and social values. It is important to note that not all environmental processes are recognized or valued.

Sources: Novitzki et al. 1997; Sheldon et al. 2005.

have economic value. Some examples of the goods wetlands provide include habitat conducive to food production, building products, and fresh water. Some examples of the services wetlands provide include the reduction of peak flows and flood damage, water storage, protection of erodible shorelines, water filtration and particulate removal, and recreational opportunities and amenities. Finally, societies value wetlands for their historic and cultural/religious significance (Schuyet and Brander 2004; USEPA 2005; Cappiella et al. 2006). Exhibit 1 provides more complete descriptions of the three functions that are a focus of this Supplement—hydrology, water quality, and habitat. Exhibit 2 provides examples of wetland values.

The functions performed by a wetland are dictated by environmental factors both within and outside the wetland. Climate, for example, is a major factor affecting wetland function at the largest geographic scale. Biochemical processes, such as the movement of water, sediment, and nutrients, affect wetland functioning at the watershed scale (Bedford 1999). Environmental interactions within the wetland itself, such as topographic location and underlying geology, proximity to water source, and the direction of flow and strength of water movement, further influence how the wetland functions (Sheldon et al. 2005).

**Climate Change and Wetlands**

Wetlands affect and may be significant factors in the global cycles of nitrogen, sulfur, and carbon by storing, transforming, and releasing these elements into the atmosphere. Human activities such as burning fossil fuels and clear cutting tropical forests have increased global atmospheric concentrations of greenhouse gases (e.g., water vapor, carbon dioxide, methane, and nitrous oxides), which, in turn, have led to increased heat and climate change (NCSU Water Quality Group, n.d.). For example, the world's wetlands contain a substantial volume of peat. By storing the carbon, the wetlands minimize the amount of carbon available to the atmosphere. Disruptions to the peat deposits could contribute significantly to worldwide atmospheric concentrations of carbon dioxide. Soils are the primary storage medium (*sinks)* for carbon on a global scale, and one-third to one-half of the world's soils are wetlands (Mitsch and Gosselink 2000).

Although wetlands may lessen the impact of climate change due to the role they play in the cycling of elemental chemicals, wetland loss magnifies the impact of climate change.

**Exhibit 1. Wetland Functions in the Watershed**

| Wetland Function | Description |
|---|---|
| **Hydrology** | **Flood Protection**<br>Wetlands trap and then slowly release rainwater, snowmelt, groundwater, and floodwater. Trees and the roots of other plants slow the speed of runoff and distribute it over the floodplain. In urban areas, wetlands can collect and counteract the increased runoff from buildings, pavement, and other impervious surfaces (USEPA n.d.). The ability of wetlands to collect, store, and release floodwater and to desynchronize flood flows is dependent on numerous factors, including groundwater storage capacity, the size and shape of the wetland, slope, soil permeability, depth of the water table, wetland condition, and landscape position (Wright et al. 2006). Riverine wetlands are especially useful in storing and holding flows, including peak flows, which tend to produce flood damage. A classic 1972 study on the hydrologic value of wetlands by the U.S. Army Corps of Engineers (USACE) demonstrated that if 3,400 hectares (approximately 8,401 acres) of wetlands were removed from the Charles River Basin in Massachusetts, flood damages would increase by |

| Wetland Function | Description |
| --- | --- |
| | $17 million (Mitsch and Gosselink 2000). The loss of wetlands also has had significant impacts on flood storage ability in the United States. |
| **Hydrology continued** | **Shoreline Erosion**<br>Wetlands along coastlines (marine or freshwater) can slow and reduce storm surges, protecting people and property from storm damage. For wetlands along the coast and along lakes, rivers, and bays, plants and roots hold sand and soil in place, absorb the energy of waves, and slow currents, resulting in reduced erosion (USEPA n.d.). When wetland vegetation is removed, increased erosion can occur, resulting in loss of property (Wright et al. 2006).<br>**Groundwater Recharge/Discharge**<br>Some wetlands help to recharge and maintain groundwater levels, while other wetlands discharge groundwater to streams, helping to maintain baseline flow and reduce flooding (Wright et al. 2006). Landscape position and soil permeability have significant impacts on wetland and groundwater interactions including flood mitigation. A 1997 study by Ewel estimated that the draining of 80 percent of a Florida Cypress swamp would result in a 45 percent loss of the groundwater in the area (Wright et al. 2006). Wetlands can also improve groundwater quality in certain cases. For example, wetlands have been shown to assimilate landfill leachate and reduce chlorinated compounds from a nearby manufacturing site (Wright et al. 2006). |
| **Water Quality** | Nonpoint source pollution is a principal threat to water quality. Wetlands help to remove, retain, or transform pollutants and sediments from nonpoint sources by acting as natural filters, resulting in discharges of higher quality water downstream. Wetlands can help improve water quality by removing numerous types of pollutants or parameters, including nutrients, biochemical oxygen demand, suspended solids, metals, and pathogens (NCSU Water Quality Group n.d.).<br>The ability of wetlands to remove pollutants depends on numerous factors, including wetland size and type, wetland condition, landscape position, water sources, types of pollutants, soil properties, groundwater connection, and vegetation (Wright et al. 2006). In the wetland areas surrounding Lake Erie, a 1999 study by Mitsch et al. estimated that restoring 25 percent of the original wetland area would result in an increase in phosphorus reduction by 24 to 33 percent (USEPA 2008b). |
| **Habitat** | Wetlands provide important habitat for aquatic, terrestrial, and avian species (Wright et al. 2006). Almost half of all federally listed endangered or threatened species depend directly or indirectly on wetlands, and more than one-third of these species live only in wetlands (USEPA n.d.). Species, including migratory species, depend on wetlands for a variety of functions, including feeding, breeding, nesting, and raising their young (NCSU Water Quality Group n.d.). For example, black ducks use prairie potholes in the upper Midwest for nesting and spend winters foraging in the coastal wetlands of the Chesapeake Bay (Wright et al. 2006). Wetlands can also function as wildlife corridors (Wright et al. 2006). Wetlands are often more productive and provide more habitat than would be expected for their size and have been equated with coral reefs and rainforests in terms of productivity (USEPA 2010). |

**Exhibit 2. Wetland Values in the Watershed**

| | | |
|---|---|---|
| **Ecological Values** | | |
| • Source of biodiversity<br>• Food, water, and shelter for migrating and breeding species | • Habitat for endangered or threatened species<br>• Hydrologic cycle contribution<br>• Role in climatic processes | |
| **Economic Values** | | |
| • Commercial fishing and shellfishing<br>• Commercial timber<br>• Habitat for animals used in fur and pelt production<br>• Reduced flood damage | • Commercial production of cranberries, wild rice, and mint<br>• Medicines produced from wetland plants<br>• Removal of pollutants and water quality maintenance | In performing this filtering function, wetlands save society a great deal of money. A 1990 study showed that the Congaree Bottomland Hardwood Swamp in South Carolina removes a quantity of pollutants that would be equivalent to that removed annually by a $5 million wastewater treatment plant. |
| **Social Values** | | |
| • Scenic beauty<br>• Recreational opportunities<br>• Nature-based tourism | • Historical and heritage value<br>• Educational opportunities | |

Sources: Novitzki et al. 1997; Kusler 2004; and USEPA 2008b.

### 1.2.2 Historical and Current Protection of Wetlands

When the Europeans first arrived in the United States, an estimated 215 to 220 million acres of wetlands existed. Less than 47 to 53 percent of that acreage remains today (Mitsch and Gosselink 2000; Dahl 2006 in Zedler 2006). Until the 1970s, physically altering or destroying wetlands was a generally accepted practice. For example, wetlands have been drained for agricultural uses, filled for urban development, impounded to supply water or to diminish flooding, and dredged for marinas and ports. Wetlands have also been indirectly impacted, or their functions and quality degraded, by agricultural and urban runoff, invasion by nonnative species, and atmospheric deposition of harmful pollutants (IWWR 2003).

Recognizing the importance of wetlands, scientists in a 1992 National Research Council (NRC) study called for the development of a national wetlands restoration strategy. Since then, federal agencies and their partners (state and local governments, non–governmental organizations, landowners, watershed groups, and others) have been working to achieve a net increase of wetlands (IWWR 2003).

Although federal agencies have been making the effort to increase and improve the nation's wetlands, they are limited in their abilities to control local land use practices that cause indirect wetland water quality impacts from activities such as natural erosion, road construction, residential and commercial development, and agricultural and urban land uses. These impacts result in the following conditions (Cappiella et al. 2006):

- Increased ponding and water level fluctuations
- Constriction of downstream flow
- Pollutant accumulation in wetland sediments
- Nutrient enrichment

- Decreased groundwater recharge
- Hydrologic drought in riparian wetlands
- Altered hydroperiods
- Sediment deposition
- Chloride inputs
- Increased abundance of invasive and tolerant plant or aquatic species
- Decline in diversity of wetland plant and animal communities

The Clean Water Act (CWA) section 404 permitting program has enabled the federal government and states to minimize the physical alterations of wetlands through such actions as dredging or filling. The CWA section 404 program is primarily administered by the USACE. Under the program, the USACE or an approved state regulates activities impacting wetlands. (See inset below for additional information on the CWA section 404 program.) However, wetlands that are vulnerable to indirect impacts from urban, suburban, and agricultural runoff and atmospheric deposition are not addressed through the federal/state permitting process and must therefore be protected using other strategies, many of which need to be implemented locally (e.g., zoning restrictions, subdivision ordinances, and other local development regulations) (Cappiella et al. 2006). Alternative strategies are also needed for addressing impacts to isolated wetlands, which are not regulated under state or local programs.

**The CWA Section 404 Program and Compensatory Mitigation**

The program requires any person planning to discharge dredged or fill materials to waters of the United States, which include wetlands, to obtain a permit. The U.S. Army Corps of Engineers (USACE) or approved state issues permits and develops the technical protocols and procedures for delineating and determining impacts on wetlands.

EPA participates in the program by developing environmental guidelines for discharges and state assumption of the program (USEPA 2005). EPA, the National Marine Fisheries Service (NMFS), and the U.S. Fish and Wildlife Service (USFWS) review and provide comments on permit applications. EPA has veto authority over permit applications or permit conditions if it finds the potential impacts unacceptable.

When damages to wetlands are unavoidable, the Corps requires the permittee to provide *compensatory mitigation* as a condition of issuing a permit (NRC 2001). In 2001, the NRC released a report recommending that mitigation site selection be conducted on a watershed scale.

Although compensatory mitigation is beyond the scope of this document, it is important to note that evaluations of the effectiveness of mitigation under the CWA section 404 program have helped to advance the science of wetland restoration and the development of performance standards. As part of wetland assessments, watershed groups often identify where in their respective watersheds wetland mitigation is occurring and by what parties. There can be opportunities to collaborate in wetland restoration if mitigation sites match up with those wetland areas the watershed group has deemed important.

Programs that incentivize private landowners or nongovernmental organizations to undertake voluntary actions play a role in protecting wetlands in addition to programs that fund the restoration of wetlands or their acquisition, easements, leases, and regulation. CWA section 319, Farm Bill, and Land and Water Conservation Fund programs are a few examples of programs that fund the restoration of wetlands or their acquisition. Appendix A outlines the various programs federal agencies implement relative to wetlands.

Watershed plans are effective tools for identifying and addressing water quality problems that result from both point and nonpoint source problems. They also provide a means to protect and restore other watershed attributes, such as the provision of wildlife habitat and other environmental features such as wetlands. Continued declines in wetland abundance and function will hamper efforts to restore watershed integrity. Subsequent chapters of this Supplement will discuss some possible ways wetlands can be incorporated into the watershed planning process.

## 1.3 What's Inside the Document?

The Supplement is presented as four chapters:

- **Chapter 1** includes an overview of the purpose and intent of the document, background on why it is valuable or important to include wetlands in watershed planning, and a brief overview of the historical and current protection of wetlands.
- **Chapter 2** provides the regulatory definition of wetlands, an overview of wetland types, and a review of wetland classification schemes.
- **Chapter 3** outlines the basic watershed planning steps and highlights the considerations that watershed group gives by including wetlands in its watershed plan. The chapter also provides general information on wetland restoration, enhancement, and creation techniques and discusses the consideration one should offer in selecting options.
- **Chapter 4** contains four case studies summarizing approaches for identifying existing and former wetlands for restoration or enhancement, as well as possible sites for wetland creation within a watershed context. The case studies also summarize approaches for prioritizing amongst potential sites based on wetlands having the greatest restoration potential and wetlands whose restored functions would address key watershed goals such as improved hydrology, improved water quality, and increased habitat.

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# 2. Wetland Basics

## 2.1 Regulatory Wetland Definition

Federal and state programs define the term *wetlands* differently, depending on the scope of their management activities. This Supplement uses the regulatory definition of *wetlands* the USACE and EPA use in relation to the CWA section 404 program:

> [T]hose areas that are inundated or saturated by surface or groundwater 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. [40 CFR 230.3(5)]

## 2.2 Wetland Types

A useful way to think about wetland types is in terms of their dominant water source—precipitation, groundwater, or surface water—as described in exhibit 3 (NCSU Water Quality Group n.d.).

**Exhibit 3. Wetland Type Descriptors**

| Precipitation-Dominated Wetlands |
|---|
| • **Bogs** obtain water primarily from precipitation and are characterized by sphagnum mosses dominating the floor of the bog and creating waterlogged, acidic conditions with low nutrient levels (USEPA 2010). Bogs prevent downstream flooding by absorbing precipitation. Because of the acidic, waterlogged conditions and low nutrient levels, only species that are specifically adapted to such conditions are able to live in bogs, resulting in many unique plant and animal species (USEPA 2010).<br>• **Pocosins** are shrub- and tree-dominated landscapes with little standing water located at a slightly higher elevation than the surrounding landscape. Precipitation is the main water source, and although there is little standing water, the soil is saturated much of the year, resulting in waterlogged, nutrient-poor, and acidic soils. Fires typically occur in pocosins every 10 to 30 years during the spring or summer dry periods, and they play a key role in maintaining a diverse tree and shrub population (USEPA 2010).<br>• **Vernal Pools, Playas, Prairie Potholes, Wet Meadows, and Wet Prairies:** Because of many similarities, these wetland types are sometimes categorized as marshes; however, unlike marshes, they receive water predominately from precipitation. Because these wetlands are isolated from surface waters, they do not typically discharge to surface waters, but many recharge groundwater (NCSU Water Quality Group n.d.). |
| **Surface Water-Dominated Wetlands** |
| • **Marshes** are generally defined as wetlands frequently or continually inundated by water. All types of marshes receive most of their water from surface water; some are also fed by groundwater. Their vegetation is characterized by emergent soft-stemmed plants adapted to saturated soil conditions. Marshes are home to an abundance of plant and animal life due to high nutrient levels and neutral pH (USEPA 2010). They play an important role in recharging groundwater supplies, moderating stream flow, and settling pollutants to improve water quality (NCSU Water Quality Group n.d.). |

**Surface Water-Dominated Wetlands (continued)**

- **Riparian Forested Wetlands** receive water from rivers, streams, and lakes and are located across the United States. Standing water is present in the winter and spring, with little to no standing water during the summer and fall (NCSU Water Quality Group n.d.). Riparian forested wetlands act as a sink for pollutants from nonpoint sources (USEPA 2010). They also receive alluvial soil from floods, and as a result, they are very productive and are important ecologically as they serve as habitat for plant and animal species (NCSU Water Quality Group n.d.).
- **Tidal Freshwater Marshes** are fed by upstream surface waters. They are located far enough upstream of estuaries to include freshwater but far enough downstream to be influenced by tides (NCSU Water Quality Group n.d.). Nutrient levels are high due to precipitation and upstream runoff, resulting in a highly productive system (USEPA 2010). Tidal freshwater marshes improve water quality through processes that remove nitrogen, phosphorus, and sediment (NCSU Water Quality Group n.d.).

**Groundwater-Dominated Wetlands**

- **Fens** are very similar to bogs, the main distinction being that fens receive water from groundwater (NCSU Water Quality Group n.d.). Fens are peat-forming wetlands; they have less acidic soil conditions and higher nutrient levels than bogs. Fens are located in northern regions characterized by low temperatures and short growing seasons (USEPA 2010). They can contribute to downstream waters and stabilize water tables by recharging groundwater at local aquifers (NCSU Water Quality Group n.d.).

## 2.3 Wetland Classification Systems

### 2.3.1 USFWS Classification System

The concept or recognition of the importance of wetland functions developed a foothold in the 1970s and has evolved since then in both the scientific and regulatory communities. Attention was first given to the structural elements of wetlands, such as vegetation. Wetlands were thought at the time to function as important habitat for waterfowl and other wildlife (Sheldon et al. 2005). In 1979, after extensive field testing and review, the USFWS published the wetland classification system in *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al. 1979). USFWS developed the Cowardin system to identify wetlands by type and facilitate monitoring of wetland losses and gains and changes in wetland type. This classification system has since become the standard system for classifying wetlands, and the USFWS and the National Wetland Inventory (NWI) use it to form the basis of their wetland monitoring and mapping efforts (USGS n.d.). (See the sidebar for an explanation of the NWI.)

**What is the NWI?**

The National Wetlands Inventory is a database of information used to identify the status of wetlands across the United States. The system contains wetland data in map and digital formats (i.e., geographic information systems, or GIS). Wetlands are classified in the system according to the Cowardin system.

Source: USFWS 2010.

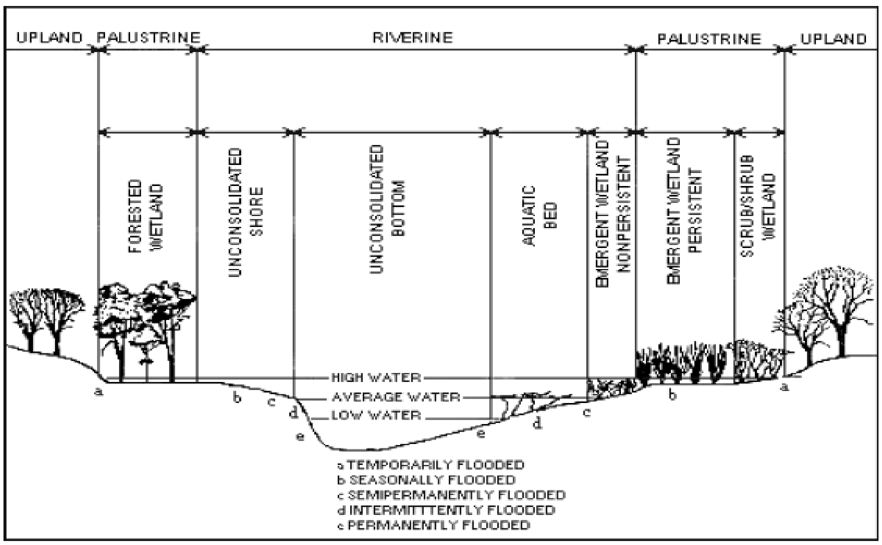
In the USFWS classification system, wetlands are defined by plants, soils, and frequency of flooding. In addition, ecologically related areas of deep water that are not traditionally considered wetlands are classified (Cowardin et al. 1979).

The USFWS classification identifies five major systems— marine, estuarine, riverine, lacustrine, and palustrine (Cowardin et al. 1979). Because this Supplement focuses on freshwater coastal and inland wetlands, only the riverine, lacustrine, and palustrine systems are further described.

Additional information on the USFWS classification system and the NWI can be found at http://www.fws.gov/wetlands/WetlandsLayer/index.html.

Exhibit 4a is a visual representation of the riverine system. The riverine system includes all wetlands and deepwater habitats that are contained within a channel with two exceptions: (1) wetlands dominated by trees, shrubs, persistent emergent, emergent mosses, or lichens and (2) habitats that contain ocean-derived salts in excess of 0.5 part per million (ppm). A channel is "an open conduit either naturally or artificially created which periodically or continuously contains moving water, or which forms a connecting link between two bodies of standing water." Examples of riverine wetlands include freshwater rivers, streams, and immediately adjacent wetlands (Gray et al. n.d.).

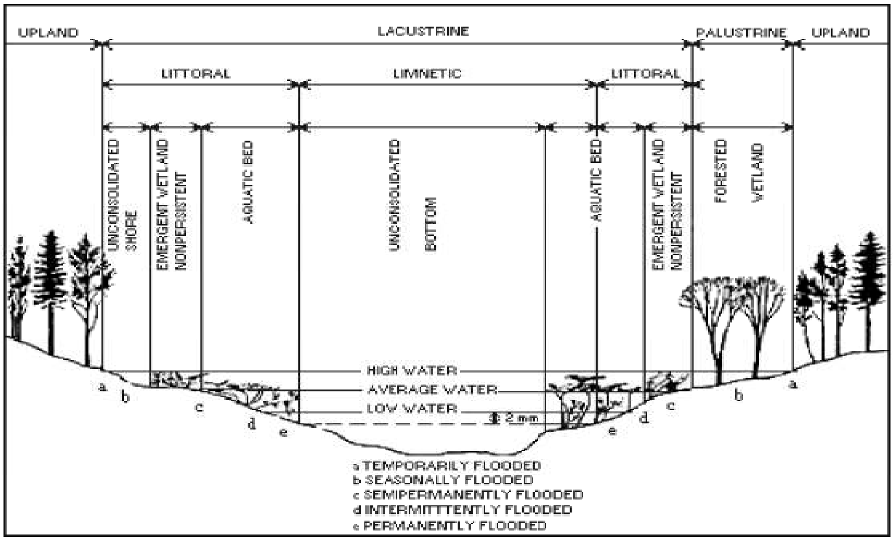
**Exhibit 4a. Riverine Wetland System**




Source: Cowardin et al. 1979.

