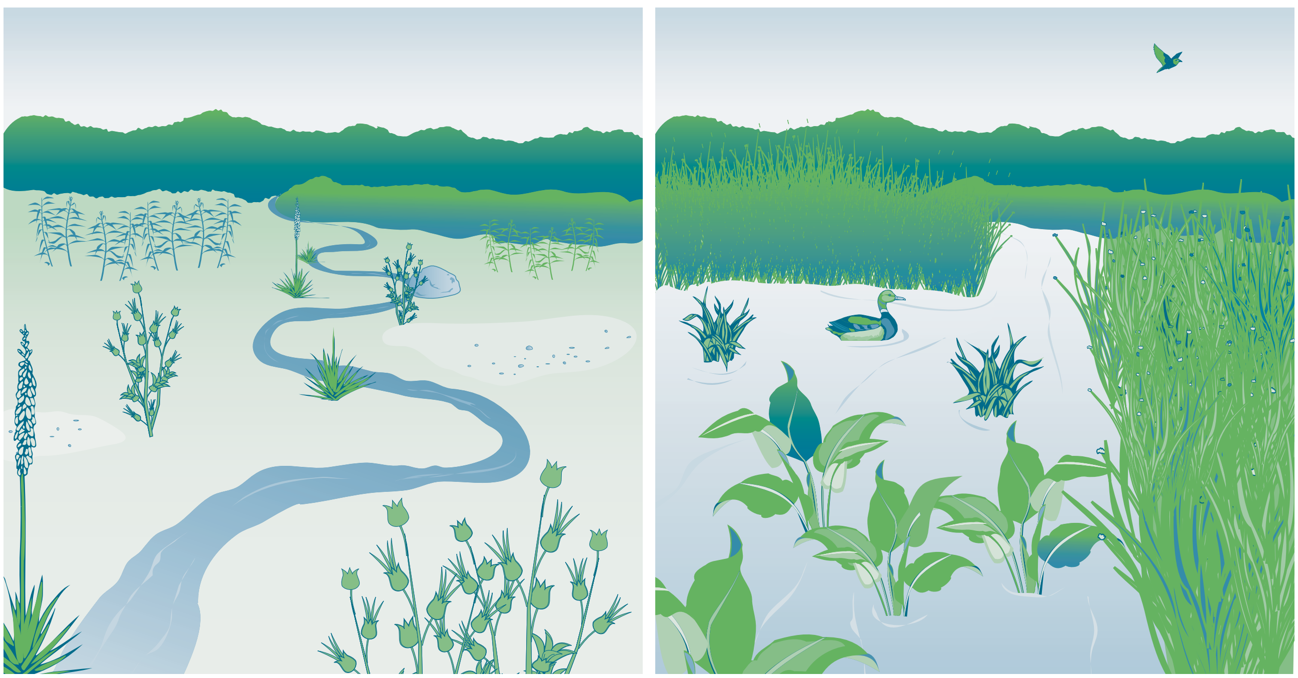
Technical Guideline

Characterization, Design, Construction, and Monitoring of Mitigation Wetlands



February 2005

Prepared by
The Interstate Technology & Regulatory Council
Mitigation Wetlands Team

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ITRC (Interstate Technology & Regulatory Council). 2005. *Characterization, Design, Construction, and Monitoring of Mitigation Wetlands*. WTLND-2. Washington, D.C.: Interstate Technology & Regulatory Council, Mitigation Wetlands Team. Available on the Internet at http://www.itrcweb.org.

ACKNOWLEDGEMENTS

The members of the Interstate Technology & Regulatory Council (ITRC) Mitigation Wetlands Team wish to acknowledge the individuals, organizations, and agencies that contributed to this technical guideline.

As part of the broader ITRC effort, Mitigation Wetlands Team work is funded primarily by the U.S. Department of Energy. Additional funding and support have been provided by the U.S. Department of Defense and the U.S. Environmental Protection Agency. ITRC operates as a committee of the Environmental Research Institute of the States (ERIS), a Section 501(c)(3) public charity that supports the Environmental Council of the States (ECOS) through its educational and research activities aimed at improving the environment in the United States and providing a forum for state environmental policy makers.

The work team also wishes to recognize the efforts of the following states' support of team leadership and guidance preparation.

- Washington Department of Ecology: Dib Goswami, Team Co-Leader
- Minnesota Department of Natural Resources: Paul Eger, Team Co-Leader
- Delaware Department of Natural Resources and Environmental Control: Gregory DeCowski
- New Jersey Department of Environmental Protection, Land-Use Regulation Program: Ginger Kopkash
- New Jersey Department of Environmental Protection, Bob Mueller, Constructed Treatment Wetland Team Co-Leader and ITRC Co-Chair
- Oklahoma Department of Agriculture, Food, and Forestry: Jim Shirazi
- Wisconsin Department of Commerce, Bureau of PECFA, Environmental and Regulatory Services Division: Shawn Wenzel

The team also recognizes the exceptional contributions from Charles Harman and Phil Perhamus, AMEC Earth and Environmental, and assistance from Bill Berti, Dupont Central Research and Development; Joel Burken, University of Missouri-Rolla; Anna Knox, Westinghouse Savannah River company; Arati Kolhatkar, BP (Remediation and Management); Ioana Petrisor, DPRA, Inc.; and Steve Hill, RegTech, Inc. and ITRC Mitigation Wetlands Team Program Advisor. We also thank the contributions made by community stakeholders and the local and community they incorporated into this document and the entire team. They are John Chambliss, Chattanooga, Tennessee, and Jimmy Mackey, South Carolina.

Special thanks go to Alan Miller of the U.S. Army Corps of Engineers, HQ for his presentation on the National Mitigation Action Plan at our team meeting in Florida and Steve Eggers, U.S. Corps of Engineers, Regulatory Branch, St. Paul District, for his presentation "Problems and Solutions in the Compensatory Wetlands Mitigation of the Corps of Engineers." In addition, the team received a warm welcome and exceptional tour of the Universal City Wetland by Brad Geob, Property Management III, LLC; Ralph DeMeo, Hopping Green and Sams; and Michael Dennis, Breedlove, Dennis and Associates. While in the Orlando area, the team also received a tour of fascinating approach at the Greenwood Urban Wetland, which the City of Orlando uses to develop parks and storm water runoff protection using wetlands. Thanks to William Chamberlain, from the City of Orlando, for the time he spent providing this tour to the team.

The team also is extremely appreciative for the long and tedious hours our peer and preconcurrence reviewers spent making this a much better guidance. They include Doug Norris, Minnesota Department of Natural Resource; Pat Trochlell, PWS, PH, PSS, Wetland Ecologist, Lakes and Wetlands Section, Wisconsin Bureau of Fisheries Management and Habitat Protection; Conrad A. Kuharic, P.G., Texas Commission on Environmental Quality; Jim Lewis, Superfund Remedial Programs, Colorado Hazardous Materials and Waste Management Department; David Scott, Savannah River Ecology Laboratory; Connie Bersok, Florida Department of Environmental Protection; David Davis, Virginia Department of Environmental Protection; and Amy Lounds, Michigan Department of Environmental Quality.

Lastly, without the leadership, organization, and coordination of Paul Eger, Dib Goswami and Bob Mueller, this guidance would not have been prepared. They spent hours of their own time maintaining team focus, reviewing numerous drafts, and planning team events. They are the cohesive and directional force of the team and the value of the guidance is greater due to their efforts.

EXECUTIVE SUMMARY

Once considered wastelands, natural wetlands are now recognized as valuable ecosystems that provide wildlife habitat, enhance water quality, control floods and erosion, provide recharge to aquifers, and offer recreational areas. By the 1980s as much as 50% of the original wetland resources in the United States had been lost and was disappearing at a rate of 300,000–400,000 acres per year (NRC 2001). No-net-less policies enacted through the Clean Water Act (CWA) and state directives are designed to halt the nation's loss of wetlands. The purpose of this document is to provide a single comprehensive technical guide for regulators, environmental professionals, or permittees to use to appropriately characterize, design, construct, and monitor any compensatory mitigation wetlands as part of any federal, state, or local permitting requirement, regardless of type, size, or location.