Exhibit 4b is a visual representation of the lacustrine system. The lacustrine system includes wetlands and deepwater habitats with all the following characteristics: (1) situated in a topographic depression or dammed river channel; (2) lacking trees, shrubs, persistent emergents, emergent mosses, or lichens with greater than 30 percent areal coverage; and (3) total area that exceeds 20 acres. Similar wetland and deepwater habitats totaling less than 20 acres are also included in the lacustrine system if an active wave-formed or bedrock shoreline feature makes up all or part of the boundary, or if the water depth in the deepest part of the basin exceeds 6.6 feet at low water. Lacustrine waters may be tidal or nontidal, but ocean-derived salinity is always less than 0.5 ppm.

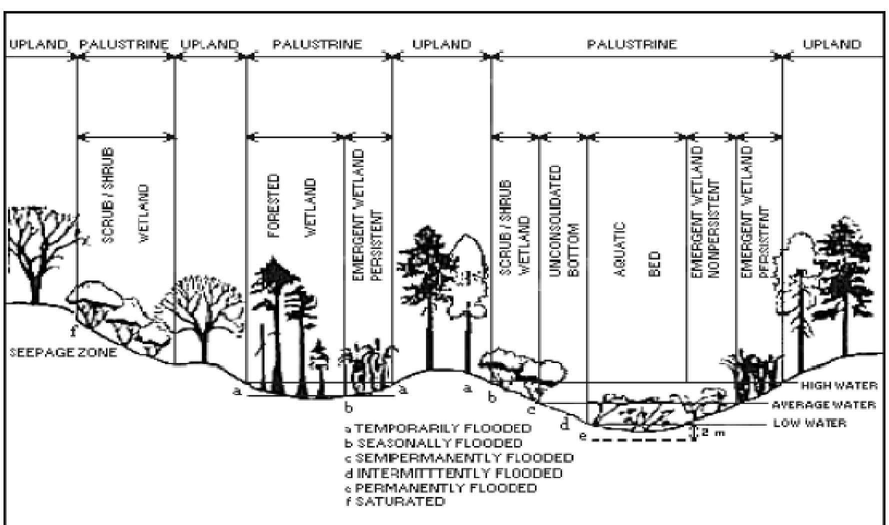
**Exhibit 4b. Lacustrine Wetland System**




Source: Cowardin et al. 1979.

Exhibit 4c is a visual representation of the palustrine system. The palustrine system includes all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5 ppm. It also includes wetlands lacking such vegetation, but with all of the following four characteristics: (1) area is less than 20 acres; (2) active wave-formed or bedrock shoreline features are lacking; (3) water depth at the deepest part of the basin is less than 6.6 feet at low water; and (4) salinity due to ocean-derived salts is less than 0.5 ppm. Examples of palustrine wetlands include marshes, swamps, bogs, and wet meadows (Gray et al. n.d.).

**Exhibit 4c. Palustrine Wetland System**




Source: Cowardin et al. 1979.

### 2.3.2 HGM Classification System and Approach

An additional wetland classification system, called the hydrogeomorphic (HGM) system was later developed to support the USACE's mission under the CWA section 404 program (Brinson 1993; Smith et al. 1995). The HGM system classifies wetlands according to geomorphic setting (topographic location), water source and transport (surface flow, groundwater flow, and precipitation), and hydrodynamics (direction and strength of water flow). It also establishes procedures for classifying wetlands regionally. The HGM system consists of seven approved wetland classes—riverine, depressional, slope, mineral soil flats, organic soil flats, estuarine fringe, and lacustrine fringe—and also has subclasses and regional classes. Exhibit 5 shows the dominant water source and hydrodynamics of each of the seven wetland classes along with examples of subclasses. Additional information on the HGM system and approach is available at http://el.erdc.usace.army.mil/wetlands/pdfs/wrpde4.pdf and http://el.erdc.usace.army.mil/wetlands/pdfs/wrpde9.pdf.

**Exhibit 5. Hydrogeomorphic Classes of Wetlands Showing Dominant Water Sources, Hydrodynamics, and Examples of Subclasses**

| Hydrogeomorphic Class (geomorphic setting) | Water Source (Dominant) | Hydrodynamics (Dominant) | Examples of Regional Subclasses | |
|---|---|---|---|---|
| | | | Eastern USA | Western USA and Alaska |
| **Riverine** | Overbank flow from channel | Unidirectional and horizontal | Bottomland hardwood forests | Riparian forested wetlands |
| **Depressional** | Return flow from groundwater and interflow | Vertical | Prairie pothole marshes | California vernal pools |
| **Slope** | Return flow from groundwater | Unidirectional, horizontal | Fens | Avalanche chutes |
| **Mineral soil flats** | Precipitation | Vertical | Wet pine flatwoods | Large playas |
| **Organic soil flats** | Precipitation | Vertical | Peat bogs; portions of Everglades | Peat bogs |
| **Estuarine fringe** | Overbank flow from estuary | Biodirectional, horizontal | Chesapeake Bay marshes | San Francisco Bay |
| **Lacustrine fringe** | Overbank flow from lake | Bidirectional, horizontal | Great Lakes marshes | Flathead Lake marshes |

Source: Adapted from Smith et al. 1995.

### 2.3.3 Distinctions Between the USFWS and HGM Classification Systems

Those involved in wetland planning and restoration efforts should understand that the USFWS and HGM classification systems were developed for different purposes. The USFWS system was designed for use in the NWI and for monitoring and mapping efforts, whereas the HGM classification system was developed to assess wetland functions as part of the USACE's responsibilities under the CWA section 404 program. A limitation of the Cowardin system is that it does not consider wetland function, and a limitation of the HGM system is that it does not consider other physical properties of wetlands that affect how wetlands function, such as vegetation, soil texture, and soil pH.

### 2.3.4 NWIPlus

To address the limitations of the Cowardin and HGM systems, researchers have designed methods for assessing wetlands for regional or localized uses based on elements or concepts in the Cowardin or HGM system, or both. In the 1990s, scientists in the northeast region of the U.S. worked with the USFWS to enhance NWI data with HGM-type descriptors to describe a wetland's landscape position, landform, water flow path, and water body type (USFWS 2010).

The enhanced NWI, now called NWIPlus, provides a consistent means of using NWI data to predict 11 wetland functions (USFWS 2010). This method looks at habitat type and also identifies potential wetland functions such as (1) surface water detention, (2) stream flow maintenance, (3) nutrient transformation, (4) sediment and particulate retention, (5) carbon sequestration, (6) shoreline stabilization, (7) coastal storm surge detention, (8) provision of fish and shellfish habitat, (9) provision of waterfowl and waterbird habitat, (10) provision of habitat for other wildlife, and (11) conservation of biodiversity.

The USFWS calls the watershed assessment approach applying NWIPlus a *Watershed-based Preliminary Assessment of Wetland Functions* (W–PAWF). This assessment method is inventory-based and evaluates every mapped wetland on the basis of properties contained in the NWIPlus database. The method is designed to reflect the potential of a wetland to provide a function (USFWS 2010). Contact your state or local USFWS office to determine the availability of state NWI or NWIPlus data.

### 2.3.5 Summary

Wetlands should be a key consideration of watershed planners. They play a role in the overall health and functioning of a watershed. In turn, their restoration, enhancement, or creation can be a strategic means to address water quality, water flow, and/or habitat issues. Incorporating wetlands into a watershed plan requires the realization that wetland types can vary significantly and that wetlands can be difficult to classify (e.g., exhibiting varying levels of the appropriate hydrology, vegetation, and soils). Some areas might not appear to be a wetland to the untrained eye. Some wetland types do not always meet all wetland classification criteria. For example, a wetland whose vegetation has been removed or altered because of natural events or human activities would not meet classification criteria for plants. Subsequent chapters in this Supplement will detail effective ways to determine areas that were once wetlands or display the characteristics conducive to facilitating wetland functions. This information will assist watershed planners in determining possible areas in which to restore, enhance, or create wetlands to address watershed plan goals related to water quality, hydrologic alteration, and habitat loss.

# 3. Incorporating Wetland Restoration, Enhancement, and Creation into Watershed Management Plans

## 3.1 Returning Wetlands to the Landscape

Given the loss and degradation of wetlands over the years and the subsequent realization of their social, economic, and ecological values, considerable effort has gone into their restoration.

> Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed. It is an activity that initiates or accelerates ecosystem recovery with respect to its health (functional processes), integrity (species composition and community structure), and sustainability (resistance to disturbance and resilience). The activity ensures abiotic support from the physical environment, suitable flows and exchanges of organisms and materials with the surrounding landscape, and the reestablishment of cultural interactions upon which the integrity of some ecosystems depends. (McIver and Starr 2001).

The concepts of wetland preservation, restoration, enhancement, and creation are embedded in the more broadly defined term *ecological restoration*. Preservation is the act of protecting and maintaining existing wetlands or protecting a wetland through implementation of appropriate legal mechanisms. When characterizing a watershed, one of the initial steps is to identify the location of relatively intact, unimpacted natural areas (i.e., areas with high ecological integrity), including wetlands. Watershed planners typically target those areas for conservation/protection. It is important to identify former wetland sites or degraded areas near those natural areas that could possibly be restored or enhanced (Weber and Bulluck 2010; Sumner 2011; and others). Wetland restoration, enhancement, and creation projects have a greater likelihood of success if they are adjacent to or part of an already functioning wetland (IWWR 2003). Although preservation is not the focus of this Supplement, it is important to understand the value of preservation activities.

For the purposes of this Supplement, the terms *restoration*, *enhancement*, and *creation* are defined as follows:

- **Restoration** is the reestablishment of a wetland in an area that was formerly a natural wetland or the rehabilitation of historic functions to a degraded wetland.
- **Enhancement** is increasing one or more of the functions performed by an existing wetland beyond what currently exist in the wetland.
- **Creation** means establishing a wetland where one did not exist previously. Note that for the purposes of this Supplement, *creation* does not include constructed wetlands to treat effluent.

Wetland restoration is sometimes confused with wetland enhancement because both may involve working in existing, degraded wetlands (IWWR 2003). Restoration is both (1) reestablishing lost wetlands (e.g., areas that were historically wetland but are not wetlands today) and (2) rehabilitating degraded wetlands. For example, in a restoration project, one might remove drainage tiles from an agricultural field and plant vegetation in an effort to reestablish a wetland area that once existed there. Conversely, wetland enhancement projects can result in reducing one function of the wetland to enhance another function. In an enhancement project, one might alter existing wetland habitat elements (e.g., water depth and vegetation) to increase the likelihood of endangered species being established. Another example of enhancement might be to modify the hydrology by increasing the amount of stored water in a wetland in order to increase aquatic habitat for fish; however, this might decrease the ability of the wetland to hold floodwaters (IWWR 2003). Regardless, when wetland enhancement is undertaken, the project goals should include minimizing any decrease in existing wetland functions.

Wetland creation occurs in areas that were not previously wetland however conditions or characteristics exist that may still produce and sustain a wetland. Creating wetlands is more difficult than restoring or enhancing them. Wetland creation requires consideration of a variety of factors. The outcome of most wetland creation projects is difficult to predict, and created wetlands often have limited functions compared to natural wetlands (IWWR 2003). Some of the baseline conditions conducive to wetland formation, such as hydric soils, are not always present in the landscape of creation projects. Therefore, creation does not typically result in the establishment of sustainable wetlands or wetlands that successfully provide beneficial ecological functions.

## 3.2 When to Include Wetlands in Watershed Plans

As outlined in EPA's Watershed Planning Handbook, the development of watershed plans has four basic steps, each with a series of substeps: (1) planning, (2) implementation, (3) monitoring, and (4) long-term management. (See exhibit 6 next page.) EPA has identified the nine substeps highlighted in exhibit 6 as critical elements that should be addressed in watershed plans where water quality improvements are the aim. In fact, EPA requires the nine elements to be addressed in watershed plans funded with incremental CWA section 319 funds and strongly recommends that they be included in all other watershed plans intended to address water quality impairments. Including wetlands in watershed plans requires that they be considered throughout each phase of the watershed planning process. As noted in the Handbook, watershed planning is an iterative process and so, too, is the process for including wetlands. An important aspect of the planning process is that it is *adaptive*. (See inset below.)

> **Adaptive Management**
>
> "Adaptive management is a decision process that promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process. Adaptive management also recognizes the importance of natural variability in contributing to ecological resilience and productivity. It is not a 'trial and error' process, but rather emphasizes learning while doing. Adaptive management does not represent an end in itself, but rather a means to more effective decisions and enhanced benefits. Its true measure is in how well it helps meet environmental, social, and economic goals, increases scientific knowledge, and reduces tensions among stakeholders."
>
> — B.K. Williams, et al. 2009 in *Adaptive Management: The U.S. Department of the Interior Technical Guide*

**Exhibit 6. Watershed Planning Steps**

**Note:** The nine items highlighted in orange are the elements EPA requires to be addressed in watershed plans funded with incremental CWA section 319 dollars.

**Planning**

1. Build partnerships
   - Identify issues of concern
   - Set preliminary goals
   - Develop indicators
   - Conduct public outreach
2. Characterize the watershed
   - Gather existing data and create a watershed inventory
   - Identify data gaps and collect additional data if needed
   - Analyze data
   - **Identify causes and sources of pollution that need to be controlled**
   - Estimate pollutant loads
3. Finalize goals and identify solutions
   - Set overall goals and management objectives
   - Develop indicators/targets
   - **Determine load reductions needed**
   - Identify critical areas
   - **Develop management measures to achieve goals**

**Characterization and Analysis Tools**

- GIS
- Statistical packages
- Monitoring
- Load calculations
- Model selection tools
- Models
- Databases

**Implementation**

4. Design implementation program
   - **Develop an implementation schedule**
   - **Develop interim milestones to track implementation or management measures**
   - **Develop criteria to measure progress towards meeting watershed goals**
   - **Develop monitoring component**
   - **Develop information/education component**
   - Develop evaluation process
   - **Identify technical and financial assistance needed to implement plan**
   - Assign responsibility for reviewing and revising the plan

**Watershed Plan Document**

**Monitoring**

5. Implement watershed plan

- Implement management strategies
- Conduct monitoring
- Conduct information/education activities

**Long Term Management**

6. Measure progress and make adjustments
   - Review and evaluate information
   - Share results
   - Prepare annual work plans
   - Report back to stakeholders and others
   - Make adjustments to program

Source: USEPA 2008a.

## 3.3 Watershed Planning Considerations When Incorporating Wetlands

Some of the primary considerations involved in including wetlands in the watershed planning process are discussed below.

### 3.3.1 Building Partnerships

#### *Identify Key Stakeholders*

Working with and soliciting input from key stakeholders is a critical aspect of any watershed planning activity, including planning for a wetland-specific project. Stakeholders are those who make and implement decisions, those who are affected by the decisions made, and those who have the ability to assist or impede implementation of the decisions. (See sidebar for a list of possible partners.) It is essential that all of these categories of potential stakeholders, not just those that volunteer to participate, are identified and included. Key stakeholders also include those that can contribute resources and assistance to the watershed planning effort and those that work on similar programs that can be integrated into a larger effort (USEPA 2008a).

The role that stakeholders play will vary depending on their affiliate organizations. Stakeholders include those that (USEPA 2008a):

- Will be responsible for implementing the watershed plan
- Will be affected by implementation of the plan
- Can provide information on the issues and concerns in the watershed
- Have knowledge of existing programs or plans that a watershed group might want to integrate into its plan
- Can provide technical and financial assistance in implementing and developing the plan

Consult chapter 3 of EPA's Watershed Planning Handbook if you want to learn more about the kinds of stakeholders that should be involved in developing and implementing your watershed plan.

**Possible Partners to Help Incorporate Wetlands into Watershed Management Plans**

Identify representatives with wetland expertise and include them in all phases of plan development and implementation.

- Landowners
- County or regional representatives
- Local municipal representatives
- State and federal agency representatives
- Tribal representatives
- Faculty and students at universities, colleges, and other schools
- Business and industry representatives
- Members of citizen groups
- Representatives of community service organizations
- Religious organization representatives
- Staff and members of environmental and conservation groups
- Soil and water conservation district representatives
- Representatives of irrigation districts

Source: USEPA 2008a.

### Identify Issues of Concern and Set Preliminary Goals

It is important to define the scope of your efforts when developing a watershed plan. Scope applies to the boundaries of your effort, which can be defined in terms of geographic area or other parameters. At this time you would also identify issues of concern in the watershed and begin conceptually mapping them to hone in on specific research/plan objectives. An issue of concern with respect to wetlands might be that they and their functions have been lost or degraded, which in turn has impaired water quality, altered hydrology, and reduced wildlife and aquatic habitat in the watershed.

To begin assessing these concerns, you would begin posing questions about such topics as the presence of former and existing wetlands in your watershed, the functions they play (or played) at various geographic scales in the watershed, the degree to which the functions are impeded, how the limited functions are impacting the larger water system, the stressors that are inhibiting or degrading the identified wetland function, and the sources of the stressors.

As you answer questions like those above for the watershed as a whole, the geographic extent of your watershed plan will begin to take shape and you will be in a position to begin developing preliminary watershed plan goals. Initially, your goals will be broad, such as "protect, restore, or enhance former and existing riparian wetlands for their abilities to filter runoff from adjacent land uses, thereby helping eliminate downstream water quality impairments of nutrients and sediment." You might have similar goals for other wetland functions as they relate to problems you are seeing in the larger watershed. As you continue to move through the planning process, you will refine the goals, develop indicators to measure environmental conditions, and establish objectives/targets to achieve. Consult chapters 4 through 9 of EPA's Watershed Planning Handbook for a detailed discussion of these topics.

## 3.3.2 Characterizing the Watershed

### Inventory and Assess the Watershed

One of the first steps in characterizing the watershed is to gather and assess existing data and create a watershed inventory. This inventory should include wetland components. Watershed-level characteristics (e.g., hydrology, soils, and vegetation; see sidebar) can be used to define and classify wetlands. This information will assist watershed groups in determining which former or existing wetlands could be restored or enhanced for successful and sustainable integration into the watershed ecosystem (IWWR 2003).

**Watershed-Level Characteristics to Define and Classify Wetlands**

- Land uses
- Topography (i.e., elevation, aspect, and slope)
- Climate (i.e., precipitation patterns and temperature)
- Soil types
- Groundwater
- Surface waters
- Floodplains
- Vegetation communities

Sources: IWWR 2003; UWM 2005.

One source of information for beginning the inventory and assessment process is local citizens. Citizens who have lived in the watershed a long time usually have a strong understanding of the natural resources of the area and can provide very valuable insights. Maps are also useful resources for characterizing watersheds and wetlands. For example, soil maps can aid in identifying current or historic wetland soils, and biological reports, if available from local agencies, can facilitate the determination of local vegetation (IWWR 2003). Aerial photography and topography can provide information on water sources, drainage, and surface runoff (and the location of former wetlands). Floodplain maps provide information on the locations and elevations of flood-prone areas. Sources for most of these resources are identified in sections 5.3.5 and 5.8.1 of EPA's Watershed Planning Handbook. These and other sources are also provided in the case studies presented in chapter 4 of this Supplement. Sources for aerial photographs include the following:

- http://nationalmap.gov/gio/viewonline.html
- http://www.globexplorer.com/products/imageconnect-mapinfo.shtml

Use an Internet browser to search for state or local aerial photographs for additional and more specific resources.

When available, digital NWI maps from the USFWS can be extremely helpful in identifying where in the watershed current wetlands are located. This information can be used to determine the watershed features that have been amenable to wetland formation (e.g., the presence of hydric soils) in the past. This information can also provide models for where new wetlands might best be located, both to replicate the landscape positions of existing wetlands and to provide for consolidation of wetland resources where and when practicable. In addition, high-quality wetlands that become targets for protection can be identified through this process. It should be noted that although NWI data might be the best source for locating wetlands on the landscape, the data, depending on the year used, might not necessarily reflect current conditions on the ground. Planners often use NWI as an initial layer and then evaluate aerial photographs or other sources to make initial decisions about current and former wetland locations.

It should be recognized that both the availability and quality of data need to be considered when determining which data sources to use. For example, a county might have a fairly advanced geographic information system (GIS) data source for the watershed-level characteristics listed on the previous page, except on vegetation communities, which might be too coarse to be useful at the watershed level. This and similar limitations to GIS datasets need to be considered. It is important to know and understand the origin, geographic coverage, and associated metadata of any data used. The metadata answer questions related to data generation (i.e., who, what, why, when, where, and how).

The purpose of this Supplement is to provide informal guidance on ways to incorporate wetland assessment activities and results into watershed plans. There might be some rare instances where a watershed group has already identified a project site prior to completion of a watershed plan. In such cases, EPA advises groups to collect watershed-level information regardless. The broader assessment could result in identifying another site with greater restoration potential. In addition, even if the group decides to proceed with the originally selected project site, the additional information will meet the larger goal of incorporating wetlands into watershed plans and provide greater insight into planning, constructing, and managing wetlands to meet watershed improvement goals.

Some potential sources for obtaining watershed-level characteristics specific to wetland resources are state natural resource or wetland protection agencies, local planning agencies, water quality control districts, water management districts, and flood control districts, as well as national agencies such as USGS, the Federal Emergency Management Agency (FEMA), the Natural Resources Conservation Service (NRCS), and Soil and Water Conservation Districts (SWCDs). Further examples of assessment data and sources are provided in appendix B and in the case studies in chapter 4.

Data collected can be quantitative and qualitative. Examples of quantitative data might include water chemistry, extent of hydric soils, soil permeability, soil organic carbon levels, and elevation data. Examples of qualitative data might include visual or expert opinions on site topography, erosion and drainage patterns, major vegetation, presence of human structures, and adjacent land uses (IWWR 2003). The type and level of data collected will influence the assessment techniques used. Some inquiries can be performed at the desktop, while others might require actual field observations; in some cases, both will be needed.

It should be clear that environmental assessment activities occur at multiple spatial scales and that they vary in complexity. For example, desktop assessments tend to be less complex than site-specific assessments. Typically, the larger the spatial scale, the coarser the assessment performed and vice versa. This continuum is illustrated in exhibit 7, which briefly outlines EPA's three-tiered wetland assessment framework. The level of assessment performed is dictated by the degree of precision needed and the user's monitoring budget.

**Exhibit 7. Three–Tiered Wetland Assessment Framework**

**Level 1: Landscape assessment**

***Purpose:*** To evaluate indicators for a landscape view of watershed and wetland condition. Level 1 wetland assessment methods do not involve a site visit and use the types of information that can be reviewed in the office at a desk, such as maps, soil inventories, and remote sensing-generated data such as GIS models, wetland inventories, and land use datasets.

⬇

**Level 2: Rapid wetland assessment**

***Purpose:*** To evaluate the general condition of individual wetlands using a relatively simple indicator. Level 2 assessments generally involve a short site visit to the wetland and are based on the identification of stressors (e.g., intensive surrounding land uses, drainage, ditching, vegetation removal, and substrate disturbance) and/or evaluation of the overall ecologic condition of the wetland through rating the relative intactness of habitat, hydrology, functions, and other significant wetland features.

⬇

**Level 3: Intensive site assessment**

***Purpose:*** To provide quantitative data on wetland ecological condition. The data can be used to refine rapid assessment methods and diagnose causes of wetland degradation. Level 3 assessments usually involve long periods spent at a site conducting detailed biological and/or biogeochemical surveys that involve the collection of quantitative data relative to the floral, faunal, physical, and/or chemical characteristics of a wetland.

(See appendix C and the case studies presented in chapter 4 for examples of monitoring methods.)

Source: USEPA 2011d.

Wetland assessment is an effort to evaluate the functions of a wetland or assignment of values to the functions of wetlands to determine their health. Assessments can be performed to evaluate an individual wetland or conducted to establish indicators of condition in multiple wetlands. Wetland assessment is accomplished through monitoring. Monitoring can be referred to as the systematic observation and recording of current and changing conditions, while assessment is the use of those data to evaluate or appraise wetlands to support decision-making and planning processes (USEPA 2011d). As such, wetland monitoring needs to occur in the planning process. This Supplement, however, focuses more on monitoring as a component in later stages of incorporating wetlands into the watershed planning process. It is discussed later in this Supplement as a means to measure the progress of specific wetland restoration, enhancement, and creation projects.

Landscape-level evaluations of the wetlands (and former wetlands) in a watershed, such as determining the distribution and abundance of wetlands types and characterizing the surrounding land uses, are best carried out using level 1 assessment tools (see exhibit 7 above). These large-scale assessments lend themselves to the use of GIS databases, aerial photography, maps, and other types of information that are best accessed in an office setting. Once the population of former and existing watershed wetlands has been identified using level 1 tools, further assessment of former and existing wetlands can be carried out using level 2 assessments.

Because level 2 tools are rapid, they make it possible for investigators to visit and assess a large number of wetlands in a relatively short period. The information from the level 2 assessments can be used as a basis for establishing the ecological condition of wetlands in the watershed and for determining which wetlands might require more intensive data-gathering efforts.

Level 3 monitoring is used when the most precise information on wetland condition or functions is needed. Generally, this level of precision is needed for regulatory determinations of wetland quality. This precision is also important in watershed wetland studies where accurate ambient condition is the ultimate data result of the survey. Level 2 tools involve subjectivity and best professional judgment (even when investigators have been principled in following the protocols), and two evaluators might put the wetland in the same condition class but have different scores. Conversely, level 3 tools are objective and typically yield the same quantitative results for each data collector. Level 3 tools are able to break the range of ecological condition into smaller and more accurate partitions. Sometimes these partition differences are unimportant, but at other times, they can make the difference between allowing and denying a wetland impact (Micacchion 2012).

**Example Showing Distinctions Between Use of Level 2 and 3 Tools**

A level 2 tool might place a wetland proposed for impacts somewhere between *good* and *excellent* ecological condition. In some states, like Ohio, a wetland in *good* ecological condition is allowed to be impacted, whereas one rated in *excellent* condition is protected. In this scenario, one would want to use the level 3 tool to be precise because there is a significant outcome attached to the assessment results. Source: Micacchion 2012.

Example monitoring methods appropriate at various scales along the planning continuum (e.g., levels 1 to 3 in EPA's Wetlands Monitoring Framework) are listed in appendix C. The case studies also demonstrate the use of level 1 and 2 methods when assessing wetlands as components of a watershed plan—as resources to be preserved, restored, enhanced, or created and as strategies to address problems in the larger watershed.

### 3.3.3 Finalizing Goals and Identifying Solutions

After the watershed is fully characterized, planning moves into a new stage: finalize goals and identify solutions. Although planning generally remains at the watershed level, it also overlaps somewhat with planning for specific projects to the extent that projects are identified as management strategies to achieve watershed plan goals. For example, a watershed plan goal might be to increase flood storage by protecting, restoring, and enhancing riparian wetlands. Achieving this goal means identifying where projects might occur and which have the greater likelihood of success. Consult chapters 8 to 11 of EPA's Watershed Planning Handbook to explore the following topics: analyzing data to characterize the watershed and pollutant sources, estimating pollutant loads, setting goals and identifying pollutant loads, identifying possible management strategies, and evaluating options and selecting final management strategies. Because the Handbook is geared toward improving water quality, it includes presentations on estimating pollutant load. Analyses appropriate to assessing hydrologic or habitat concerns could just as easily be made during this phase of planning if they were more in line with a watershed group's planning goals.

**Water and Pollution Roll Downhill**

A common thread in urbanizing watersheds is that development in the headwater areas tends to coincide with the loss of headwater streams and wetlands. Increased development is associated with increased imperviousness of the watershed due to the establishment of large areas of concrete and asphalt surfaces and rooftops. These hard surfaces do not absorb water. Thus, all stormwater immediately makes its way downhill. The increases in stormwater pass through the remaining streams and wetlands at ever increasing volumes and velocities. The result is a degradation of streams and wetlands at lower elevations; they become unable to assimilate the increases in water quantity, energy, sediment, and pollutants. Some of the best watershed restoration projects in urban areas can be achieved in the headwaters.

Source: Micacchion 2011.

#### *Wetland Project Goals*

Similar to the goals established for watersheds, goals for wetland projects should be specific and well-documented. The goals should reflect the desired results and motivations for the project. For example, a wetland goal might be to restore native plant species to improve wetland habitat for an endangered migratory bird species. Wetland-specific project goals should also be linked back to the overall goals for the watershed. For example, watershed goals might be to reduce flooding and improve water quality. As such, a wetland project goal might be to increase wetland acreage in key areas of the watershed to protect against downstream flooding (Cappiella et al. 2006) and to select a mix of native wetland plants that will meet the habitat needs of the endangered migratory bird species and maximize the uptake of waterborne pollutants. Another wetland project goal might be the restoration or enhancement of former and existing wetlands near degraded waterways to enable them to filter runoff from upland developments that cause water quality impairments.

Although wetlands provide multiple functions within a watershed, it might not be possible to design a single project that addresses all watershed goals. One way to begin a project with a wetland focus is to identify existing and former wetland functions in the watershed and then prioritize those desired in relation to watershed goals. As discussed earlier, the important role wetlands play in improving water quality, addressing hydrologic problems, and creating habitat should be worked into the watershed planning process. Some examples of the important roles wetlands play follow:

- Streams in watersheds with more wetland area are less prone to flooding and have better water quality and more stable levels of stream flow.
- Wetlands adjacent to large streams can store stormwater when the channel overflows and slowly release the water to the channel after the peak flows have subsided. The vegetation of riparian wetlands works to slow down flow rates, which contributes to stream bank stability by reducing the pressures on the channels during storm events.
- This reduction of water velocity also causes sediments and the chemicals adhered to the sediments to fall out of the water column thereby improving water quality.
- The composition of wetlands promotes denitrification, chemical precipitation, and other reactions that result in chemicals being removed from water. These attributes are important in urban, semi-urban, and rural landscapes.
- Although headwater streams receive small overflows, the surrounding wetlands in these headwater systems contribute to flood control by retaining surface water runoff, which might never enter a stream. Headwater wetland vegetation slows down flows, softens the watershed, and captures and recycles pollutants that otherwise would enter the local stream system.
- If the goal of a watershed group is to provide areas for recreation, then a wetland project that increases habitat for migratory bird species, thus improving bird watching in the area, could be a potential wetland restoration project. Such a project would not only improve the wetland function of providing habitat for migratory bird species but also would meet the watershed group's goal of providing areas for recreation (i.e., bird watching).

A project that works to achieve multiple watershed goals and wetland functional goals (i.e., improve priority wetland functions) should be prioritized over a project that just works to achieve one or the other. This prioritization will aid in decision-making when project circumstances, whether ecological or nonecological, are limiting (UWM 2005).

During this phase of watershed planning, a watershed group should consider and incorporate restoration, enhancement, and creation of wetlands as a component of the strategy for addressing the overall goals and management objectives for the watershed. Taking this step requires that the watershed group understand the condition and extent of wetlands in the watershed and the functions served or that could be served. Other strategies for addressing watershed problems, beyond the restoration, enhancement, or creation of wetlands, should be considered at this time as well.

Factors to consider when choosing whether to proceed with incorporating wetlands (as well as other projects) during the planning stage of a watershed project include the following (Cappiella et al. 2006):

- Accomplishment of watershed goals
- Watershed functions provided
- Total cost
- Cost per unit (e.g., acres)
- Permitting and approval responsibilities
- Short- and long-term maintenance responsibilities
- Integration with other work going on in the watershed
- Community acceptance
- Partnership opportunities
- Availability of funding to implement project
- Public visibility
- Potential for success

Funding for projects is inevitably a major consideration for all stakeholders involved in implementing projects to achieve the goals of watershed plans. Consult section 12.7 and appendix 13 of EPA's Watershed Planning Handbook for information on estimating financial and technical assistance needed for projects and public and private funding resource documents.

## 3.4 Watershed Implementation Considerations When Incorporating Wetlands

### 3.4.1 Developing an Implementation Plan

Once a decision is made about how to address problems in the watershed (e.g., projects have been identified to achieve watershed goals) and the watershed plan has been completed, the watershed group is in a position to develop an implementation program. This program will augment the group's watershed plan. An implementation program generally consists of the following components (USEPA 2008a):

- An information/education component to support public participation and build management capacity related to adopted management measures
- A schedule for implementing management measures
- Interim milestones to determine whether management measures are being implemented
- Criteria by which to measure progress toward reducing pollutant loads and other actions to meet water quality, water quantity, and habitat goals in the watershed plan
- A monitoring component to evaluate the effectiveness of implementation efforts
- An estimate of the technical and financial resources and authorities needed to implement the plan
- An evaluation framework

EPA's Watershed Planning Handbook provides an example implementation plan matrix in section 12.8.

### 3.4.2 Using Reference Wetlands to Develop Site Plans and Measure Progress

EPA recommends the use of reference sites when designing and implementing a wetland restoration, enhancement, or creation project when historical data on local wetland characteristics are unavailable. Ideas regarding potential reference sites will likely have emerged during the watershed plan development process. Those sites can now be further assessed as necessary for their value as reference sites when plans for specific wetland restoration, enhancement, or creation projects are developed. Typically, the entity undertaking the restoration project, which could be a partner organization (e.g., governmental or non-governmental organization) or a surrogate for the primary entity, such as a consultant, would be the party to identify reference sites. If multiple parties are engaged in wetland restoration, enhancement, or creation activities across the watershed, they could combine efforts as appropriate to identify reference sites.

Reference wetlands are essentially models of the wetland characteristics needed to design a restoration project that will be high functioning and successful. Brinson and Rheinhardt (1996) define reference wetlands as "sites within a specified geographic region that are chosen for the purposes of functional assessment, to encompass the known variation of a group or class of wetlands, including both natural and disturbance mediated variations."

Others define reference sites as nearby wetlands that represent the least disturbed wetlands in the area. The sites are located in a similar landscape position to the project site. In general, only natural wetlands of high ecological integrity should serve as reference sites. They should be comparable in structure and function to the project site before it was degraded (IWWR 2003). This means that not only do the reference wetlands demonstrate the highest achievable ecological condition, but they also are performing the group of functions associated with that wetland type at the highest levels to be expected.

An area targeted for wetland restoration may have only one reference wetland or may be a subset of a group of reference wetlands, also called reference standards (Craft and Hopple 2011). In most cases, it is best to use several reference sites to account for the natural variation inherent in the population of unaltered wetlands in the project area (IWWR 2003). Reference standards represent conditions exhibited by a subset of reference wetlands that correspond to the highest level of functioning of the ecosystem across multiple functions (Brinson and Rheinhardt 1996).

> Wetlands can be characterized by their condition and functions. ***Wetland condition*** is the current state as compared to reference standards for physical, chemical, and biological characteristics. ***Wetland funct***ions represent the processes that characterize wetland ecosystems.
>
> Source: USEPA 2011d.

The morphometry (detailed measurements of bottom elevations, microtopographic features, and basin slopes) of a reference wetland can be recorded and the results used to plan and develop the elevations, including microtopographic features, of the substrates of a restored wetland. Detailed data on the plant species present, their heights or diameters at breast height, and cover values can be used for selecting the plants and seed mixes that are most likely to replicate in the restored wetlands over time. Hydrologic regimes for new wetlands can be developed using the data on water sources, water depths, and durations at the reference wetlands.

Not only can information on reference wetlands be used, but their buffers can also be monitored and replicated to further ensure that the project will most closely duplicate the conditions of the reference wetlands. Once wetland targets are developed, based on the characteristics of the reference wetlands, monitoring can be designed at the restored site to determine whether the desired features are present and functioning as planned.

### 3.4.3 Restoration, Enhancement, and Creation Techniques

Restoration activities range from *passive* to *active* techniques. Passive techniques focus on minimizing disturbances to the project area and can include tile decommissioning, ditch plugging, amending soils, and planting and seeding of native species. Active restoration involves more significant modifications to the existing landscape. Active restoration can include soil excavation, filling and grading, the development of water control structures, and the construction of berms and dikes to impound water. Whether active or passive, the goals for any restoration, enhancement, or creation activity should be to use techniques that address multiple wetland functions. For example, buffers might be used to reconnect wetlands with uplands to provide habitat for native wildlife (wetland function = habitat), and they might also be used to slow and filter runoff containing pollutants (wetland function = water quality).

Scientists and policymakers generally support the concept that restoring and enhancing wetlands is preferred over creating them. Creation requires considerable planning and the control of myriad factors. Because creation occurs in locations that were not historically wetland, substantial modifications and disturbances to the landscape are often required to mimic the hydrogeologic setting of wetlands. The scale of these disturbances increases stress on the system and provides opportunities for stress-related problems, such as invasive plant species establishment, to occur. Moreover, the outcome of creation projects is usually difficult to predict (IWWR 2003).

As noted earlier, one of the wetland assessment steps is to identify wetlands of high ecological integrity. Those wetlands are typically prioritized for protection. The next subset includes existing or former wetlands that have high restoration or enhancement potential. Those adjacent to areas of high ecological integrity would be preferred over areas with less ecological value. Adjacent land uses and the availability of implementable control methods factor into the priority-setting process. Creating wetlands is generally considered an option of last resort because of the limitations discussed above.

Wetland restoration, enhancement, and creation techniques are generally the same, but the considerations that go into planning and implementing the techniques vary in intensity and scale. The simpler the design, the easier it can be to predict the outcome of the project (IWWR 2003). Bioengineered approaches, or those that mimic natural ecosystem processes, are preferred over engineered approaches that replace wetland functions with human-created structures (e.g., large earthen impoundment berms, concrete and steel water control devices). Engineered approaches are generally much more expensive than bioengineered approaches, and they require long-term maintenance. Thus, opportunities for failure are high (IWWR 2003). Exhibit 8 provides some guiding principles for wetland restoration, enhancement, and creation.

**Exhibit 8. Guiding Principles for Restoration, Enhancement, and Creation**

- Restore ecological integrity
- Minimize disturbances during implementation
- Restore natural structure
- Restore natural function
- Design for self-sustainability
- Work within the watershed/landscape context and understand the potential of the watershed
- Involve a multidisciplinary team in planning, implementation, monitoring and long-term management
- Develop clear, achievable and measurable goals for project
- Plan projects adjacent to or as part of naturally occurring aquatic ecosystems and healthy upland buffers
- Provide a hydrogeomorphic regime similar to wetland type or riparian area being restored
- Address ongoing causes of degradation
- Use passive restoration, when appropriate
- Restore native species; avoid non-native species
- Focus on feasibility (i.e., expectations for the project are ecologically, socially, and financially feasible)
- Monitor and adapt where corrective actions are necessary
- Provide ongoing maintenance that starts during the implementation stage

Sources: IWWR 2003; USEPA 2000 and 2005.

A list of wetland restoration, enhancement, and creation techniques is provided in appendix D. The techniques are organized according to the three wetland functions of primary interest in this Supplement: (1) hydrology, (2) water quality, and (3) habitat. Some considerations for selecting or using many of the techniques are also presented. Please note that few *rules of thumb* apply nationwide. Watershed groups should consult local, state, and regional resources for additional guidance on techniques used in their respective areas.

### 3.4.4 Fundamental Design Considerations for Wetland Projects

The *project design phase* requires the consideration of site-specific factors, operating interdependently, to determine the structure and function of a wetland (Kentula 2002). The following should be considered when designing a wetland restoration project: (1) site selection, (2) hydrologic conditions, (3) water source and quality, (4) soils, (5) plant material selection and handling, (6) site topography and surrounding land uses/cover, (7) buffer zone placement, and (8) long-term management. Exhibit 9 at the end of the section summarizes a number of the considerations that should be made. Some of those considerations are also discussed below.

Selecting the appropriate location is the most critical decision when designing a wetland restoration, enhancement, or creation project. The wetland should be located where its services will address watershed planning goals. One of the first considerations in selecting the location is the hydrogeomorphic setting. This means that the wetland should be located where all the hydrologic and geologic features are conducive to the establishment of the wetland type desired to enable it to perform the range of desired functions. For example, as water runs downhill, it pools in depressions. If the goal is to build a headwater depressional wetland that will provide flood control, water quality improvements, and wildlife habitat features, one of the first steps should be to locate the wetland where there is an existing depression, or where one could be developed, that will receive and pool rainwater. There could be many areas in a watershed that would meet these criteria, but by identifying them, those implementing the watershed plan can be assured that they have properly considered hydrogeomorphic setting in the selection process.

The next consideration would be to determine which of the identified sites will best meet the requirements for achieving overall project goals. If we continue with the goals of flood control, water quality improvement, and wildlife habitat as presented in the example above, the selection would focus on the characteristics that would make a project site most likely to be successful. To maximize flood control, the areas where larger depressions could be developed would be considered, and to assure the wetland will empty and fill as many times as possible, a site in a forested setting would be targeted. The trees on the pool edges will act as water pumps during the growing season and release water from the pool to the atmosphere. This will result in quicker dry downs, which will allow the pool to refill providing its full water storage capacity when additional rains occur. The more times a depressional wetland empties and fills during the year, the greater the flood storage capacity, resulting in a higher volume of stormwater that never enters local streams (Gamble et al. 2007).

**Urban Watersheds**

Urban development trends generally are detrimental to wetlands. Many wetlands are lost in the process and those that remain are degraded by the high intensity of uses in the urbanized surrounding areas. For example, the almost continuous concrete, asphalt, and rooftops that harden the landscape result in increased levels of stormwater runoff. Attempts to restore urban watersheds include *softening* the watershed by restoring important resources in locations where their functions will add green structure (i.e., slow down the flow of stormwater and contribute in other ways to the overall improvement of the watershed).

In most situations, wetland restoration projects are planned to provide the highest level of ecological condition possible. Included in this planning tenet is the assumption that the wetlands will also perform their functions at the highest levels possible. Restorations in highly urbanized portions of watersheds can make this standard difficult or impossible to achieve.

The wetlands needed in some parts of urban watersheds end up being planned and implemented to perform functions such as flow attenuation, water quality improvement, and floodwater retention at the expense of overall wetland quality. These working wetlands, because of the constant stress they experience, may be mostly or completely comprised of an invasive species plant community and have poor water quality, high rates of sedimentation, and other indications of degradation. However, their role is not to be pristine examples of wetlands; instead, their mission is to perform their designed functions in a way that maximizes the overall good for the watershed. While these wetlands may not be “pretty to look at,” some would consider them “true beauties” when the overall benefits they provide for the watershed are considered.

Source: Micacchion 2011.

Because most of the year water is not escaping the depression through overflow, due to the fact that it is emptying between rain events through evapotranspiration, any pollutants in the immediate basin that drain to the pool remain there. With the exception of large storm events possibly flushing out these systems, pollutants generally do not have an opportunity to enter local streams because water is not able to run down the surrounding slopes and dislodge and carry the pollutants in its path into the neighboring stream network. In this way, the depression also achieves the water quality improvement goal.

To meet the goal of providing wildlife habitat, a site can be selected from the locations that have appropriate habitat features in the existing upland areas. These upland areas will act as buffers and become the surrounding land uses of the newly established wetlands. Different selection criteria can be used based on the desired habitat features of the wildlife species or community targeted.