The CWA, a 1977 amendment to the Federal Water Pollution Control Act of 1972, regulates discharges of pollutants into U.S. waters, including wetlands. Under Section 404, the CWA requires permits for actions that may negatively impact or degrade natural wetland functions. As part of the Section 404 permitting process, sequencing of mitigation is required to include avoidance, minimization, and compensatory actions.

While the rate of wetland loss has decreased over the past 20 years, only about 30%–50% of mitigation wetland projects are considered successful in replicating the values and functions of original wetlands. The Interstate Technology & Regulatory Council (ITRC) Mitigation Wetlands Team believes that mitigation wetland projects can be improved to help ensure their success. This guidance offers a unique flow diagram that illustrates the decision points in the overall mitigation process: assessing original wetland functions; defining goals and objectives based on mitigation option selections; and designing, constructing, and monitoring mitigation wetlands. To promote the long-term sustainability of mitigation wetlands, this guidance provides developers, consultants, regulators, and communities with example checklists for evaluating and documenting habitat health and measuring other performance criteria of mitigation wetlands. Through this guidance the team does not intend to affect policy, change regulations, or disregard past experience. This guidance is intended to identify and simplify the technical elements of sound characterizations, design, construction, and monitoring of wetlands mitigation projects.

Spurred by a National Research Council report on failed mitigation wetland projects, the U.S. Army Corps of Engineers and others have developed a National Mitigation Action Plan (MAP) to further achieve the no-net-loss goal by improving ecological performance of mitigation wetland projects. In accordance with the recommendations of the MAP, the ITRC Mitigation Wetlands Team supports increased use of functional assessments of original and mitigation wetlands relative to the complex interrelationships in a watershed. To lay the foundation for sound mitigation planning, the guidance argues for a thorough assessment of the wetlands being disturbed or impacted to understand the hydrology, soil, and plants and how they interact to affect the functions or values provided by the wetlands. A thorough assessment of the original wetland leads to the establishment of goals and objectives for the mitigation wetlands.

Another step in mitigation planning is identifying performance standards for the restored or created wetland. Performance standards are measurable metrics for determining whether the mitigation wetland is achieving its planned goals. Standards relate to measures of the three major parameters of a wetland: water, soil, plants. Although this guidance document does not recommend specific performance standards, it does provide practical advice for designing, building, and monitoring a restored or newly created wetland.

One issue the guidance addresses is the siting of mitigation wetlands. The guidance prefers on-site, as opposed to off-site, mitigation, i.e., placing the mitigation wetlands adjacent or close to the original wetlands. However, the decision should be based on the best way to replicate the functions or values of the original wetland and an objective evaluation of the likelihood of success, ecological sustainability, practicality of long-term monitoring, overall benefits to the watershed, and relative costs of maintenance.

Mitigation banking as a method of achieving wetland mitigation is discussed. Mitigation banks are generally large wetlands that are restored, enhanced, or created to provide mitigation for smaller wetland impacts. Permittees can purchase wetland credits from an established bank in lieu of doing mitigation themselves. By purchasing existing credits, the permittee does not have any responsibility for the monitoring or maintenance of the wetland. Complicating the issue of achieving successful mitigation is the complexity of the regulatory climate. Regulatory authority is often divided among federal, state, and sometimes even local government. The guidance recognizes the benefit of federal authorities to oversee larger watersheds but also supports local protection in meeting the needs of local communities and environments. The ITRC Mitigation Wetlands Team recommends that where multiple agencies are involved, the guiding principle should be communication and coordination. Multiple authorities should work together in establishing mitigation requirements, instead of relying on applicants to coordinate among various authorized agencies.

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CHARACTERIZATION, DESIGN, CONSTRUCTION, AND MONITORING OF MITIGATION WETLANDS

1. INTRODUCTION

Wetlands are among the most productive ecosystems in the world. Species of microbes, plants, insects, amphibians, reptiles, birds, fish, and mammals are part of wetland ecosystems. Physical and chemical features such as climate, topology, geology, and the movement and abundance of water help determine the plant and animal varieties that inhabit each wetland. Consequently, wetlands in various geographic regions of the United States differ from one another. The purpose of this document is to provide a single comprehensive technical guidance for regulators, environmental professionals, or permittees to use to appropriately characterize, design, construct, and monitor any compensatory mitigation wetlands as part of any federal, state, or local permitting requirement, regardless of type, size, or location.

Figure 1-1. Example of an emergent marsh (courtesy Charles Harman, AMEC Earth & Environmental).

The functions of a wetland and the associated values depend on a complex set of relationships between the wetland and the other ecosystems in the watershed. A watershed is a geographic area in which water, sediments, and dissolved materials drain from higher elevations to a common low-lying outlet point on a larger stream, lake, underlying aquifer, or estuary. The combination of shallow water, high nutrient levels, and productivity is ideal for the development of organisms that form the foundation of the food chain. Birds and mammals rely on wetlands for food, water, and shelter, especially during migration and breeding. Wetlands store carbon within their plant communities and soil instead of releasing it to the atmosphere as carbon dioxide. Thus, wetlands help to moderate global climate conditions. Typical wetland functions are listed in Section 3 of this document.

The history of wetlands loss is well documented, and the need for wetlands protection and mitigation is well understood. Wetland ecology is scientifically complex, however, and at times the need for wetlands legislation and regulation outpaces the underlying science. We are trying to replicate the diversity of natural wetland systems with science and engineering. However, the fewer engineering controls on the hydrology, fauna, and soils, the less maintenance a mitigation wetland requires, and the more natural and passive the maintenance becomes.

The Clean Water Act (CWA) is a 1977 amendment to the Federal Water Pollution Control Act of 1972, which set the basic structure for regulating discharges of pollutants to waters of the United

Figure 1-2. Wetlands creation in progress (courtesy Charles Harman, AMEC Earth & Environmental).

States. The CWA's objective is to restore and maintain the chemical, physical, and biological integrity of the nation's waters (Federal Water Pollution Control Act, Public Law 92-500). The CWA charges the U.S. Army Corps of Engineers (USACE), or a delegated state, to oversee and provide protection of U.S. waters through this or equivalent state laws. Wetlands are included as waters of the United States. Since wetlands improve water quality through nutrient recycling and sediment trapping and retention, it is universally accepted that the objectives of the CWA cannot be achieved without protection of wetlands.

The CWA prohibits discharges of material such as soil or sand into U.S. waters unless authorized by a permit issued under Section 404 of the CWA or by an equivalent state program. Under this approval, "no-net-loss" policies require that damage be mitigated using wetland restoration, wetland creation, or wetlands enhancement (NRC 2001).

This guidance has been developed by the Interstate Technology & Regulatory Council (ITRC) Mitigation Wetlands Team members, with input from ITRC's federal partners, other federal and state agencies, private parties, national resource protections groups, and local communities.

1.1 Historic Concerns with Mitigation Success

Once regarded as wastelands, wetlands are now considered a valuable ecosystem. By the 1980s as much as 50% of the original wetlands resources in the United States had been lost, and they were disappearing at a rate of approximately 300,000–400,000 acres per year (NJDEP 2002). According to the U. S. Fish and Wildlife Service (FWS), 53% of the conterminous United States' presettlement wetland area was lost between 1780 and 1980 (Dahl 2000). The rate of loss has decreased over the past 20 years.