If the goal is to establish a vernal pool community, then the project would be selected from those areas that could provide a large amount of undeveloped area around the pool. The undeveloped area should be forested, and there should be some existing functional vernal pools in the surrounding areas. This will enable repopulation of the restored pool through migration from existing pool amphibian populations. If the goal is to provide waterfowl habitat instead, then a more open situation surrounding the pool with a mix of emergent and shrub vegetation communities and far less trees would be desirable. A water quality goal in this scenario could also be accomplished: the vernal pool may act to remove contaminants from flood waters and runoff, including those waters from agricultural and urban lands.

Multiple other criteria beyond those above would be evaluated to judge the remaining sites to determine which one or ones have the best chance to successfully provide the desired functions, including:

- Are hydric soils present?
- Are the desired microtopographic features present or can they be established?
- Can the desired hydrologic regime be restored with minimal disturbance to the site and surrounding landscape?
- Are the soil organic carbon and other nutrient levels amenable to plant growth?

To address conditions farther down in the watershed, where runoff from larger areas is occurring, wetland restoration projects that provide primarily flood storage and water quality improvement functions would have a high priority. The location of the wetland project is once again the most important criterion. Here the wetlands should be placed to maximize the amount and frequency of overflow they receive from the large streams in this part of the watershed. The ideal location for the wetlands would be in the floodplain near the channels of the large streams. Also, the wetlands should be established at elevations that assure they will receive floodwaters in most bank overflow situations.

The larger the size of a wetland, the more floodwater storage it can provide. So if the space exists, larger wetlands should be situated in the floodplain. To make sure the location will maximize attenuation of peak flows, some level 1 assessment data can be used to make selections on which parts of the watershed are experiencing problems related to flooding and poor water quality and where placement of additional wetlands would provide the most benefit.

Wetlands in those locations will also maximize water quality improvement functions. As the wetlands slow the flow of the water, pollutants including sediments, nitrate-nitrogen, phosphorus, and pesticides will settle out or be taken up by wetland vegetation before they can enter streams. As a secondary benefit, the addition of wetlands in the floodplains and riparian corridors of large streams will also provide contiguous areas of wildlife habitat. Using all the data assembled, the watershed plan implementer can make a decision on the best available site for a wetland project. Once this step is complete, project planning can begin in earnest. See exhibit 9 for additional site design considerations.

**Exhibit 9. Wetland Design Considerations**

| Factors | Considerations |
|---|---|
| **Site Selection** | The selected site will have significant impacts on the outcome of the wetland project.<br>1. Have you determined the acreage needed for the wetland to perform the desired functions?<br>2. Have you considered present and projected future land uses (Kentula 2002)?<br>3. Have you considered sites on a local, regional, or state priority wetland restoration lists (IWWR 2003)?<br>4. Have you considered areas of special interest (e.g., previously identified because site harbors endangered and threatened species or represents last remaining remnants of particular wetland type) (IWWR 2003)?<br>5. Have you considered the presence of manmade boundaries including political boundaries, private property boundaries, and utility and transportation corridors (UWM 2005)?<br>6. Have you determined whether site is adjacent to existing wetland complexes and/or in an area of former wetland? |
| **Hydrologic Condition** | 1. Does the project site have hydrologic conditions that allow the area to distribute water received from precipitation and groundwater sources? Projects that only receive water from surface runoff are limited in certain wetland functions, including retention time. Reduced retention time in a wetland limits the ability of the wetland to improve water quality and provide base flow to neighboring streams during drought conditions (UWM 2005).<br>2. Have you accounted for inflows and outflows from groundwater and nearby streams (Kentula 2002)?<br>3. What is the configuration of the basin, slope relative to the water table, flooding frequency and duration, and degree of soil saturation (Kentula 2002)?<br>4. Have you assessed the impact restoration might have on neighboring properties? Will the water be kept on site and not raise surface or groundwater levels of surrounding property owners that do not want their hydrology to change? |
| **Water Source and Quality** | 1. Will the project site receive runoff from roads, agricultural lands, or developed areas? The associated pollutants, nutrients, or sediments in the runoff may overwhelm and limit the functioning of the restored wetland (UWM 2005). Unless nutrient trapping is a chosen function.<br>2. What is the connectivity of the wetland project site to other wetlands in the watershed (UWM 2005)?<br>• Wetlands that have increased connectivity to other natural or restored wetlands in the watershed are better able to support increased biodiversity, water quality, and hydrology.<br>• Wetlands that are inter- and intra- connected can help to increase individual wetland retention time, making them better able to abate flooding and improve water quality. |

<table>
<tr><th>Factors</th><th>Considerations</th></tr>
<tr><td>Water Source and Quality continued</td><td><ul><li>Wetlands with little or no connectivity when inundated with pollutants may not be able to filter and improve water quality for downstream areas.</li><li>The presence of pollutants can also leave the vegetation in the wetland vulnerable to invasion by nonnative species, which further modifies wetland condition and function (Kentula 2002).</li></ul></td></tr>
<tr><td>Soils</td><td>Wetland soils exhibit anaerobic (oxygen-deficient) conditions during the growing seasons, which are caused by saturated and flooded conditions for long periods of time. Those inundated and saturated soils, called hydric soils, are capable of storing chemicals and controlling plant species and growth (Kentula 2002). Allowing soil profiles to remain intact and select or amend them to provide high levels of organic matter and appropriate amounts of nutrients to encourage establishment and growth of robust and diverse plant communities (EPA 2012)<ol><li>Are pollutants or toxic substances from previous activities present in the soil at the project site or in areas adjacent to the site? This situation should be avoided as chemicals may be toxic to human health or inhibit proper functioning of the wetland (Kentula 2002).</li><li>What are the soil elevation, porosity, and erosion rate of existing soil at the site (IWWR 2003)? Selected sites should require as little disturbance of the soils as possible, which puts a premium on targeting those areas where hydric soils and other preexisting wetland features are still present. Existing soils may serve as a seed bank for native plants. If grading is necessary, topsoils should be stockpiled and used for the last upper 6 to 12 inches of the soil profile.</li><li>Does the soil need to be amended to aid the formation of hydric soils? Organic matter from another area of the wetland could be used as an amendment if available. Note that the addition of amendments can increase the risk of the introduction of unwanted plant species (Kentula 2002) or minerals such as phosphorus.</li></ol></td></tr>
<tr><td>Plant Material and Seed Handling</td><td>Vegetation plays a key role in the functioning of a wetland site.<ol><li>Have you identified native plant species and sources thereof? Use seeds, plantings, or cuttings from local plants to ensure that the vegetation mimics other area wetlands. Consider plant species that are adaptable and resilient (IWWR 2003). Identify whether native species are on site or nearby that could pose problems.</li><li>Establish a robust wetland plant community as quickly as possible. Plant and seed at high densities to rapidly establish a thick carpet of vegetation that will jump start a healthy plant community and minimize opportunities for establishment of nonnative and invasive species.</li><li>Consider species adaptable and resilient to varying water depths (Kentula 2002). Use the elevations from your plans and information on the resulting water depths and durations to pick the appropriate plant species for the differing hydrologic regimes experienced across the wetland.</li><li>Avoid planting nonnative or invasive species since they can quickly take over the wetland and eliminate any native species planted (Kentula 2002). Make sure your plant selections are species that have historically been present in the area. USDA Plants (plants.usda.gov) and other more local sources can be checked to determine the natural range of wetland and buffer area plant species.</li></ol></td></tr>
</table>

| Factors | Considerations |
|---|---|
| **Buffer Zone Placement** | 1. Include a buffer zone around the project. Buffers provide additional habitat around the edge of the wetland for use by wildlife species and can increase the overall diversity of the wetland (Thompson and Luthin 2010). In addition, buffer zones can help minimize the effects of current neighboring, developed land uses and help prevent land development near the wetland in the future. Buffers can collect and prevent undesirable materials, such as fertilizers, herbicides, pesticides, and other soluble pollutants from entering the wetland through runoff (Kentula 2002). Consider establishing at least 50 meters on all sides (EPA 2012).<br>2. Consider using fencing around the outside of a buffer in urbanized areas to provide additional protection of the wetland (Kentula 2002). Be sure the fence is located above the high water level on adjacent uplands or else it will act as a debris collector requiring regular maintenance. |
| **Long Term Management** | 1. Have you considered who will be responsible for the long-term monitoring and maintenance of the project site? Monitoring will likely be required for periods of 10 years or more. Maintenance should be in perpetuity.<br>• Projects that are not maintained often fall into disrepair and may no longer function as intended (IWWR 2003).<br>• The long-term manager should be identified at the beginning of the process and should be involved in making important decisions about the design of the wetland project.<br>• Consider ways to reduce maintenance and monitoring. The more human-developed the structures is, the more burdensome maintenance is likely to be (Kentula 2002; IWWR 2003).<br>• Techniques that are simple, self-sustaining, or self-managing will have the highest long-term success rate (Kentula 2002; IWWR 2003).<br>2. Have you identified who will maintain the monitoring data collected from the project site? A repository for this information should be designated in the planning stages and a standard format for recording, analyzing, and presenting monitoring data results should be used. This practice will allow comparisons through the years and provide a history for others who may inherit project management responsibilities in the future. |

Sources: Kentula 2002; IWWR 2003; UWM 2005; Thompson and Luthin 2010.

The success of a wetland project is not entirely dependent on the achievement of ecological factors. Other nonecological factors can pose implications for a project's outcome. Typical constraints are summarized below (IWWR 2003; USEPA 2005). Awareness and consideration of constraints is critical to project success and to achieving goals of the larger watershed plan.

**Typical Ecological Constraints**

- Poor water quality
- Nutrient poor soils limiting plant growth or allowing invasive species dominance
- Lack of sufficient water/drawdown of local aquifer
- Overly deep water
- Pollutants
- Improper sun exposure for chosen

**Typical Nonecological Constraints**

- Resources to implement project
- Resistance by landowners and mistrust of watershed groups and others trying to undertake wetland restoration, enhancement, or creation
- Time and resources to contact landowners whose properties have been identified as high quality restoration

| Typical Ecological Constraints | Typical Nonecological Constraints |
|---|---|
| plantings<br>• Plants placed in habitats too wet or too dry to survive<br>• Sparse or no vegetation growth<br>• Presence of invasive and/or nonnative species in and around project site<br>• Presence of invasive and/or nonnative species on adjacent lands<br>• Presence of herbivores that decimate plantings and seedlings | sites; providing them with information on the benefits and limitations of restoration; and assisting landowners throughout the entire restoration process<br>• Disagreement amongst landowners over project components affecting their respective properties<br>• Community concerns<br>• Legal or regulatory issues (e.g., requirements for permits)<br>• Presence of cultural resources<br>• Incompatible land uses on adjacent lands<br>• Incompatible planned future land uses<br>• Sources of funding |

### 3.4.5 Project-Specific Implementation Activities

Project-specific implementation activities are typically undertaken by federal, state and local governmental entities and nongovernmental organizations (e.g., citizen groups, local land trusts, and conservation organizations) that have committed to undertaking the project. These *implementers* are likely one or more of the stakeholders the watershed group identified and involved early in the watershed planning development process. (See section 3.3.1 under the subtitle "Identify Key Stakeholders" for a further discussion of this topic and for examples of possible implementers.) Project implementers, regardless of who they are, should develop an implementation plan that links back to the watershed plan. The more aligned and involved those parties have been in the development of the watershed plan, the more likely it will be that their efforts are explicitly being undertaken to achieve one or more goals specified in the watershed plan. In other words, the watershed management plan is "everybody who is working in the watershed's plan or roadmap." That is, of course, the ideal situation.

There are generally six common steps to implementing a wetland project: (1) volunteer or staff preparation, (2) site preparation, (3) plant preparation, (4) installation/construction, (5) review and preparation of as-built documentation,[2] and (6) maintenance activities. Each step would be addressed in the implementation plan. The complexity of each step will vary depending on project goals. Exhibit 10 provides a list of some wetland restoration activities in each of the six steps.

**Exhibit 10. Example Implementation Activities by Project Implementation Phase**

| Project Implementation Step | Example Activities |
|---|---|
| **Volunteer Preparation (if volunteers are used) or Staff/Contractor Training** | • Involving the community in a wetland project can have numerous immediate and long-term benefits.<br>• Volunteers can help with implementation and monitoring and help reduce costs and encourage community support.<br>• Local volunteers can be found through nonprofit environmental groups, |

[2] As a project is constructed, changes in the design inevitably occur. Those changes are noted on the design plans. The revised plans or drawings become the *as-builts* when the project is completed.

| Project Implementation Step | Example Activities |
|---|---|
| | schools, and public and private service groups.<br>• If staff or contractors are used, some degree of training or consultation would need to be provided to discuss expectations and protocols to be followed. |
| **Site Preparation** | • Removal of soil, debris, and trash<br>• Removal of polluted soils<br>• Plugging or disabling drains<br>• Breaching of levees |
| **Plant Preparation** | • Collecting seed and cuttings<br>• Propagating plants<br>• Collecting newly grown whole plants<br>• Seeding<br>• Buying plants<br>• In most wetlands some natural revegetation will occur, but for almost all projects, it is best to plant and seed with indigenous species. |
| **Engineering Design and Permitting and Installation and Construction** | • Developing any necessary engineering plans; applying and receiving any required permits<br>• Constructing water control structures<br>• Grading existing soils<br>• Decommissioning and backfilling tiles<br>• Installing bank stabilization structures |
| **As-built Assessment** | The purpose of an as-built assessment is to ensure that the project has been completed as designed and specified and that it complies with regulatory requirements. Any deviations from the plan should be addressed, documented, and corrected. The as-built assessment serves as a baseline for future monitoring of the project site. |
| **Regular Maintenance/Management** | Regular maintenance, starting immediately after construction, is conducted to ensure the site is functioning properly and is achieving project goals. Any problems that arise should be addressed without delay. Maintenance practices and frequency may be modified based on monitoring results throughout the life of the site. Maintenance activities are an integral part in the overall success and long-term management of a site. Experienced wetland managers are good sources of information regarding important maintenance and management activities to perform. |

Source: IWWR 2003.

## 3.5 Watershed Monitoring Considerations When Incorporating Wetlands

This Supplement uses the term *monitoring* to mean the design and implementation of methods and tools to collect information that will answer questions on the health and integrity of ecosystem resources. Monitoring can also be referred to as the systematic observation and recording of current and changing conditions, while assessment is the use of that data to evaluate or appraise wetlands to support decision-making and planning processes.[3] As stated earlier, at this phase, monitoring is performed to measure restoration progress in relation to specified goals

[3] http://water.epa.gov/grants_funding/wetlands/monitoring.cfm.

and objectives in the site plan. Monitoring methods can be visual or quantitative. The protocols selected should ensure that the information collected will measure whether wetland activities have performed as expected. Additionally, monitoring should be planned in a way that will allow analysis of the data to provide direction for how any shortcomings can best be addressed through adaptive management. Monitoring should be performed to measure success and then to assess the need for adaptive management. Refer to chapters 12 and 13 of EPA's Watershed Planning Handbook for further information on monitoring during project and watershed plan implementation. Chapter 8 of the Handbook provides information on how one might use monitoring data or literature values to estimate pollutant loads.

### 3.5.1 Wetland Project Site Monitoring

Most of the monitoring during the implementation stage will be qualitative (visual) and will entail keeping close track of developments and eliminating any problems as they arise. For instance, invasive species may show up in a few locations even as the construction is still ongoing. If those few plants can be observed and eliminated as they become established, they will not be able to spread and become a larger problem. Further, when soils are disturbed, there is an increased risk of invasive species establishing themselves. Without monitoring during implementation, there is potential for invasive species to become well-established and require large amounts of time and resources for eradication. The case for early and continuous monitoring during the establishment phase cannot be overstated.

An accurate appraisal of the restored/reconstructed site is needed to be able to apply the appropriate management techniques or gauge the performance of the project. To reach the level of detail required for some elements (e.g., soil or water chemistry), more intensive data gathering that goes beyond visual observations is necessary. This next level, known as quantitative monitoring, involves the collection and recording of physical, chemical, and biological measurements. The measurements that will provide in-depth understanding of the ecological condition and functioning of the wetlands and provide the best opportunities to address any deficiencies are selected. Some example elements for which qualitative and quantitative monitoring might be performed for wetland projects are listed in exhibit 11.

**Exhibit 11. Examples of Qualitative versus Quantitative Monitoring Mechanisms and Parameters and Monitoring Frequency Considerations**

| Qualitative | Quantitative |
|---|---|
| **Mechanism:** visual, includes aerial and ground-level photographs<br><br>**Factors/Parameters Assessed:** water clarity, species present, vegetation condition, and integrity of structures | **Mechanisms:** Recording and collecting samples; physical/analytical measurements<br><br>**Factors/Parameters Assessed:** wetland delineation (area measurement), water levels (hydrographs), plant and animal species, plant cover and animal densities, index scores for flora or fauna, soil chemistry and bulk densities, and erosion rates |

| Monitoring Frequency | |
|---|---|
| • Annually for most elements<br>• More frequent monitoring until project integrates into watershed based on achievement of performance standards. (This can range from a few years to decades.) Projects should be monitored for a minimum of 5 years, longer if the end goal is a forested system or when goals and sustainability are not met. | • During growing season for vegetation and wetland delineation<br>• During breeding, nesting, and/or migration seasons for animals<br>• Year-round for hydrology |

Source: IWWR 2003.

### 3.5.2 Performance Standards

Restoration projects include explicitly stated goals and objectives that tie into those stated in the watershed plan. To assess whether a project is successful, performance standards (also called success criteria, performance indicators, or measures of success) are established. The standards are the means through which the project implementer will assess whether the restoration project is achieving stated objectives and, thus, project goals.

The need for performance standards was highlighted in the 2001 NRC report on wetland mitigation. The NRC recommended measurements of the viability of replaced wetland functions and defined performance standards as follows:

> …observable or measurable attributes or outcomes of a compensatory mitigation project that help determine whether the project meets its goals and objectives (NRC 2001).

In addition, the panel suggested that performance standards be clear, measurable standards that indicate whether a restored or created wetland can be or already is self-sustaining (ELI 2004a). Although performance standards are often discussed in the context of mitigation projects, they should be applied to all wetland restoration projects as a way to measure the progress and success of a project.

**Performance standards should be tied to the restoration goals and objectives established for the site during the planning process** (IWR 2007). They should measure the functionality and condition of a wetland. As a result, performance standards are site-specific. Ideally, they are measurable and specific enough to enable one to evaluate site progress and success, and provide the feedback needed to identify needed adaptive management. Performance standards need to be quantifiable and specify numeric criteria, or, rather than being held to a single value, they may specify a minimum, maximum, or range of acceptable values (Ossinger 2008). In this way, the standards are flexible to accommodate those measured characteristics of wetlands that naturally vary from wetland to wetland or for which a value anywhere in a range is acceptable. Those implementing performance standards need to know the methods for measuring them and the time frames for their achievement (IWR 2007; Ossinger 2008).

**Example Performance Standards**

| Biotic standards | Abiotic standards |
|---|---|
| • Amphibians | • Hydrology |
| • Fish | • Soils |
| • Macroinvertebrates | • Sediment |
| • Birds | • Nutrients |
| • Mammals | |
| • Algae | |
| • Vegetation | |

Source: ELI 2004a.

Performance standards will be based on project goals and can be grouped into biotic, abiotic (see inset), and landscape-level standards and can be time-specific. For wetland restoration sites, performance standards typically include at a minimum some sort of measurement for hydrology, vegetation, fauna, and soils (ELI 2004a). Standards for hydrology may include saturation of the surface or standing water during a certain time of the year. Vegetation and fauna standards may specify species present, diversity of species, number of breeding populations (fauna), sizes and densities (plants), or reaching an index score (flora and fauna) within a certain number of years (Ossinger 2008; Mack et al. 2004). Examples of performance standards grouped by wetlands function is provided in exhibit 12. Any time a performance standard is not met, an investigation into causes should be undertaken and corrective actions taken. (Ossinger 2008).

**Exhibit 12. Examples of Performance Standards Grouped by Wetland Function**

| | |
|---|---|
| **Wildlife Habitat** | Interspersion of differing wetland plant communities |
| | Aquatic invertebrate diversity |
| | Plants species diversity/Index of Biological Integrity (IBI) score/ Floristic Quality Index (FQI) score |
| | Presence of birds/amphibians/fish/mammals |
| | Presence of bird/amphibian/fish/mammal breeding populations |
| | Wildlife community IBI score |
| **Water Quality** | Slope |
| | Sedimentation rates |
| | Plant phosphorus/nitrogen removal |
| | Soil carbon/phosphorus/nitrogen sequestration rates |
| **Flood Attenuation** | Size of wetland |
| | Number of annual dry downs (number of times the wetland empties and fills during the year; the greater the frequency, the greater the flood storage capacity of the wetland) |
| | Surface water depth and duration |

Source: Ossinger 2008.

Although detailed performance standards such as meeting a minimum number of plant species or a target number of breeding populations, or reaching an index score within a set period, might not seem attainable due to lack of time, and/or money, project implementers need performance standards to drive the adaptive management process. Watershed management plans should at the very least include generalized wetland performance standards similar to those for other NPS BMPs. These should include, reaching a minimum target size and meeting design criteria to be considered a wetland (e.g., contain a predominance of hydrophytic vegetation, hydric soils, and sufficient hydrology and not be dominated by invasive species). There is an increased likelihood that projects without performance standards will not only fail to address the water quality, quantity, and habitat goals/objectives established in the watershed plan but become an additional problem project sponsor will have to eventually address. It is important to note that some project funding sources will require that monitoring be performed in accordance with specified standards and procedures. Others will require some form of monitoring to demonstrate progress and project success. Performance standards will help project implementers ensure that they have designed and implemented a wetland restoration, enhancement, or creation project that meets specified goals in the watershed plan.