1.2 Problem Statement

While the rate of wetland loss has decreased over the last 20 years, only about 30%–50% of wetlands mitigation projects are considered successful in replicating the functions and values of original wetlands. Mitigation projects have failed for a variety of reasons:

- The mitigation was never done, suggesting a lack of regulatory oversight.
- Hydrodynamics are not designed correctly, so the wetlands will never develop and survive.

- Mitigation sites are not built according to the plans (e.g., improper grading, soil amendments, and/or planting).
- Soils are compacted, with an adverse effect on wetland hydrology and plantings.
- Invasive species colonize the site and out-compete target plant communities.
- Plant material is lost to herbivory by wildlife such as deer, rodents, and geese.
- Clear performance standards are not written in the permit document.
- Maintenance of the mitigation site is lacking, resulting in problems such as illegal dumping in the area. All-terrain vehicle traffic can damage the plant community and cause erosion.
- Soils are unsuitable for the species/community/functions to be replaced (DeWeerdt 2004).
- Ecological requirements are not fully or correctly understood during the design process (DeWeerdt 2004).

Based on a review of the professional literature, case studies, and recent field research, example checklists have been developed to evaluate and document habitat health and measure performance of mitigation wetlands. These can provide a standard set of attributes that developers, consultants, regulators, and communities can use to monitor mitigation wetlands in their areas of responsibility.

There is abundant literature on mitigation wetlands. However, there is no single source of information or flow diagram describing characterization, design, construction, and monitoring logic. Figure 1-3 is a flow diagram of the decision points in the process of mitigation selection, design, construction, and monitoring. The ITRC Mitigation Wetlands Team does not intend, through this guidance, to affect policy, change regulations, or disregard past experience. This guidance is intended rather to identify and simplify the technical elements of sound characterization, design, construction and monitoring of wetlands mitigation projects. By providing a document which offers a “hands on” approach, the team hopes to increase the success of mitigation projects.

1.3 Wetlands Overview

The scientific literature recognizes that wetlands are unique and sensitive ecological units that fill a valuable role in their niche as a transitional zone between terrestrial and aquatic ecosystems (Mitsch and Gosselink 1992). Functionally, wetlands play a role in flood conveyance, flood storage, and sediment control as barriers to waves and erosion and as spawning grounds for fish and shellfish. Other functions include recreation, waterfowl and wildlife habitat, and improvement of water quality (NWPF 1988). Wetlands can be found along coasts, in forests, and along rivers and creeks. They can be found anywhere that the saturated soil conditions necessary for wetlands development exist.

The CWA defines wetlands as “those areas that are inundated or saturated by surface or groundwater at a frequency or duration sufficient to support, and that under normal circumstances does 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). “Wetland” can refer to marshes, swamps, bogs, and fens, all of which are characterized by frequent or prolonged presence of water at or near the surface, soils formed under saturated conditions, and habitation by plants adapted to saturated soil conditions.

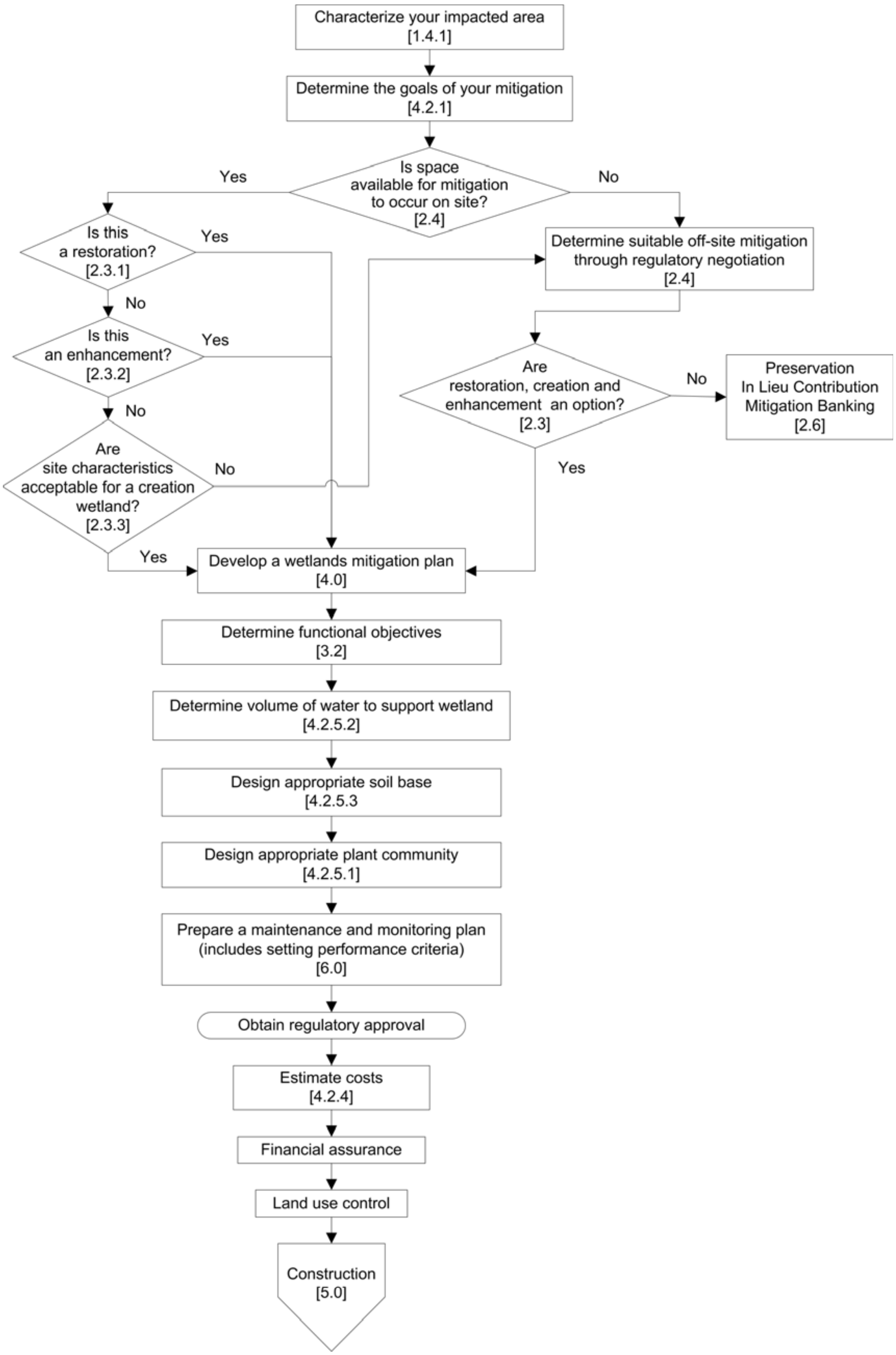

Figure 1-3. Decision tree for wetlands mitigation.

1.3.1 Wetland Characterization

Wetlands are generally characterized by the presence of three basic parameters: soils, hydrology, and vegetation. Water is present at the surface or within the root zone for at least a portion of the growing season. As a result of the saturated conditions, the soils present in wetlands develop characteristics that are different from those of upland soils. Consequently, wetlands support vegetative species that are adapted to living in wet conditions. The following sections more thoroughly describe the parameters used to identify and characterize wetlands.

1.3.1.1 Hydrology

"Hydrology is probably the single most important determinant for the establishment and maintenance of specific types of wetlands and wetland processes" (Mitsch and Gosselink 1992). It is the permanent or periodic saturation of a wetland area that results in the anaerobic conditions in the soil under which typical wetland biogeochemical processes occur. These processes are what result in the development of characteristic wetland soils, which support a dominant plant community adapted to living in saturated soils. The hydrologic state of a wetland can be represented by a hydrologic budget, which is essentially the difference in the amount of water moving into the wetland and the amount moving out. Wetland water budgets are influenced by the balance between inflows and outflows of water; surface contours of the landscape; and subsurface soil, geology, and groundwater condition (Mitsch and Gosselink 1992). Section 4.2.5.2 provides a more detailed discussion of water budgets.