## 3.6 Watershed Long-term Management Considerations When Incorporating Wetlands

Long-term maintenance plans for restored wetlands should be developed as part of the watershed plan. These plans help to ensure that restored wetlands are maintained to help improve water quality, quantity, or habitat issues in the watershed. Critical maintenance activities associated with a newly restored wetland site include invasive plant species control, maintenance of water control structures, site access restriction, and other activities. The maintenance plans should specify who is responsible for the site, the specific activities to be performed, and over what time frames. A key consideration in developing long-term management plans is to secure the requisite funds or funding mechanisms for implementing the project plan, as well as identifying the manager or responsible third party to manage the site long term. The timeline for site maintenance is *into perpetuity*. One option for long-term stewardship might be to sell or donate the site to a natural resource agency or land trust. Ideally, the identified long-term manager would participate in the project and long-term management planning processes. In addition, a conservation easement should be made for the wetland project area that clearly spells out the activities that can and cannot occur there. This site protection mechanism transfers with the deed; it will provide long-term protection for the wetland project and ensure that the watershed improvement function remains in place.

If the project implementer has arranged with different parties, such as citizen groups, schools, or consultants, to help perform monitoring or other activities, the plan should clearly specify or reference when and where the activities are to occur and the specific sample collection and other protocols that are to be followed. It is also important to ensure the retention of records for use by future watershed and wetland planners should the project site change ownership.

If a wetland project is designed and implemented properly, it will likely require little long-term maintenance. As discussed under the restoration techniques section earlier (section 3.4.2), the less engineered a project, the fewer long-term maintenance requirements. If project implementers are limited in terms of staff and resources, they should, at a minimum, develop a generalized long-term management plan. This generalized plan would need to specify how and when the project implementer or watershed group will follow up on a restoration project after it is constructed. The plan would also need to document routine maintenance and corrective measures to be taken in the event performance standards are not being met in perpetuity. Protection of the restored wetland through a conservation easement must occur. With such mechanisms in place, the project has a much greater likelihood of long-term success. Investments in the design and implementation of wetland restoration projects, or other environmental projects for that matter, could be lost without some degree of maintenance being performed.

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# 4. Approaches for Assessing Wetlands in a Watershed Context

This chapter includes four case studies, each of which outlines an approach for identifying former and existing wetlands in a watershed context and prioritizing those areas that would contribute to resolving such watershed problems as altered hydrology, impaired water quality, and destruction or fragmentation of habitat. Linkages to watershed management plans are made where appropriate. The costs to conduct analyses like those described in the case studies are highly variable. Readers interested in this type of information are encouraged to contact the investigators whose contact information is provided at the end of each case study.

Future editions of this Supplement might include case studies that show how wetlands sites identified through assessment processes like those presented in this chapter have proceeded to the project planning and implementation phase and have been assessed for success in relation to performance criteria. Those case studies might also show how project implementation ties back to the goals and objectives of the applicable watershed plan.

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## 4.1 Michigan's Landscape Level Wetland Functional Assessment Tool and Wetland Restoration Prioritization Model

*This case study discusses an approach the state of Michigan has developed to help watershed groups assess the location, condition, and function of wetlands as part of the watershed planning process. Specifically, it discusses use of an assessment process in the Paw Paw and Clinton River watersheds. The case study also summarizes a model developed to prioritize existing and former wetlands for restoration in the Clinton River watershed.*

### 4.1.1 Overview of Michigan's Wetland Assessment Tool

The landscape-level wetland functional assessment (LLWFA) tool was developed by staff of the Michigan Department of Environmental Quality (MDEQ) in conjunction with cooperating state and local agencies, universities, and nongovernmental organizations. It enables users to identify existing wetlands and the functions those wetlands currently perform. The LLWFA tool also enables the user to identify historical or former wetlands (i.e., areas of hydric soils that are not currently wetlands) and the functions they would likely perform if restored. Exhibit 13 summarizes uses of the LLWFA.

**Exhibit 13. LLWFA Uses**

> The information contained in an LLWFA analysis is intended to approximate wetland function across the landscape. The NWI was used in the LLFWA analysis to report status and trends. The approach addresses both current wetland inventory and a pre-European Settlement inventory, to approximate change over time and provide the best information possible on wetland status and trends from original condition through today.
>
> Source: MDEQ 2011.

The LLWFA is modeled after the NWIPlus and W–PAWF (see chapter 2). Essentially, MDEQ staff, with the assistance of staff of several federal and state agencies, developed an NWIPlus database for the Midwest through the addition of regional and state-specific datasets and mapping tools. MDEQ then pilot-tested the LLWFA in the Paw Paw River watershed. Since the pilot, MDEQ has worked with many watershed groups in the state to use the LLWFA to assist and encourage watershed groups to incorporate wetlands into their watershed planning projects; the MDEQ now routinely prepares the LLWFA tool for all watershed planning projects funded under its CWA section 319 nonpoint source program.

### 4.1.2 Pilot Test of the LLWFA in the Paw Paw River Watershed

#### *About the Watershed*

The Paw Paw River watershed (PPRW) is in the southwestern corner of the lower peninsula of Michigan in Berrien, Van Buren, and Kalamazoo counties. The surface area of the watershed is approximately 445 square miles. The Paw Paw River flows westward through southwestern Lower Michigan, where it joins the St. Joseph River, which in turn empties into Lake Michigan near the town of Benton Harbor.

Source: SWMPC 2008.

The river and lands of the PPRW support a variety of unique natural features. They include rare Great Lakes marshes; floodplain forests that serve as important corridors for migratory songbirds; wetland systems and complexes, including areas where groundwater swells up over peat mats and across glades; oak barrens; prairie remnants; and one of the largest fen complexes in southwest Michigan. The PPRW is home to a multitude of threatened, endangered, and general concern species and natural communities, including 23 species of animals, 46 species of plants, 7 natural communities, and the Great Blue Heron Rookery (SWMPC 2008).

Land cover in the Paw Paw River watershed was largely forested prior to European settlement in the early to mid-1800s. This land cover has become fragmented due to agricultural, residential, and urban development; however, large patches of intact, natural land cover remains. Watershed planners in the region recognize that "preservation and restoration of natural land cover, as well as proper management of agricultural lands, will be critical to protecting and improving water quality in the PPRW." (SWMPC 2008, p. 27.)

Threats to the ecological health of the watershed include hydrologic alterations, invasive species, habitat loss and fragmentation, incompatible land uses, and shoreline development. Threats to the region's wetlands and floodplains include filling or draining for agricultural, industrial, and other uses; altered hydrology; exotic species invasion; altered fire regimes; and polluted runoff containing sediments, nutrients, and chemicals (SWMPC 2008).

### *Developing a Watershed Management Plan and Building Partnerships*

In 2008, the Southwest Michigan Planning Commission (Commission) and partners completed development of the *Paw Paw River Watershed Management Plan*. The plan is available online at http://www.swmpc.org/pprw_mgmt_plan.asp. The plan's intention is "to guide individuals, businesses, organizations, and governmental units working cooperatively to ensure the water and natural resources necessary for future growth and prosperity are improved and protected. It can be used to educate watershed residents on how they can improve and protect water quality, encourage and direct natural resource protection and preservation, and develop land use planning and zoning that will protect water quality in the future. Implementation of the plan will require stakeholders to work across township, county, and other political boundaries." (SWMPC 2008, p. 11).

The Commission accomplished this goal by soliciting public input on all stages of plan development and developing a steering committee made up of representatives of governmental and non-governmental organizations to provide technical input into the plan. The Commission reported that "[s]teering committee and sub-committee participants were instrumental in identifying and commenting on designated uses, desired uses, pollutants, sources and causes of pollutants, priority or critical areas and in developing goals, objectives and an action plan. Many partners were instrumental in providing information, completing modeling efforts, organizing and implementing the volunteer inventory and providing feedback on early versions of the plan." (SWMPC 2008, p. 61.) During plan development, the Commission maintained a website containing meeting summaries and providing an online forum that allowed individuals to submit comments in an effort to keep partners and stakeholders involved. The media also assisted by alerting watershed stakeholders and residents of the plan.

### LLWFA Components

Development of the LLWFA for the Paw Paw River watershed involved the collection and integration of spatial data, the classification of NWI polygons with HGM descriptors, and the correlation of wetland functions with the NWI polygons. (See chapter 2 for background on the NWI and HGM.) GIS technology enables users to define one or more areas of specified coverage on a map. One can use the areas to find relationships to other features that are represented as polygons, point data, addresses, and specific geographic locations. Exhibit 14 presents a summary of the GIS spatial data collected and integrated for the LLWFA.

**Exhibit 14. GIS Spatial Data Collected and Integrated for the LLWFA**

**Data Collection and Integration, General Methods**

- USFWS NWI (digital data based on 1:24000 aerial photos from the late 1970s and early 1980s)
- USGS and EPA National Hydrology Dataset (NHD), medium resolution (based on Digital Line Graph (DLG) hydrography at 1:100,000 scale)
- USGS Digital Raster Graphic (DRG) topography and Digital Elevation Models (DEM) (scanned USGS topo quads)
- NRCS Soil Survey Geographic (SSURGO) soil surveys (digitized data from paper soil surveys at 1:24000)
- USGS National Aerial Photographic Program (NAPP) 1998 digital orthophoto mosaics (photography usable at 1:12000)
- Michigan Center for Geographic Information's (CGI) Framework (includes roads, political boundaries, hydrography, census figures, etc.)

**Data Collection and Integration, Pre-settlement Wetland Inventory**

- NRCS soil survey data (based on 1:15,840 soil maps)
- Michigan's Natural Features Inventory (MNFI) pre-settlement vegetation maps (derived from General Land Office Survey maps created between 1816 and 1856)

**Data Collection and Integration, 1998 Wetland Inventory**

- NWI mapping based on USFWS Cowardin wetland classification system

Source: Fizzell 2007.

As noted previously, the LLWFA is modeled after the NWIPlus and W–PAWF, both of which are described in chapter 2. At the time the LLWFA was developed, the W–PAWF could be used to predict 10 wetland functions. The LLWFA evaluated nine of those in the Paw Paw River watershed: (1) surface water detention, (2) streamflow maintenance, (3) nutrient transformation, (4) sediment and other particulate retention, (5) shoreline stabilization, (6) provision of fish and shellfish habitat, (7) provision of waterfowl and waterbird habitat, (8) provision of other wildlife habitat, and (9) conservation of biodiversity (rare or imperiled wetland habitats in the local region with regional significance for biodiversity). Stream shading was evaluated as a subfunction of fish and shellfish habitat. MDEQ and the Commission did not evaluate the W–PAWF wetland function of coastal storm surge detention as it was determined to not be applicable for the watershed (Fizzell, 2007; Tiner et al. 2001).

## LLWFA Products

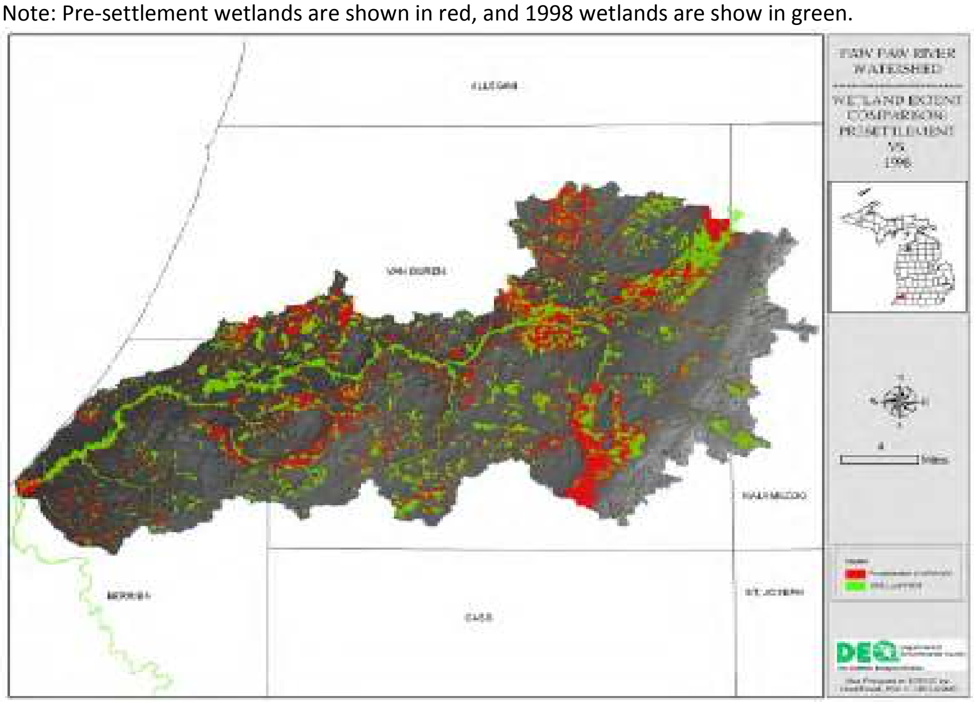
MDEQ produced a set of hard-copy maps as final products of the Paw Paw River watershed LLWFA. The maps illustrated the extent of wetlands during pre-settlement and the 1998 (*current* conditions) predicted wetlands of significance for the above nine wetland functions, wetlands separated by HGM type, and wetlands separated by USFWS classification (Cowardin) type (Fizzell 2007).

### Trends by Generalized USFWS (NWI) Type

The LLWFA revealed that wetland *acreage* had fallen in the Paw Paw River watershed by 43 percent from pre-settlement (early to mid-1800s) to 1998. Wetlands went from constituting 23 percent of the total watershed *area* to constituting 13 percent during the period. Exhibit 15 illustrates these findings in map format. The number of non-forested, palustrine wetlands increased during the period, from 1 to 15 percent for emergent wetlands and from 3 to 13 percent for scrub-shrub wetlands. (See inset next page.) In general, MDEQ attributes the increases to large areas of forest having been cut for timber or ineffectively drained for agriculture and then later reverting to emergent wetlands. Some of the emergent wetlands later went to scrub-shrub condition through succession (Fizzell 2007).

**Exhibit 15. Paw Paw River Watershed Wetland Extent**

Note: Pre-settlement wetlands are shown in red, and 1998 wetlands are show in green.




Source: Fizzell 2007.

**Paw Paw River Watershed Wetland Types**

**Pre-settlement Wetland Types:** Vegetated wetlands

- 96% forested (mixed hardwood swamp, black ash swamp, and tamarack swamp)
- 3% shrub
- 1% emergent

**1998 Wetland Types**: Vegetated wetlands

- 65% forested
- 15% emergent
- 13% shrub

Source: Fizzell 2007.

### Trends by HGM Type

Pre-settlement wetlands covered 64,657 acres across 3,161 wetlands. Terrene wetland types represented nearly 60 percent of wetland area; lotic types, 34 percent; and lentic types, 7 percent. (See sidebar for definitions of these wetland types.) The LLWFA revealed that the number of individual wetlands increased by 187 percent during the period, but wetland acreage dropped by 43 percent. In general, MDEQ attributes the increase in the number of wetlands to landscape (i.e., habitat) fragmentation. The types of wetlands present also shifted: terrene (not including ponds) and lentic wetlands dropped to representing 48 percent and 5 percent of wetland area; lotic wetlands, however, increased to representing 47 percent of wetland area. Ponds were found to have increased in the watershed by 174 percent since pre-settlement times.

***Terrene wetlands*** are those surrounded by upland (non-hydric soils).

***Lotic wetlands*** are associated with a river or stream or their active floodplains.

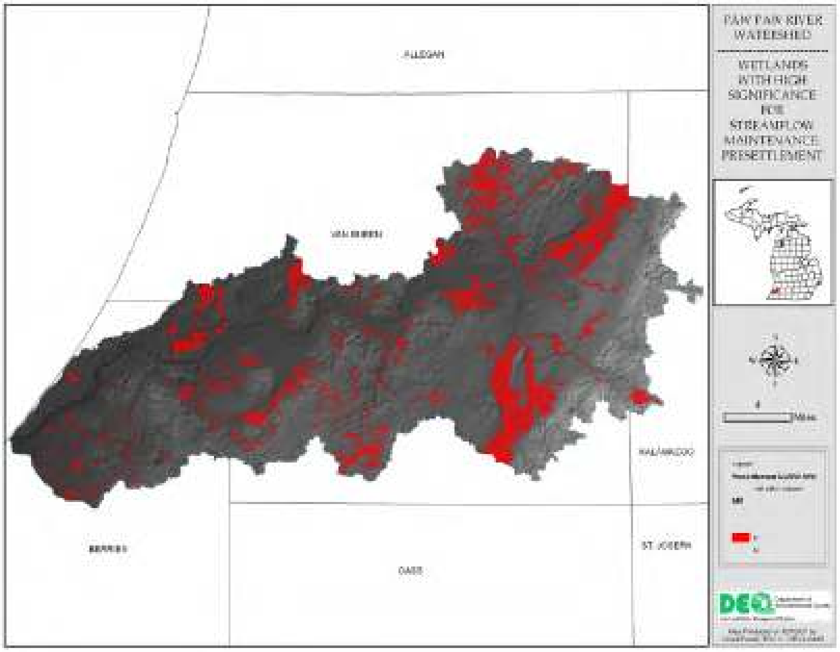
***Lentic wetlands*** consist of all wetlands in a lake basin (i.e., the depression containing the lake), including lakeside wetlands intersected by streams emptying into the lake.

Source: Tiner 2003.

### Trends by Wetland Function

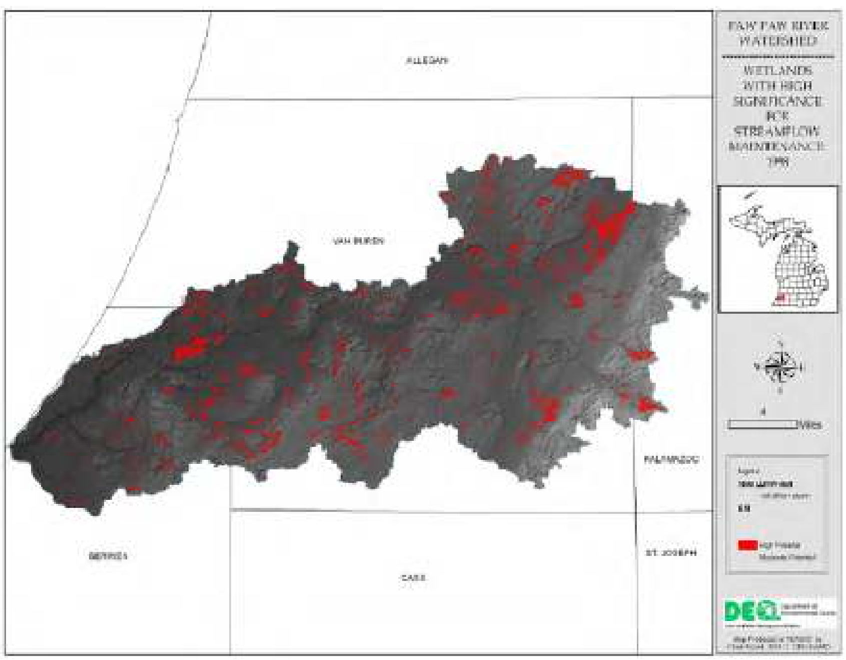
In terms of total area, the LLWFA revealed that functional loss in the Paw Paw River watershed ranged from 62 percent (conservation of biodiversity) to 27 percent (waterfowl and waterbird habitat). Wetlands that served as sources of streams (stream flow maintenance) experienced an overall decrease of 44 percent (exhibits 16 and 17) (Fizzell 2007).

**Exhibit 16. Paw Paw River Watershed Pre–Settlement Wetlands with High Significance for Stream Flow Maintenance**




Source: Fizzell 2007.

**Exhibit 17. Paw Paw River Watershed 1998 Wetlands with High Significance for Stream Flow Maintenance**




Source: Fizzell 2007.

In addition, ditching of headwater wetlands was found to have resulted in lost wetland hydrology completely or to a point at which the wetlands could no longer effectively contribute to downstream flow. The LLWFA further revealed a 50 percent reduction in the ability of the watershed's wetlands to retain sediment, and nutrient transformation was found to be performing at 55 percent of the wetlands' original capacities. These factors contribute to worsening of surface water quality in the watershed. In terms of habitat, waterfowl habitat was reduced by 27 percent and fish/shellfish habitat by 61 percent. The steep decline in fish/shellfish habitat has been attributed to the loss of forested floodplain wetlands and the reduced stream flow from the headwaters that once provided cold water for Paw Paw River watershed trout fisheries.

### LLWFA Limitations

The authors of the LLWFA caution that the approach has certain limitations, which should influence how the tool is used. For example, care should be taken when using the results of analyses based on interpretations of aerial photography alone, such as with some of the historical wetland extent and condition data. The LLWFA does not consider the relative significance of two wetlands predicted to perform the same function (Fizzell 2007). The tool and others like it, however, are not intended to be the only form of analysis performed. The LLWFA is, in essence, a screening tool for identifying wetland types and their functions.

### Summary

This study found that wetland resources in the Paw Paw River watershed have changed drastically since pre-settlement, with both wetland acreage and function decreasing significantly. Therefore, it was realized that wetland restoration activities could possibly lead to water quality improvements in the watershed. It is important to remember that the LLWFA is intended as a first-level or coarse-scale assessment of wetland location, condition, and function. A subsequent step in the watershed planning process is to ground-truth the data from the LLWFA through other level 1 or 2 analyses, as discussed in chapter 3. The LLWFA provides a general picture of wetland extent and function within a watershed that can be used to identify trends in wetland condition and function, identify initial restoration locations, and form the basis of a wetland inventory. Watershed planners in the Clinton River and other watersheds in Michigan have used the LLWFA to develop criteria specific to their watersheds for prioritizing potential sites for wetland restoration, creation, or enhancement. The approach planners in the Clinton River watershed followed is discussed in subsection 4.1.3 below.

### Monitoring and Long-Term Management

Following completion of the LLWFA and other natural resource assessments, the Commission and partners made decisions about the strategies they were going to undertake to protect/restore the integrity of the Paw Paw River watershed. These included plans to protect and restore wetlands. The SWMPC and partners developed milestones for implementing their various strategies and criteria for evaluating the success of their actions. The wetland-related strategies developed are summarized in exhibit 18.

**Exhibit 18. Paw Paw River Watershed Management Plan Implementation Tasks Associated with Wetlands**

| Wetland–Related Tasks | Implementation Dates | Milestones | Evaluation Method(s) |
|---|---|---|---|
| Protect Wetlands | 20092013 | By 2015: 20 acres<br>By 2018: 80 acres<br>By 2023: 180 acres | • Number of acres protected<br>• Number of landowners protecting wetlands<br>• Estimate pollutant loading reduction |
| Protect Sensitive Lands | 20142018 | By 2020: 200 acres<br>By 2023: 600 acres<br>By 2028: 1,400 acres | • Number of acres protected<br>• Estimate pollutant load reduction |
| Restore Wetlands | 20092013 | By 2015: 80 acres<br>By 2018: 180 acres<br>By 2023: 240 acres | • Number of acres restored<br>• Number of landowners restoring wetlands<br>• Estimate loading reduction |
| Protect Wetland Streambanks | 20092013 | By 2015: 120 acres<br>By 2018: 320 acres<br>By 2023: 720 acres | • Number of acres protected<br>• Number of landowners protecting wetlands<br>• Estimate pollutant load reduction |

Source: SWMPC 2008.

The milestones developed for wetlands and other natural features of the watershed serve as long-term watershed goals. As individual projects are completed and their success evaluated, the Commission and partners plan to reevaluate the watershed management plan to ensure that the stated strategies for achieving watershed goals and objectives are still appropriate. The watershed plan recommends that management and implementation plans be reviewed annually and that they be evaluated against stated watershed goals and objectives at least every 5 to 10 years (SWMPC 2008).

### 4.1.3 Clinton River Watershed LLWFA and Restoration Prioritization

#### *About the Watershed*

The Clinton River watershed is in southeast Michigan and spans 760 square miles across four counties. The watershed is north of Detroit and has high levels of urban development. The Clinton River watershed has been listed as a Great Lake Area of Concern (AOC)[4] since the 1980s. The AOC includes the entire watershed, as well as a portion of Lake St. Clair immediately downstream of the mouth of the Clinton River. The


Source: Clinton River Watershed Council n.d.

[4] AOCs are defined in the *U.S. – Canada Great Lakes Water Quality Agreement* as "geographic areas that fail to meet the general or specific objectives of the agreement where such failure has caused or is likely to cause impairment of beneficial use of the area's ability to support aquatic life." As part of the *U.S. –Canada Great Lakes Water Quality Agreement*, a Remedial Action Plan must be completed for the AOC through cooperation between the U.S. and Canadian governments (GLIN 2005).

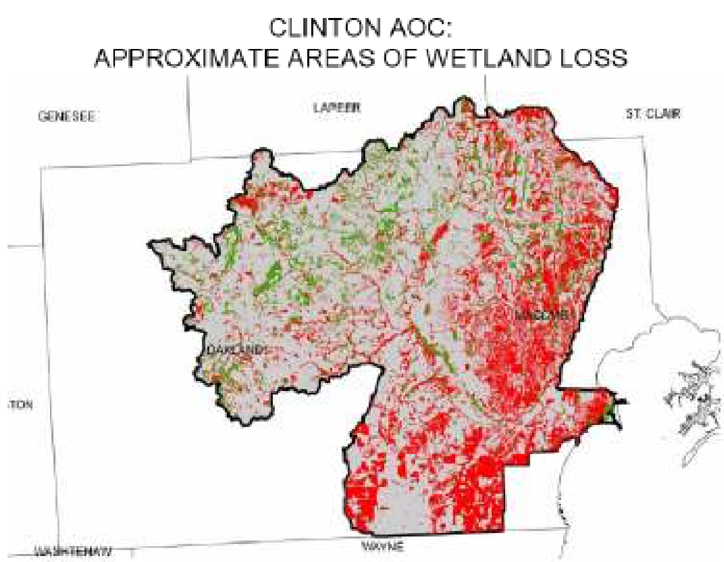
AOC has eight beneficial use impairments, which include restrictions on fish and wildlife consumption, eutrophication or undesirable algae (in the lower river and inland lakes), degradation of fish and wildlife populations, beach closings, degradation of aesthetics, degradation of benthos, restriction of dredging activities, and loss of fish and wildlife habitat (USEPA 2011a). The pollutants of concern in the watershed include conventional pollutants, high fecal coliform bacteria and nutrients, high total dissolved solids, contaminated sediments with heavy metals, polychlorinated biphenyls (PCBs), and oil and grease.

Because of the Clinton River watershed's status as an AOC, a Remedial Action Plan has been completed. Local restoration criteria have been developed and approved by the Public Advisory Committee to the AOC to address six of the eight beneficial use impairments. Efforts are underway to further refine criteria for the fish and wildlife beneficial use impairments, including degraded fish and wildlife populations and loss of habitat. Clinton River project priorities include elimination of combined sewer overflows (CSOs) and storm sewer overflows (SSOs); nonpoint source control; Superfund waste site remediation; spill notification; habitat restoration; and elimination of illicit connections and failing septic systems. Analysis of potential wetland restoration projects is part of the Remedial Action Plan to help restore the watershed (USEPA 2011a).

## Clinton River Watershed LLWFA

A base LLWFA was performed in the Clinton River watershed using data layers similar to those used in the Paw Paw River watershed LLWFA. Analysis of the composite map revealed that wetlands in the Clinton River watershed have decreased significantly since pre-settlement. Specifically, the watershed has experienced an estimated loss of 150,457 acres of wetlands between pre-settlement and 2005, with only 25 percent of the pre-settlement wetland acreage remaining. The average size of wetlands also decreased from 30 acres during pre-settlement to 7 acres in 2005 (exhibit 19).

**Exhibit 19. Clinton River Watershed Wetland Areas from Pre-Settlement to 2005**

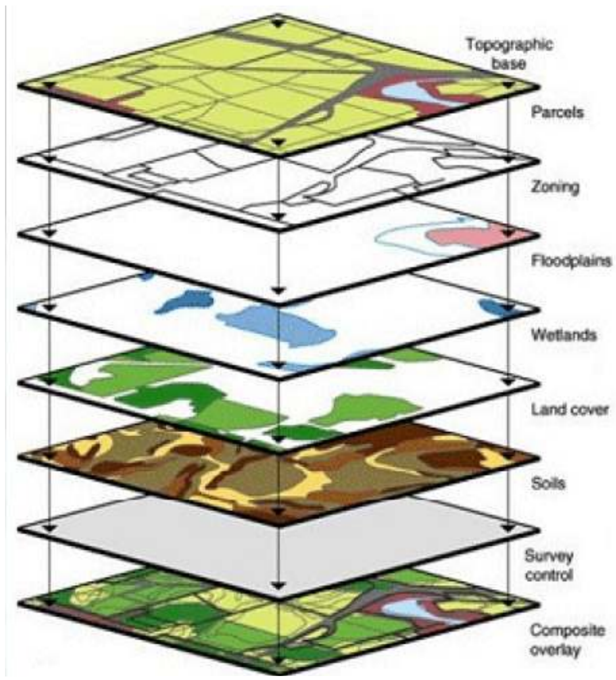



Note: Pre-settlement wetlands are shown in red, and remaining wetlands (2005) are shown in green.
Source: Fizzell and Zbiciak n.d.

## Prioritization of Wetland Restoration Areas

Exhibit 20 shows the various data layers composing the spatial map for the Clinton River watershed. Note that beyond the layers used in the Paw Paw River watershed, zoning and parcel layers were also added. The zoning layers were added to facilitate the determination of current and future land uses, and the parcel layers were added to show land ownership. Those layers were developed as part of the prioritization model discussed below. The incorporation of the multiple layers in the spatial map component of the LLWFA allows researchers to consider multiple factors that can affect a wetland restoration effort (Fizzell and Zbiciak n.d.).

**Exhibit 20. Map Layers for Inclusion in Clinton River Watershed Wetland Assessment**




Source: Fizzell and Zbiciak. n.d.

A soils/restoration analysis model was developed to accompany the GIS models and final dataset generated by the LLWFA to assist watershed partners in selecting potential wetland restoration sites within the Clinton River AOC (spatially the Oakland and Macomb County portions of the watershed).

The model scores potential sites for the likelihood of implementing a successful long-term wetland restoration using two sets of criteria: (1) wetland ecological integrity criteria and (2) social and biological criteria. The wetland ecological integrity criteria are used to assess the ability of a given site to be successfully restored and maintained as a functioning wetland. The social and biological criteria are used to score sites for factors that may make restoration easier or provide value added to a restored wetland (Schools n.d.). Exhibit 21 describes the methodology used to select an initial group of potential restoration sites. This is followed by exhibit 22, which lists the ecological and social/biological criteria and methodologies used to refine the list of potential restoration sites.

**Exhibit 21. Site Selection Methodology in Clinton River AOC**

**Datasets/Models Used:**

- MDEQ Michigan Restoration Analysis model[1]
- Michigan Framework V7 Road dataset provided by the Michigan Center for Geographic Information Spatial Data Library[2]

**Methodology:** The Michigan Restoration Analysis model combines hydric soils data from the USDA's SSURGO database with data from Michigan's circa 1800 wetlands database; it assigns scores of "1" to polygons that coincide with hydric soils and circa 1800 wetlands. It assigns a "2" to polygons that coincide with only hydric soils, and it assigns a "3" to polygons representing only circa 1800 wetlands. Clinton River analysts selected only polygons assigned a "1" or a "2". The analysts also limited their polygons to those representing an area of one acre or more. Those polygons were then cut with a 66-foot buffer of the Michigan Framework V7 Road dataset. Once the road buffer was removed, analysts selected those polygons greater than one acre with a restoration ranking of "1" or "2" and having their centroid in Oakland and Macomb counties.

**Results:** Potential wetland restoration areas of 14,871 polygons ranging in size from one acre to 674 acres.

[1]MDEQ. 2008. Land and Water Management Division, Wetlands, Lakes and Streams Unit. Statewide Wetland Restoration Analysis, (MI_RestorationAnalysis.shp). Unpublished material, vector digital data. Contact Chad Fizzell.

[2]http://www.michigan.gov/cgi

Source: Schools n.d.

**Exhibit 22. Ecological Integrity Criteria and Social and Biological Criteria Used to Score Potential Wetland Restoration Sites in the Clinton River AOC**

| Criterion | Assumptions, Datasets Used, Scoring Protocol, and Results |
|---|---|
| **Ecological Criteria** | |
| Proximity to an existing wetland | **Assumption:** A wetland restoration is more likely to be successfully implemented if it is connected to, or located close to, an existing wetland. (If an existing wetland is already in place, existing landscape condition such as intact hydrology, appropriate soil conditions, and lack of drainage will be conducive to a successful restoration.)<br>**Datasets Used:** NWI for Macomb and Oakland counties<br>**Scoring:** Potential restoration sites within 200 feet of an existing wetland were given a score of "1," and sites within 100 feet were given a score of "2."<br>**Results:** Out of 14,871 potential restoration sites, 8,604 (58%) were within 100 feet of a wetland and 853 (6%) were over 100 feet but less than 200 feet from a wetland. |
| Proximity to a waterway | **Assumptions:** A wetland restoration is more likely to be ecologically successful if it is connected to, or located close to, an existing water body. It is easier to implement a wetland restoration if the site intersects a ditch that can be blocked.<br>**Dataset Used:** NHD Gap dataset from the Institute for Fisheries Research at the University of Michigan<br>**Scoring:** Sites within 100 feet of a stream feature were given a score of "1," and sites that intersected a canal or ditch were given a score of "2."<br>**Results:** Out of the 14,871 potential sites, 3,353 (23%) were found to be within 100 feet of a stream and 36 (less than 1%) were found to intersect a waterway feature. |
| Landscape context | **Assumption:** A wetland restoration is more likely to achieve maximum wetland functionality if it is buffered from anthropogenic stresses. In Michigan, wetland restoration tends to occur most often on or within close proximity to agricultural lands as opposed to natural lands or urban areas.<br>**Datasets Used:**<br>• 2000 IFMAP dataset from the Michigan Department of Natural Resources. The dataset is a 30-meter raster derived from Thematic Mapper remote sensed imagery. It includes 26 |

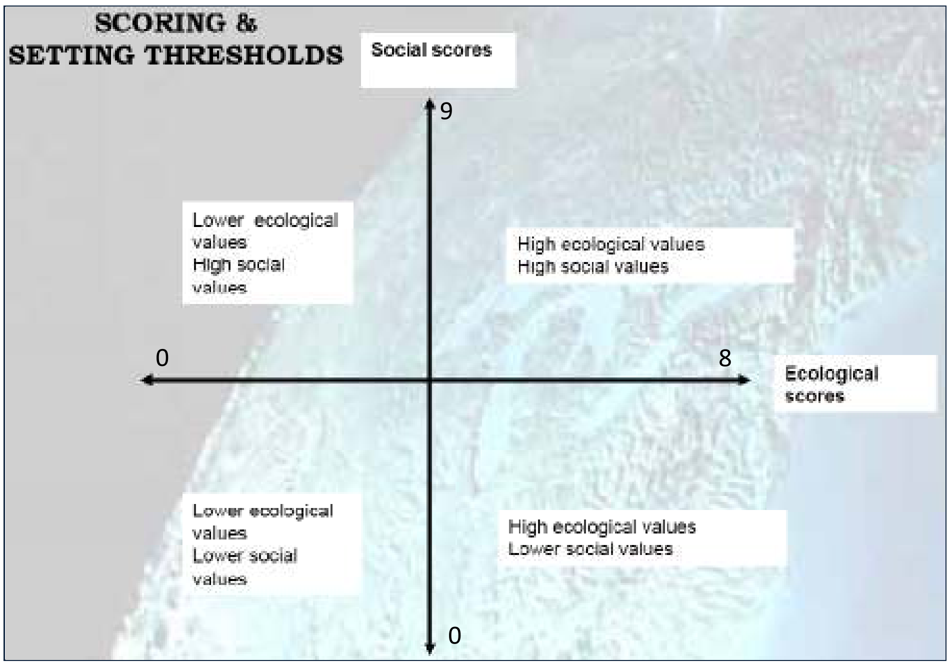
| Criterion | Assumptions, Datasets Used, Scoring Protocol, and Results |
|---|---|
| Landscape context continued | land cover types. For the purposes of the Clinton River model, the land cover types were reclassified into three categories: urban, agricultural, and natural.<br>• Hawth's Tools Thematic Raster Summary Tool to tabulate areas within polygons where the polygons overlap (http://www.spatialecology.com/htools/tooldesc.php)<br>**Scoring:** Potential restoration sites with buffers containing less than 50 percent urban land cover were given a score of "1." Sites within buffers containing greater than 50 percent agricultural land cover were assigned a score of "2," and those sites with buffers greater than or equal to 50 percent urban were given a score of zero.<br>**Results:** Of the 14,871 potential restoration sites, 2,465 (17%) had 50 percent or greater agricultural lands in the 100 meter buffer and received a score of "2;" 9,567 sites (65%) had less than 50 percent agricultural and less than 50 percent urban land in the buffer, receiving a score of "1," and 2,839 sites had 50 percent or greater urban land in the buffer, receiving a score of zero. |
| Isolation from roads | **Assumption:** Roads can block the natural flow of water across the landscape and can hydrologically isolate wetlands. Runoff from roads can contaminate wetlands. A wetland restoration will be better able to maintain wetland functionality if the restoration is isolated from a road.<br>**Dataset Used:** Michigan Framework V7 Road dataset from Michigan's Center for Geographic Information Spatial Data Library (The potential restoration sites were intersected with the 66-foot buffer of the dataset. The selection was then switched, selecting those sites not intersecting the road buffer.)<br>**Scoring:** Potential restoration sites were scored one point for being isolated from a road.<br>**Results:** Of the 14,871 potential restoration sites, 5,410 (36%) were found to be isolated from a road and given a score of "1." |
| Proximity to historic wetlands | **Assumptions:** See assumptions under "Site Selection" category above.<br>**Dataset Used:** MDEQ's Michigan Restoration Analysis dataset<br>**Scoring:** To give additional emphasis to those potential sites where both hydric soils and historic wetlands are present, the sites were scored a point. Potential sites based solely on hydric soils were not assigned a score.<br>**Results:** Of the 14,871 potential restoration sites, 3,033 (20%) were found to be based on both hydric soils and the presence of historic wetlands. |
| **Social and Biological Criteria** | |
| Number of landowners involved | **Assumption:** A wetland restoration is more likely to be implemented when the restorable wetland is controlled by one landowner. The smaller the number of landowners involved, the more likely the project is to occur.<br>**Dataset Used:** Parcel data supplied by counties (A limitation of parcel data is that multiple parcels can be owned by the same person. To reduce bias against larger sites, analysts used the ratio of the number of parcels intersecting a site to the area of the site (number of parcels divided by the site area) as a scoring criterion. The smaller the ratio, the better.)<br>**Scoring and Results:** Of the 14,871 potential restoration sites, 1,818 (12%) were found to have a ratio of less than 0.5 parcel per acre and were assigned a score of "1" and 2,594 potential sites (17%) were found to contain only one parcel and were assigned a score of "2." |

| Criterion | Assumptions, Datasets Used, Scoring Protocol, and Results |
|---|---|
| Proximity to protected areas | **Assumption:** A wetland restoration is more likely to be successfully implemented if it is located on an already protected area versus an area under private ownership. (Areas that are already protected also presumably have arrangements for their long-term management, which is an important component to successful wetland restoration over the long term.)<br>**Dataset Used:** Conservation and Recreation Lands (CARL) dataset of Ducks Unlimited and The Nature Conservancy<br>**Scoring:** Potential restoration sites completely contained within one of the selected protected areas was given a score of "2." Potential sites that cross the boundary of a selected protected area were given a score of "1."<br>**Results:** Of the 14,871 potential restoration sites, 320 (2%) were found to be completely contained within the boundaries of protected areas and 594 (4%) were found to intersect the boundaries of protected areas. |
| Proximity to an MDEQ conservation easement for wetland mitigations | **Assumption:** Potential restoration sites within or overlapping with an easement owned by the state has greater likelihood to be restored.<br>**Dataset Used:** Easement boundaries supplied by MDEQ<br>**Scoring:** Sites were given a score of "2" if they were completely within the area of an MDEQ conservation easement. Sites were assigned a score of "1" if they were found to cross the boundary of an MDEQ easement.<br>**Results:** Of the 14,871 potential restoration sites, 459 (3%) were found to reside completely within an MDEQ easement and 552 (3.7%) were found to intersect an easement. |
| Location within a headwaters area | **Dataset Used:** Stream drainages supplied by the Institute of Fisheries Research (firstOrderReach Watersheds.shp). Only first order streams were selected.<br>**Results:** 9,960 (67%) of the 14,871 potential restoration sites were found to intersect a headwater stream drainage. |
| Development threat | **Assumption:** A wetland restoration is more likely to be successfully implemented if the general area is not highly urbanized.<br>**Dataset Used:** U.S. Forest Service model dataset that contains projected housing densities for the years 2010, 2020, and 2030 in any given area (mi_pbg00.shp)<br>**Selection:** Potential restoration sites that are completely within polygons having a housing density greater than zero and less than 0.25 units/acre.<br>**Scoring:** 5,944 (40%) of the 14,871 potential restoration sites met the criterion and were given a score of "1." |
| Presence of significant biological features | **Assumed Value:** Potential restoration sites that could enhance documented significant natural features such as rare species habitat were desired over otherwise equivalent sites not known to enhance rare species habitats.<br>**Dataset Used:** MNFI, which is a model based on the Natural Heritage database of rare species and high quality natural communities. The model uses the known locations of rare species and natural communities and scores areas based on species' state and global imperilment, the viability of each occurrence record, and the age of the species record. The Clinton River analysts selected 160-acre test cells with a score of 25 or greater.<br>**Results:** 191 (1%) of the 14,871 potential restoration sites intersected the cells in the MNFI model with a score greater than or equal to 25. These sites were given one point. |

Source: Schools n.d.

The next step in the model is to prioritize the sites. The Clinton River wetland restoration prioritization model plots site scores on separate axes in a Cartesian coordinate (XY) system, thus dividing the scored sites into four quadrants as shown in exhibit 23. Sites with scores falling into the upper right quadrant (high ecological and high social values) were considered to have greater potential for restoration over sites with scores falling into the lower right quadrant (high ecological value but lower social values) and upper left quadrant (lower ecological values but high social values). Sites with scores in the lower left quadrant (lower ecological and social values) were prioritized as having the least potential for restoration of sites identified (Fizzell and Zbiciak n.d.; Schools n.d.).

**Exhibit 23. Clinton River Watershed Restoration Prioritization Scoring**




Source: Fizzell and Zbiciak n.d.

Each potential restoration site could score up to eight points on the ecological axis and up to nine points on the social/biological axis. Seven was the highest score achieved by a potential wetland restoration site on either axis. Of the 14,871 potential sites, 2,331 (16 percent) scored five or higher on the ecological axis and 1,039 (7 percent) scored five or higher on the social axis.