The hydrologic component of a wetland is considered to be present when there is sufficient inundation or saturation of the near-surface soils to produce anaerobic conditions during portions of the growing season. During the periods when inundation or saturation is not present, a number of characteristics (e.g., hummocking, aerial roots, oxidized roots, stained leaves) can be used to determine whether wetlands hydrology exists.

1.3.1.2 Soils

Soils consist of unconsolidated, natural material that supports or is capable of supporting plant life. The upper limit is air, and the lower limit is either bedrock or the limit of biological activity. Soils are generally divided into two different types, mineral and organic. Soils can be further categorized based on the amount of moisture present. Under wetland conditions, soils are considered to be hydric. Hydric soils are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in the upper portion. Hydric soils are developed under sufficiently wet conditions to support the presence of vegetation typical to wet areas (hydrophytic vegetation).

A soil profile consists of various soil layers described from the surface downward. These layers, called "soil horizons," are generally oriented approximately parallel to the soils surface. A soil horizon usually is differentiated from contiguous horizons by characteristics (e.g., color, structure, texture) that can be seen or measured in the field. Soil horizons can be divided into major classifications called the "master horizons," designated with the letters O, A, E, B, C, and R. The depth and content of these horizons varies greatly depending on the type and location of the soil.

The O horizon is a layer of soil dominated by organic material. The O layer often consists of undecomposed or partially decomposed leaf litter, mosses, lichens, and twigs that have been deposited on the surface. The A horizon, usually referred to as the "surface soil" or "topsoil," is a zone under the O horizon in which organic material is being added. This horizon often has the characteristics of cultivation and other disturbances. Under the A horizon is the E layer, a mineral horizon in which the loss of silicate, clay, iron, aluminum, or a combination, has resulted in a concentration of sand and silt. The E horizon is usually darker than the B horizon located below it. The B horizon is a zone of maximum accumulation of materials from the A horizon. It is usually characterized by higher clay content and/or more pronounced soil structure development and lower organic matter than the A horizon.

Under the B horizon is the C horizon, consisting of unconsolidated parent material. In this horizon, the unconsolidated parent material has not been sufficiently weathered to exhibit characteristics of the B horizon. Clay content and degree of soil structure development in the C horizon are usually less than in the B horizon. The last major horizon, the R horizon, consists of consolidated bedrock.

Because of the saturation characteristic to a wetland environment, soils tend to develop certain characteristics found only in wetlands. Again, these unique characteristics result from the influence of anaerobic conditions induced by permanent or periodic saturation. For example, anaerobic conditions result in a reducing environment, thereby lowering the reduction/oxidation (redox) potential for a soil. This condition results in the chemical reduction of some of the soil components, such as iron and manganese, leading to the development of soil colors indicative of wetland soils.

Other soil characteristics—such as high organic content, gleying, histic epipedons, sulfidic materials, aquic or peraquic moisture regime, and iron or manganese concretions—are also indications of a hydric soil condition. Gleyed soils develop when anaerobic soil conditions result in chemical reduction of iron, manganese, and other elements. This process results in characteristic bluish, greenish, or grayish colors. A histic epipedon is an 8–16-inch soil layer at or near the surface that is saturated with water for 30 consecutive days or more in most years and contains a minimum of 20% organic matter when no clay is present or a minimum of 30% organic matter when 60% or greater clay is present. Soils with histic epipedons are saturated for sufficient periods of time to prevent decomposition of the organic surface. An aquic or peraquic moisture regime is characterized by groundwater at the water surface and soil totally free of dissolved oxygen. Iron or manganese concretions are soft masses of these elements that are sometimes segregated during oxidation-reduction processes.

The indicators described above cannot be applied to sandy soils due to their unique nature. Sandy soils are determined to be hydric based upon the presence of high organic content in the surface horizon, vertical organic streaking in the lower horizons, or the presence of wet spodosols (deep organic layers at the typical water table).