The model was designed so the user can select the thresholds for each set of criteria that determine the highest priority sites for the user's watershed. MDEQ personnel used the model to select potential restoration sites for the Clinton River AOC. MDEQ used thresholds of "5" for the ecological criteria and "5" for the social criteria to arrive at an initial selection of 43 high-priority sites. Agency personnel then used additional criteria, such as single land ownership in conjunction with a desktop review of aerial photographs, to narrow the list of 43 to six (Schools n.d.).

### *Summary*

The LLWFA was used to identify the location, condition, and extent of wetlands and their functions in the AOC portion of the Clinton River watershed. LLWFA results were further refined by use of a wetlands prioritization model. That model enabled MDEQ to refine its list of potential wetland restoration sites in the AOC using ecological and social/biological criteria. Both assessment procedures are desktop-based and do not require site visits, which reduces assessment costs. Once the number of potential restoration sites is limited, more intensive site assessments and visits can be performed. Based on the design of MDEQ's LLWFA and prioritization model, the final selection of sites included only those that were historically wetland but are not currently wetland, do not include buildings or roads, and have single or limited land ownership. The strategy of the Clinton River AOC partners would be to restore the hydrology of those sites.

### 4.1.4 Conclusion

Thus far, multiple watersheds across Michigan have found innovative ways to use the LLFWA (USEPA 2008). Planners in the Black River watershed in Allegan and Van Buren counties have used the LLWFA and incorporated it into watershed planning. The watershed coordinators have implemented analyses on the connections between inland lakes and wetland resources. They have also created a prioritization process meant to inform decision making on the site selection of wetland restoration projects (Fuller 2005).

Another example of how the LLWFA can be incorporated into the watershed planning effort is in the Gun River watershed. The watershed coordinators for this project used the LLWFA in combination with their local knowledge of landowners to prioritize wetland restoration efforts down to actual properties using parcel data. They then met with local landowners to gauge their interest in completing a wetland restoration project on their property, assisting interested landowners with the procedural aspects of working through the various requirements of state/federal restoration programs (Wetland Reserve Programs, Partners for Fish and Wildlife, etc.) to help address the needs of the overall watershed (FTC&H 2004).

**For Further Information** contact Chad Fizzell or Rob Zbiciak of Michigan's Department of Environmental Quality. Mr. Fizzell can be reached at (517) 335-6928 or fizzellc@michigan.gov, and Mr. Zbiciak can be reached at (517) 241-9021 or zbiciakr@michigan.gov.

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## 4.2 Virginia's Catalog of Known and Predicted Wetlands

*This case study presents an approach the state of Virginia has developed in a pilot watershed to identify wetlands in a watershed context that are suitable for wetland restoration, creation, or enhancement based on the functions and services they provide. The resultant product is a catalog that can be used to help applicable entities select potential wetland mitigation sites under the CWA section 404 program. The intent of the pilot was to provide a foundation upon which a catalog for the entire state could be developed for use in multiple water quality contexts.*

### 4.2.1 Overview

In 2006, the Virginia Department of Conservation and Recreation (VDCR), Natural Heritage Program (VNHP) developed the Virginia Wetland Restoration Catalog (VWRC). This statewide effort originated with a request from the Virginia Department of Transportation (VDOT) for VNHP to identify the "best places for wetland restoration in a particular VDOT district." The purpose of the catalog was to provide VDOT with a tool for identifying potential wetlands mitigation sites that harbored rare plant and animal populations as well as exemplary rare natural community types. The original catalog identified 122 potential wetland restoration sites, which were generally situated near Natural Heritage Conservation Sites. VNHP researchers identified the potential restoration sites by analyzing Natural Heritage data, aerial photography, NWI data, and other GIS datasets (Weber and Bulluck 2010). (See sidebar on NWI coverages.)

**Limited NWI Coverage in Some States**

In some regions of the country, the NWI database contains limited wetland coverages. Researchers therefore need to overlay other data sources with NWI data to identify a more comprehensive universe of existing and former wetlands. Researchers often use aerial photographs as a means to identify existing and future sites along with data on soils and hydrology. After initial assessments are completed, promising sites can be visited wherein more detailed assessments of soils, vegetation, and hydrology can be made. Development of Virginia's Wetland Restoration Catalog involved the creation of wetland prediction models based on such data integration efforts.

In 2010, VNHP scientists conducted a pilot study in the Pamunkey River watershed (described below). The aim of the pilot was to expand the methodology developed for the initial VWRC and create a methodology that is flexible, repeatable in other watersheds and states, and easy to follow. VNHP is poised to expand the methodology statewide and for use in other water quality contexts once project funding is secured (Bulluck 2011, personal communication).

Source: Weber and Bulluck 2010.

### 4.2.2 Pamunkey River Watershed

The Pamunkey River watershed, in eastern Virginia, covers 411 square miles and consists of 11 subwatersheds (Weber and Bulluck 2010). The Pamunkey River flows southeast before merging with the Mattaponi River to form the York River, which ultimately discharges to the Chesapeake Bay.

Designated uses are not being attained in streams in this watershed due to pH imbalances, dissolved oxygen levels, and the presence of *Escherichia coli (E. coli)*, and thus most streams in the watershed are listed as impaired waters under section 303(d) of the Clean Water Act. Aquatic life uses are also not being attained for benthic macroinvertebrates.

### 4.2.3 Virginia Wetland Catalog Components

Scientists at VNPH integrated input data layers from multiple data sources—most of which are publicly available at no cost—into one GIS layer and output map, which is in turn linked with a full attribute table of input data. The input data layers consisted of either wetland source data or priority sources, as summarized in exhibit 24. Wetland source data were used to identify all wetlands on the ground, beyond those in the NWI. Identification of wetlands not included in the NWI required a preliminary modeling step, which made use of data in the NHD dataset, FEMA's Digital Flood Insurance Rate Maps (DFIRM), and the NRCS's SSURGO. This model output, and quality control (QC)/verification using aerial photography, identified many wetland areas not indicated in the NWI coverage. The output, plus the NWI, provided the wetlands and streams base layers to which the prioritization was applied. All wetland areas in the Pamunkey watershed (NWI and modeled) were then prioritized using a basic suite of input datasets that rank the integrity of lands and waters, from ecological and water quality standpoints.

**Exhibit 24. Wetland Source and Priority Source Layers Used in the Virginia Wetland Catalog**

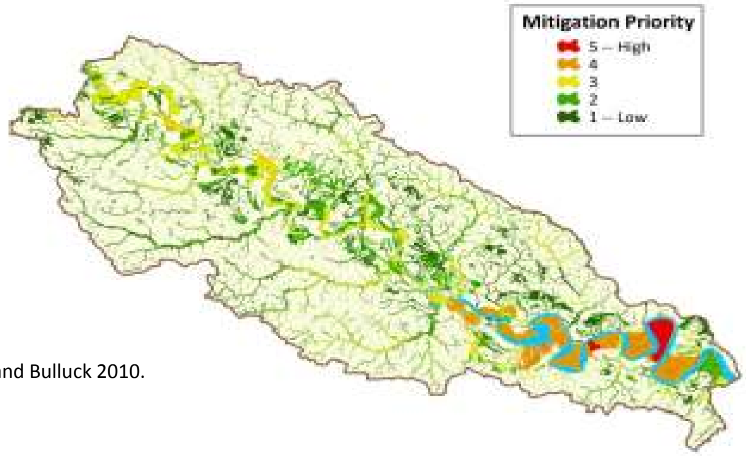
| Wetland Sources | | |
|---|---|---|
| **Layer** | **Source** | **Description** |
| National Wetlands Inventory | USFWS | Shows the extent of wetlands, surface waters and deepwater habitats in terms of type and function. |
| National Hydrography Dataset | USGS | Shows position and flow direction of lakes, ponds, streams, rivers, canals and oceans. |
| Digital Flood Insurance Rate Map (DFIRM) Database | FEMA in the U.S. Department of Homeland Security | Shows 100-year and 500-year floodplains with zone designations. |
| Soil Survey Geographic Database | NRCS in the U.S. Department of Agriculture (USDA) | Shows soils classified as hydric or partially hydric with indicators of hydric conditions. |
| **Prioritization Sources** | | |
| Natural Heritage Priority Conservation Sites (NHPCS) | VDCR/VNHP | Shows areas of known high biodiversity and the degree to which those places are protected. Includes high-quality natural environments. |
| Virginia Natural Landscape Assessment (VaNLA) | VDCR/VNHP | Identifies, prioritizes, and links natural habitats. Uses land cover data to identify natural habitats that are not fragmented. Ecological integrity is also represented. |

| Prioritization Sources continued | | |
|---|---|---|
| Regional Internet Bank Information Tracking System (RIBITS) | USACE | An Internet-based tracking system for wetland mitigation banking. |
| Impaired Waters of Virginia | Virginia Department of Environmental Quality (VDEQ) | Shows waters that do not meet water quality standards in accordance with CWA section 303(d) list requirements. |
| Healthy Waters of Virginia | VDCR | Shows streams that are considered ecologically healthy based on data collected on aquatic species, instream habitat, condition of banks, and condition of buffer areas. |
| Farmed Wetlands | VDCR/VNHP | Shows lands that were likely prior-converted wetlands based on agricultural land cover data and wetland data. |

Source: Weber and Bulluck 2010.

Researchers subsequently assigned weights to the priority data layers to derive an overall ranking of a wetland's relative value for mitigation within the watershed. Weights were assigned to the priority layers on a scale of 1 to 5 with "1" being the least important/least valuable and "5" being the most important or valuable (Weber and Bulluck 2010). Those weights were assigned with full transparency so that any user of the catalog's outputs could manipulate weights (i.e., influence outputs such that different types of mitigation sites would be highlighted in the output map). In this pilot, weights were assigned as follows: the Natural Heritage Priority Conservation Sites were ranked from 1 (lowest) to 5 (highest) based on Biodiversity Site score. Core habitat areas from the VaNLA carried 1 (lowest) to 5 (highest) weights based on various factors, including habitat core size, length of interior streams, abundance of wetlands, diversity of wetland types, and known presence of rare species. Areas in the landscape corridors portion of the VaNLA were all weighted "1," and sites in RIBITS, the CWA section 303(d) impaired waters dataset, healthy waters dataset, and farmed wetlands dataset were all weighted "3." A collective mitigation priority ranking was then calculated for each site, and the sites were ranked based on the sum of their weights for all priority layers on a final 1-to-5 point scale (Weber and Bulluck 2010). Exhibit 25 is a map of the streams and wetland areas ranked by their collective priority scores.

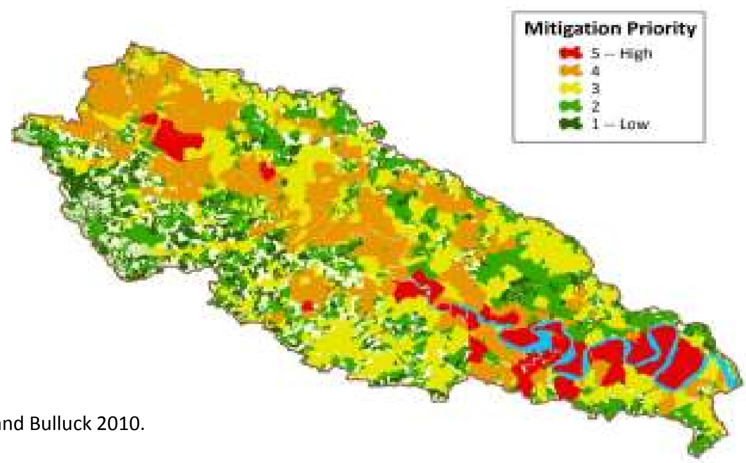
**Exhibit 25: Pamunkey River Watershed Wetland Priorities**




Source: Weber and Bulluck 2010.

To add practical value to outputs, each priority mitigation area was intersected with land ownership parcels, so that users of the catalog could easily see (through the output map and the output data table) the parcel-specific contribution to a particular mitigation opportunity (Weber and Bulluck 2010). Exhibit 26 is a map of the parcels, prioritized by their potential to contribute to mitigation efforts on the wetlands and streams they harbor.

**Exhibit 26: Pamunkey River Watershed Wetland Priorities by Parcel**




Source: Weber and Bulluck 2010.

### 4.2.4 The Results

The outputs of the pilot study included GIS outputs and maps of prioritized wetlands and streams where mitigation opportunities exist in the Pamunkey River watershed. The GIS outputs include a full attribute table that delivers all input data for all priority areas identified in the analysis. Indeed, this output table offers the most useful study outputs. Users can include additional data in the analysis, remove certain datasets, and/or alter the weights assigned to all prioritization layers, and thereby run their own analyses, leading to output maps that focus on the aspects of wetlands they find most valuable. For example, a user might like to elevate weights for all wetlands and streams with rare species conservation values, so that those opportunities are highest ranked in output maps. Or, one might prefer to adjust weights to select for CWA section 303(d) streams and associated wetlands to highlight restoration opportunities. Alternatively, one could elevate the weights for healthy waters, so that that those conservation opportunities are highlighted in the map. Project outputs also included systematic instructions on how to apply the methods used in other areas of Virginia (Weber and Bulluck 2010). This straightforward, practical approach could be employed by researchers in other states using the same national and analogous state level datasets.

### 4.2.5 Summary

VNHP is ready to expand the methodology statewide, enhance it with updated input data and modify it for alternative water quality purposes. For example, VNHP staff envision adding certain additional input layers to lead to outputs that more finely "tease apart" the best potential opportunities for restoration versus creation, versus preservation, versus enhancement. This could be accomplished with a similarly undemanding approach that incorporates available datasets, which more thoroughly identify the following:

- A biological health assessment of all stream reaches and watersheds in Virginia (Only exceptional waters were incorporated into the pilot study.)
- All Virginia surface waters based on water quality tier
- CWA section 303(d) impaired waters
- CWA section 319 watersheds
- Updated parcel-level conserved lands with biodiversity management intent and legal protection status classifications
- The Nature Conservancy's forest matrix blocks
- 2012 updates to all other inputs as available
- Others, as appropriate

In this pilot, analyses of 2009 high-resolution aerial photography were used to QC modeled wetland finds. In a statewide approach, VNHP inventory biologists will ground-truth the results of the wetland prediction model *and* the prioritization of mitigation opportunity areas through field visits to assess wetland presence (via wetland soils, hydrophytic vegetation, and evidence of wetland hydrology), wetland habitat value, and wetland function.

**For Further Information** contact Jason Bulluck, Natural Heritage Information Manager, Virginia Department of Conservation and Recreation at (804) 786-8377 or Jason.bulluck@dcr.virginia.gov.

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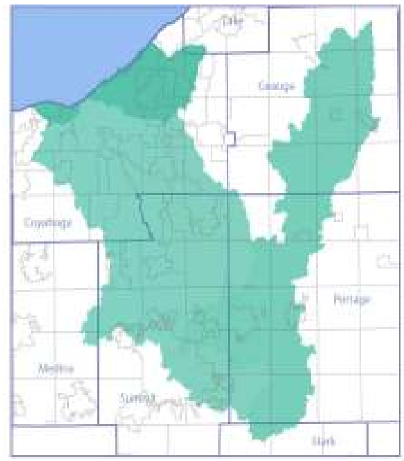
## 4.3 Assessing Wetland Restoration Potential for the Cuyahoga River Watershed (Ohio)

*This case study presents an approach to identify a suite of sites and then predict their suitability for wetland restoration for the Cuyahoga River watershed in northern Ohio. The prediction model was aimed at prioritizing wetlands sites that, if restored, would enhance water resource integrity or the ability of the watershed to meet CWA goals for the support of aquatic life (White and Fennessy 2005).*

### 4.3.1 Watershed Description




Source: CRCPO n.d.

The Cuyahoga River watershed spans 813 square miles and drains 1,220 miles of streams across four counties in northeastern Ohio. The Cuyahoga River changes direction, flowing south before flowing north into Lake Erie near Cleveland (Fennessy et al. 2007).

The Upper Cuyahoga River watershed has a large number of high-quality and intact wetlands, a large portion of which are owned by the City of Akron. Land use in the upper basin is primarily agricultural. This portion of the watershed is known for having a large number of rare and listed plant and animal species. The Middle Cuyahoga watershed is predominately suburban and urban with some agriculture. Soils are considered highly erodible, making sediment and nutrient loadings an issue for water quality. The Lower Cuyahoga watershed is highly urbanized with industrial and urban development. Construction site runoff, industrial and municipal point sources, CSOs, and land disposal of waste are all threats to water quality in the Lower Cuyahoga watershed (Fennessy et al. 2007).

### 4.3.2 Cuyahoga River Watershed Assessment Components

Researchers first used a modeling approach to identify the spatial distribution of sites most suited for wetland restoration. They assigned scores to six variables known to influence wetland restoration (see sidebar). Each grid (i.e., at a 25 meter cell resolution) in the study area (entire Cuyahoga River watershed) was assigned a score for each criterion. The relative importance of each of the criteria was then weighted using best professional judgment. The relative importance of pairs of criteria were then rated using a nine point scale (White and Fennessy 2005).

**Local Variables**

- Hydrologic regime
- Vegetative character
- Soil character
- Topography

**Landscape Variables**

- Overland flow distance
- Attainment of aquatic life use standards in adjacent streams

Source: White and Fennessy 2005.

Researchers selected variables for the model on two spatial scales: (1) using local parameters or those that define wetland properties or form and (2) using landscape parameters or those that best characterize wetland function. Each of the local and landscape variables was scaled based on presence or absence. For example, if hydric soils were not present in a site (grid cell), it was excluded and if land use classes for a site were urban, water, or transportation, the site was excluded (White and Fennessy 2005).

Researchers used five additional criteria related to wetland form and function. Strahler stream order and overland flow length (i.e., distance from each grid cell to the nearest stream channel) were used to represent watershed position. Topographic-based saturation index and land use/cover type, after excluding urban, water and transportation uses, were used to determine the suitability of a given site (grid cell) to support a wetland (e.g., whether wetland hydrology could develop). Water quality impairments were included to enable prioritization of sites for restoration. Sites with a higher proportion of stream segments not meeting water quality standards have a higher potential to benefit from wetland restoration (White and Fennessy 2005).

Water quality use attainment is of particular concern in the Cuyahoga River watershed because eight beneficial uses are considered impaired due to cultural eutrophication (nutrients), toxic substances (PCBs and heavy metals), bacterial contamination, habitat modification, and sedimentation. The sources of these contaminants vary but include municipal and industrial discharges, bank erosion, commercial/ residential development, atmospheric deposition, hazardous waste disposal sites, urban stormwater runoff, combined sewer overflows, and wastewater treatment plant (WWTP) bypasses (USEPA 2011b).

**Water Quality Beneficial Use Impairment in the Cuyahoga River**

- Restrictions on fish and wildlife consumption
- Degradation of fish and wildlife populations
- Beach closings
- Fish tumors or other deformities
- Degradation of aesthetics
- Degradation of benthos
- Restriction on dredging activities
- Loss of fish and wildlife habitat

Source: USEPA 2011b.

Researchers developed three different variations of the model depicting restoration potential by altering the weights assigned to the five parameters described above. The three model variations generated were (1) base model, (2) alternative weights model, and (3) transmissivity variation model.

### 4.3.3 The Results

The base model identified potential wetland restoration sites in the watershed based on estimating land suitability by averaging data layers with no adjustments or priorities established. In the base model, few areas scored in the top restoration potential category (White and Fennessy 2005). Those that did were areas located in the headwaters of subwatersheds. The highest density of sites was found in the upper northeastern peninsula of the watershed (Geauga County). Researchers posited that this was due to land use in the area being primarily agricultural, water quality being impaired, and hydric soils being present (White and Fennessy 2005).

Researchers developed two different variations of the suitability (base) model depicting restoration potential by altering the weights or calculations for the functionality criteria described above. In one analysis, more weight was given to aquatic life use attainment and stream order (alternative weights variation). As a result, a greater number of high-restoration-potential sites were identified downstream in rapidly urbanizing areas, such as Akron and Cleveland. In a second sensitivity analysis, researchers examined the inclusion of soil permeability in the topographic saturation index to account for the drainage potential of soils (transmissivity variation). Researchers found an inverse relationship between transmissivity (i.e., horizontal water flow in an aquifer per unit of time) and soil "wetness." That is, as transmissivity increased, soil wetness decreased. Few sites with low soil wetness or high transmissivity scored in the high restoration potential category (White and Fennessy 2005).

An examination of the similarities of the three model runs showed similar distributions of wetlands but differences in many of the restoration potential values within a grid cell. All three models allocated a high restoration potential to the northeastern peninsula portion of the watershed (i.e., the area with low water quality, a high proportion of hydric soils, and low levels of urbanization). Overall, the analyses highlight the significance of variation of model inputs on model output (White and Fennessy 2005).

Researchers also examined the spatial patterns of the three models and their relationships to the local and landscape variables and the five-factor criteria. They found that sites that meet state standards for supporting aquatic life tend to dominate the distribution of sites with high restoration potential in the three models. Conversely, the distribution of overland flow length was found to have a very low influence on model results. Researchers suggest that the overland flow length criterion might have greater influence on model outcomes in watersheds with less articulated stream networks. In such watersheds, the criterion could be used to help identify sites with the highest potential downstream benefits (White and Fennessy 2005).

### 4.3.4 Summary

The model developed for the Cuyahoga River watershed, like others discussed in this Supplement, could be adapted for use in other watersheds. Toward this end, the Cuyahoga researchers generalized the model into two phases—a *resource* phase and an *application* phase (exhibit 27). The first phase involves the identification of the broad expanse of sites to investigate. The second phase involves the selection of a subset of sites having high restoration potential using criteria developed to achieve the stated watershed goal(s), which, in the case of the Cuyahoga, was to improve water resource integrity. For the purposes of the investigation, researchers defined water resource integrity as the ability of a lotic system to meet CWA goals for the support of aquatic life (White and Fennessy 2005). Researchers in other watersheds might have different goals, such as the restoration of hydrologic integrity or the addition of certain types of habitat, and they could modify the weighting of the model's factors accordingly.

**Exhibit 27. Two–Phase Model Description**

| **Resource Phase** |
|---|
| • Soil properties (e.g., hydric, percent organic matter, permeability) |
| • Proximity to other wetlands (e.g., seed banks of hydrophytic vegetation) |
| • Topographic properties (e.g., concavity and flow accumulation) |
| • Existing land use and land cover |
| • Existence of an appropriate hydrology (saturation index) |
| • Land ownership (in terms of availability) |
| **Application Phase** |
| • Land ownership (in terms of cost to purchase) |
| • Connectivity of landscape patches |
| • Size (as a minimum area) and contiguity of adjacent land use types |
| • Overall wetland quality desired |

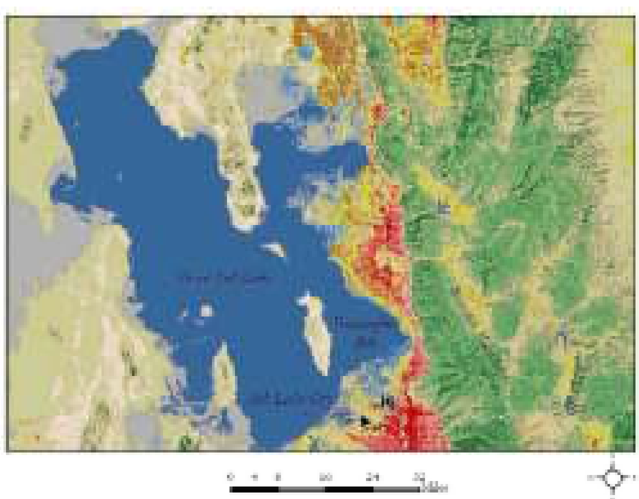
**For Further Information** contact Dr. M. Siobhann Fennessy, Associate Professor of Biology and Environmental Studies, Kenyon College, at (740) 427-5455 or fennessym@kenyon.edu.

## 4.4 Alternative Futures Analysis (AFA) of Farmington Bay Wetlands in the Great Salt Lake Ecosystem (Utah)

*This case study presents another method for assessing wetlands in a watershed context and prioritizing those for restoration. In this approach, researchers modeled future scenarios based on the stated goals and objectives of watershed groups and other stakeholders using landscape and site-level scientific data in a geospatially explicit format. Study outcomes are intended to help environmental managers envision future conditions of wetlands under varying cumulative management practices. The information can assist environmental managers and others in making informed land and resource use decisions. The approach and tools used in the Farmington Bay study could readily be tested in other communities in the Great Salt Lake Basin and could be adapted for use elsewhere in the country.*

### 4.4.1 Purpose and Overview

EPA's Office of Research and Development (Sumner et al. 2010) conducted an AFA of Farmington Bay wetlands in the Great Salt Lake (GSL) Ecosystem. The Bay is located northwest of Salt Lake City, Utah, and includes parts of Salt Lake and Davis counties. The Farmington Bay wetlands provide essential habitat for migratory shorebirds, waterfowl, and waterbirds from the Pacific and Central Flyways of North America, and the wetlands help control excess nutrient pollution to the bay. The greatest threats to the wetlands are upland development, increased pollutant loadings, and changes in freshwater availability. Average annual population is expected to increase in the area roughly two percent between 2005 and 2020.



Source: Sumner et al. 2010.

EPA's aim in conducting the study was to develop a method of forecasting and quantifying the cumulative effect of management practices on wetland ecosystem services. The scope of the study was limited to assessing the wetlands' support for biodiversity (avian habitat, in particular) and ability to retain, recover, and remove nutrients. One underlying premise of the study was that "project-by-project review by communities leaves too little time and money for regulatory, conservation and development to adequately plan and assess land and water use. Monitoring is frequently inadequate to reveal problems or trigger corrective actions." (Sumner et al. 2010). A landscape-level approach, however, enables stakeholders to consider and adopt explicit ecosystem management goals for wetlands (or other natural resources) in the context of a larger watershed. The goals are developed through an open community process and form the initial boundaries around which alternative futures are examined.

### 4.4.2 AFA Approach

The AFA was developed by Carl Steinitz in 1990 as a planning framework to help communities consider options for managing land and water use (Steinitz 1990). The approach helps communities articulate their visions for the future and understand the consequences of different land and water management decisions. The AFA generates a collection of alternative landscape design scenarios for a geographical area. In particular (Sumner et al. 2010):

- The AFA illustrates the scenarios on maps by showing future land use.
- The trend scenarios show future land use based on assumed implementation of current day management practices into the future.
- Conservation-based scenarios depict future land use based on assumed implementation of a plausible set of innovative protection, restoration, and treatment practices.
- Once the scenarios are developed, they are modeled and evaluated against a set of ecological endpoints or outcomes. (The Farmington Bay study specifically focused on the ecological outcomes of water quality and avian habitat use as forecasts of ecosystem services.)

An AFA is aimed at answering some of the same fundamental questions outlined in EPA's Watershed Planning Handbook. The specific questions posed in the Farmington Bay study included the following (Sumner et al. 2010):

1. How should the landscape be described?
2. How does the landscape operate?
3. By what actions might the current representation of the landscape be altered?
4. How does one judge whether the current state of the landscape is working well?
5. What predictable differences might the changes cause?

Answers to questions 1, 2, and 4 help investigators establish baseline conditions for a watershed management plan. Answers to questions 3 to 5 can be used in the watershed planning process to develop an implementation strategy. Those two specific questions allow for integration of wetlands and wetland restoration into the watershed planning process. To complete use of the AFA, the design questions are reordered and discussed. This sets the stage for a second iteration of the AFA, which can be performed by environmental managers and community stakeholders.

### 4.4.3 Land Use Scenarios, Wetland System Templates, and Ecosystem Service Models

In the Farmington Bay study, the project team used models to evaluate a set of five scenarios—one to reflect current landscape settings (2003) and four to provide alternative visions of the future based on land use projections to the year 2030. The five scenarios are called the Current Scenario 2003, Future Scenarios, Plan Trend 2030 Scenarios, Conservation 2030 Scenarios, and 2030 Lake Level Rise Scenarios. The Current Scenario 2003 was developed to serve as a baseline for measuring the cumulative effects of land use and water use change, as predicted for each future scenario. A common set of urban growth and water use/availability projections were applied in each of the future scenarios. The wetland and habitat management assumptions used in each of those scenarios, however, varied. The Plan Trend 2030 Scenarios characterized the future landscape under two different water level elevations for the Great Salt Lake. Each of the Plan Trend Scenarios assumed that currently enacted policies and development and conservation trends would continue into the future. The Conservation 2030 Scenarios were based on the same land use and water use assumptions as presented in the Plan Trend Scenario; however, the 2030 Scenario designated certain wetlands as priorities for conservation and restoration. The Conservation Scenarios identified all natural wetlands below 4,217 feet as critical lands for protection and restoration and assumed that there would be no net loss in the quantity and quality of wetlands above 4,217 feet in elevation (i.e., within the shorelands area of Farmington Bay, between 4,217 feet and 4,230 feet in elevation) (Sumner et al. 2010).

The 2030 Lake Level Rise Scenarios involved the overlay of the effects of a lake level rise to 4,212 feet onto the Plan Trend and Conservation Scenarios using FEMA flood assessment GIS data and digital elevation model data and allowed researchers to evaluate wetland acreage change resulting from higher lake water levels (Sumner et al 2010). Additional design features for each of the five scenarios briefly described above are provided in exhibit 28a.

In addition to the scenarios, researchers also developed three study templates designed to represent “typical” landscape patches (i.e., functional units of the landscape) common across the Farmington Bay shorelands. The purpose of the templates was to evaluate how different classes of wetland patches along the shorelands would respond to the management practices assumed in the five scenarios. The name of each template corresponds to the dominant class of wetland within the template—Impoundment Template, Fringe/Emergent Template, and Playa Template (Sumner et al 2010). Exhibit 28b further describes design aspects of the templates.

Researchers also developed ecosystem services and evaluation models as part of the Farmington Bay AFA. They focused specifically on two ecosystem services: support for avian habitat and control of excess nutrients and pollutants. The two services were selected in response to perceived community concerns and values associated with wetland ecosystems. Further details regarding the two ecosystem models are provided in exhibit 28c.

### 4.4.4 Results

Through the study, researchers determined that the Conservation Futures model would protect the most wetland acreage and highest category of suitable avian habitat. In contrast, the model based on implementation of current day management practices (Current Scenario 2003) predicted declines in the highest class of suitable avian habitat. Researchers further found that both management scenarios predicted that future loadings of nutrients to the watershed would increase due to point source discharges.

The Farmington Bay study included an assessment of restoration opportunities in the watershed. Wetlands with *high restoration potential* were those identified as meeting the following spatial criteria:

- Must intersect a 30-meter buffer around conveyances because of a conveyance’s ability to deliver managed flows to the wetland. (Conveyances are manmade structures designed to carry water, such as canals and drainage ditches.)

- Must contain all-hydric soils because they are an indicator of areas containing existing wetlands or suitable for restoration.
- Must possess interior habitat of at least 30 meters from a wetland edge (i.e., areas with no major roads, train tracks, power lines, or developed structures).
- Must not be seasonally flooded lacustrine, nonvegetated wetlands that are typically found below 4,200 feet.

Researchers also assessed the presence of public or private lands. Public lands (i.e., lands owned by federal, state, and local governments) provide the most immediate opportunity for conservation or restoration activities as there would likely be fewer barriers for obtaining the wetlands. For the purposes of the analysis, public lands also included lands owned by non-governmental organizations; and private lands included all categories of private ownership.

### 4.4.5 Summary

Although there were some limitations in the availability of Farmington Bay wetland monitoring and assessment data, the overall approach and GIS-based evaluation models that were used provided useful future predictions regarding potential impacts to wetland areas that could support decision making. The AFA provides a transparent means for organizing and communicating complex scientific information to a diverse group of stakeholders and improving communication among stakeholders (Sumner et al. 2010).

This assessment approach provides watershed groups with information on tools they can use to predict what a watershed, including its wetlands, would look like in the future depending on the criteria used for land use management. Watershed groups and local and other decision makers can incorporate this information into watershed plans and develop proactive approaches to addressing water quality problems, altered hydrology, and habitat fragmentation or destruction.

**For Further Information** contact Richard Sumner, Regional Liaison to EPA National Wetlands Program, Western Ecology Division, EPA Office of Research and Development at (541) 754-4444 or sumner.richard@epa.gov.

**Exhibit 28a. Current and Future Scenarios under AFA of Farmington Bay Wetlands**

Information in this exhibit was directly excerpted from Sumner et al. 2010.

<table>
<tr><th>Current Scenario</th><th colspan="4">Future Scenarios</th></tr>
<tr><th rowspan="2">2003</th><th colspan="2">2030 Plan Trends</th><th colspan="2">2030 Conservation Trends</th></tr>
<tr><th>Plan Trend 4,200<br>*(characterizes future landscape under GSL water elevation of 4,200 feet)*</th><th>Plan Trend 4,212<br>*(characterizes future landscape under GSL highest water elevation of 4,212 feet)*</th><th>Conservation Trend 4,200<br>*(characterizes future landscape under GSL water elevation of 4,200 feet)*</th><th>Conservation Trend 4,212<br>*(characterizes future landscape under GSL highest water elevation of 4,212 feet)*</th></tr>
<tr><td rowspan="2">Baseline for measuring cumulative effects of land use and water use change as predicted for each future scenario.<br><br>Information in the baseline characterization include:<br><br>• Water availability estimates<br>• Annual estimates of ground and surface water withdrawals<br>• Point source discharge data<br>• Dam flows and irrigation canal flows<br>• Annual estimates of water imported via Davis Aqueduct<br>• Flows and concentrations of nutrients in effluent from point sources</td><td colspan="2">• Assumes current policies and conservation trends will continue.<br>• Wetlands below 4,212 feet in elevation were presumed safe from development.<br>• Based on projected population growth, land use change, increase in flow delivery and nutrient loads, and a decrease in the quantity of upland wetlands.<br>• Wetlands and associated habitat above 4,212 feet in elevation were removed from land use data layer.<br>• Wetlands between 4,212 and 4,217 feet were assumed to be at risk from land conversion; they were converted to upland land use in scenarios. FEMA has set 4,217 feet as the critical elevation line for planning around Farmington Bay. Development below this line poses risks to property, persons and structures as lake levels rise and recede. Assumption made that counties adhere to *no build zones* less than 4,217 feet.<br>• Design assumption is that *lost* wetlands will be replaced with a mix of low-density development and parks.<br>• Design assumption that current extent of invasive plant, *Phragmites,* will increase by a perimeter rate of 5 meters per year based on studied perimeter expansion rates by other researchers.<br>• Lake level rise to 4,212 feet was taken into account (simulation allowed for an evaluation of wetland acreage levels).</td><td colspan="2">• Uses same land use and water use assumptions as in Plan Trend scenarios.<br>• Scenarios differ from Plan Trend scenarios in that certain wetlands are designated for conservation and restoration.<br>• All natural wetlands below 4,217 feet are identified as critical lands for protection and restoration.<br>• Scenario assumes *no net loss* in the quantity and quality of wetlands above 4,217 feet elevation within the shorelands area (4,217 to 4,230 feet in elevation).<br>• Provisions are included for restoration of wetlands and associated habitat in the shorelands area to offset wetland degradation and conversion.<br>• Assessment of potential restoration opportunity was performed to identify areas suitable for restoration; these provide resource capacity needed to sustain the *no net loss* design.<br>• Lake level rise to 4,212 feet was taken into account (simulation allowed for an evaluation of wetland acreage levels).</td></tr>
<tr><td colspan="4">***Data sources for all four future scenarios:***<br>• Land use projection data from Salt Lake and Davis Counties. Adjustments were made using proposed changes presented by the Northwest Quadrant Master Plan.<br>• Water availability based on flow return projections from wastewater treatment plants (WWTPs), groundwater discharge, municipal and industrial discharges, inputs from canal diversions and other withdrawals.<br>• Future projected flow estimates for Salt Lake County WWTPs and an additional facility in Riverton from County.<br>• Future projected flow estimates for Davis County based on population projections from Central Davis Sewer District 2008 Operating Budget.</td></tr>
</table>

**Exhibit 28b. Wetland Type Study Templates under AFA of Farmington Bay Wetlands**

Information in this exhibit was directly excerpted from Sumner et al. 2010.

| Study Templates | | |
|---|---|---|
| **Impoundment Template** | **Fringe/Emergent Template** | **Playa Template** |
| • Impoundments are critical for controlling high flows, administering water rights allocations, and managing habitat for migratory waterfowl.<br>• Template is a 2,230-acre wetland complex consisting of a string of several diked units.<br>• The major conveyance of water is the Ambassador Cut.<br>• Flows to the Ambassador Cut are first subjected to dams, diversions, and wetlands. | • Template is a large, 10,922-acre complex of wetlands located on the eastern shore of Farmington Bay.<br>• Comprised mainly of lacustrine wetland types on the southwestern edge of the template.<br>• Upslope, the fringe template becomes dominated by emergent class wetlands.<br>• Three major water conveyances to template include Baird Creek, Holmes Creek, and Kays Creek.<br>• The Central Davis Sewer District is located at the outflow of Baird Creek into the Farmington Bay wetlands.<br>• Also located in template is the 4,000-acre Great Salt Lake Shorelands Preserve. | • The template is a 1,167-acre wetland complex located in the northwest corner of Salt Lake County.<br>• The major conveyances of water to the template are the North Pointe Consolidated Canal and the Goggin Drain. Both structures carry diverted water from the Jordan River and flow into the GSL at the Kennecott Mitigation wetlands.<br>• The Goggin Drain carries natural drainage and surplus water spilled from canals.<br>• Playa class wetlands in the template are shallow depressional systems that have highly variable hydric periods. They fluctuate from dry and wet throughout the entire year. They can be vegetated or nonvegetated.<br>• The wetlands in the template are managed by the Inland Sea Shorebird Preserve. Water level fluctuation within the wetlands is controlled to support their use by migratory shorebirds and waterbirds. |

**Exhibit 28c. Ecosystem Service Models under AFA of Farmington Bay Wetlands**

Information in this exhibit was directly excerpted from Sumner et al. 2010.

| Ecosystem Service Models | |
|---|---|
| **Avian Wetland Habitat Assessment Model (AWHA)** | **ArcView–enabled, Generalized Watershed Loading Function (AVGWLF) Model** |
| • The profiles provide a means of tallying and reporting the abundance of wetland classes within a defined area. The theory behind profiles is that the abundance, distribution and condition of wetlands in the landscape reflect the broad scale of processes that sustain ecosystems (Sumner et al. 2010,Bedford 1996, Bedford 1998, Gwin 1999, and Johnson 2005). Those same processes factor into the delivery of ecosystem services.<br>• The developed profiles provide a coarse index of wetland support for avian habitat, one of the key ecosystem services provided by the Farmington Bay wetlands.<br>• The model is GIS–based.<br>• The model produces a habitat index that predicts the change in the highest class of suitable habitat available for each bird grouping under conditions set by the future scenarios defined as part of the AFA as opposed to indicating the presence or absence of a species.<br>See Sumner et al. 2010 for further details on development of the model. | • The objective of the exercise was to build understanding about the risks posed by the delivery of pollutants to wetlands and avian habitat.<br>• The AVGWLF is based on the Generalized Watershed Loading Function (GWLF) Model originally developed by Haith and Shoemaker in 1987 in New York to simulate runoff, sediment and nutrient (nitrogen and phosphorus) loadings from a watershed with various land uses, soil distributions, and management practices.<br>• The AVGWLF was developed by Dr. Barry Evans (2008) at Pennsylvania State University for use by the Pennsylvania Department of Environmental Protection. It has been used by state and federal agencies for simulating watershed processes and allocating pollutant loadings among various sources.<br>• The final calibrated model allowed the outputs of water flow, sediment, and nutrients being delivered to the Farmington Bay wetlands from the various sources through the watershed to be simulated. This information on present-day loading enabled future scenarios to be modeled in AVGWLF to predict future loads in the wetlands due to various changes in the watershed.<br>See Sumner et al. 2010 for further details on development of the model. |

## 4.5 Conclusion: Next Steps

The Supplement is not intended to be inclusive of all the potential ways to incorporate wetlands into the watershed planning process. The approaches discussed, however, are now successfully being used to target specific wetlands in watersheds to address water quality, water quantity, and habitat issues—problems that plague most of the nation's watersheds.

Future editions of this Supplement might include additional case studies that show how wetland sites identified through assessment processes like those discussed in this chapter proceeded to the planning and implementation phases of wetland restoration, enhancement, and creation projects and how each of those projects was designed in keeping with watershed plan goals. Below are two examples that provide a glimpse of such efforts.

**Example 1**

The Gun River Greenbelt and Wetland Restoration Initiative (GRWI) partnered with the Allegan and Barry County NRCS Field Offices and the USFWS to implement a "door to door" wetland restoration program targeted at properties identified as having high wetland restoration potential based on use of the LLWFA and other analyses. The "door to door" campaign targets restoration sites within the watershed that would have a high potential to reduce nutrients and sediment within the watershed. Once those land parcels were identified, a direct mailing effort was used to inform the respective landowners of wetland restoration opportunities and funding avenues for the identified properties. The wetland restoration program successfully funded three wetland restorations sites within the Gun River watershed through the NRCS Wetland Reserve Program The three projects were able to access conservation easement funding for local producers and are currently (November 2011) in the easement writing stage of implementation. Construction of the three projects is slated to begin in the fall of 2012. The restorations include over 176 acres of conventional farmland being converted to their historic wetlands within the Gun River watershed. Those restorations once completed will have a dramatic impact on sediment reductions in the watershed as well address the flashiness of the river system.

Source: MDEQ 2011.

**Example 2**

The conservation districts in the Black River watershed in Allegan and Van Buren counties have worked to develop a wetland restoration prioritization process meant to inform decision making. Specifically, the Van Buren County Conservation District in Michigan partnered with the Southwest Michigan Land Conservancy (SWMLC) for several wetland protection projects through both donation and purchase of development rights. One of the parcels donated to the SWMLC contained approximately 30 acres of lost wetland. According to the LLWFA, there were historic wetlands on the site that scored "high" for streamflow maintenance, nutrient transformation, and wildlife habitat. There were also lost wetlands that scored "medium" for surface water detention, sediment retention, and shoreline stabilization.

The District used the significance of the functions to justify its request for funding and local in-kind match from the MDEQ, Ducks Unlimited, and the USFWS. All three partners committed funds and/or technical assistance on the restoration. The group is currently in the preliminary design phase. USFWS and MDEQ will likely fund a majority of the construction through the CWA section 319 grant the District received. A neighboring landowner heard about the project and decided he would like to donate his development rights and have the restoration expanded onto his property.

Source: Fuller 2005.

Further, we have established an ongoing process to identify successful wetland restoration projects that have resulted in water quality/quantity improvements. We will post links to these selected projects, along with the Supplement, on the Wetlands, Oceans, and Watersheds web site when they are finalized (http://www.epa.gov/owow_keep/NPS/pubs.html). Although some examples may not be part of a watershed plan, they show how wetland restoration can begin to address water quality/quantity goals that are likely to be part of a watershed group's watershed management plan.

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