1.3.1.3 Wetland Plants

Wetland ecosystems support plant communities dominated by species that are able to tolerate either permanent or periodic saturation. In general, plants can be divided into either herbaceous or woody vegetation. Herbaceous plants are those soft-stemmed plants devoid of woody tissue that often dies back to the soil surface on an annual basis. Based on types of life forms, herbaceous wetland plants can be divided into those hydrophytes that are attached to the soil or sediment substrate and those species that are free-floating. Attached species include emergent species, floating-leaved plants, and submerged plants. Emergent plants are those species in which at least a portion of the foliage and all of the reproductive structures extend above the surface of any standing water. Typical of this type of plant include cattails (*Typha* sp.), rushes (*Juncus* sp.), and sedges (*Carex* sp.). Emergent species are usually found in shallow water or on saturated soils.

Floating-leaved plants have leaves that float on the surface of the water and are attached to the bottom by long stalks. These species are usually found in shallow-water habitats ranging 12–40 inches deep. Typical of this type of plant are water lilies (*Nymphaea* sp.) and spatterdock (*Nuphar* sp.). Submerged plants are those species in which all foliage is underwater. These includes eelgrass (*Zostera* sp.) and pondweed (*Potamogeton* sp.). Floating herbaceous hydrophytes are those species, such as duckweed (*Lemna* sp.), that float on the surface of the water and do not contact the underlying substrate.

Woody species are generally divided into either trees (greater than 20 feet tall) or shrubs (3–20 feet tall). Trees and shrubs are generally found on exposed, saturated soils, though in a few exceptions (bald cypress, *Taxodium distichum*) they can be found in standing water. Woody wetland species generally are characterized by physiological features, such as knees, adventitious roots, prop roots, expanded lenticels, and buttress swellings that allow for the interchange of oxygen in saturated, anaerobic conditions. Some of the more common wetland trees and shrubs include maples (*Acer* sp.), gums (*Nyssa* sp.), willows (*Salix* sp.), mangroves (*Rhizophora* sp.), and blueberry (*Vaccinium* sp.).

1.3.2 Wetland Classifications

Wetlands can be classified in a variety of manners. Historically, wetlands have been divided into freshwater and estuarine types (Mitsch and Gosselink 1992, Dennison and Berry 1993). Freshwater wetlands are generally divided into swamps, bogs, marshes, and deep-water systems. Estuarine wetlands include tidal flats, salt marshes, and mangrove swamps. Table 1-1 presents an overview of some of the common wetlands classification systems in use today.

The most common means of characterizing wetlands is under the system developed by Cowardin and others for the U.S. Fish and Wildlife Service. As described in *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al. 1979), wetlands types can be broken into five basic categories: marine, estuarine, riverine, lacustrine, and palustrine. The major categories or systems are based mostly on the hydrologic base for the wetlands. Each of these systems can be further broken down into subsystems, classes, subclasses, and dominance types based on the type of vegetation present and/or the bottom substrate for the wetlands.

Table 1-1. Overview of various wetland classification terms

USFWS Circular 39 (1956) (Number and type)	Golet and Larson (1974) (Wetland class)	Cowardin et al. (1979) (System and subsystem)	Hydrogeomorphic (1993)
1. Seasonally flooded basins or flats	Open water	Marine	Riverine
2. Fresh meadows	Deep marsh	*Subtidal*	Depressional
3. Shallow fresh meadows	Shallow marsh	*Intertidal*	Slope
4. Deep fresh marshes	Seasonally flooded flats	Estuarine	Mineral soil flats
5. Open freshwater	Meadow	*Subtidal*	Organic soil flats
6. Shrub swamps	Shrub swamp	*Intertidal*	Estuarine fringe
7. Wooded swamps	Wooded swamp	Riverine	Lacustrine fringe
8. Bogs	Bog	*Tidal*	
9. Saline flats		*Lower Perennial*	
10. Saline marshes		*Upper Perennial*	
11. Open saline water		*Intermittent*	
12. Shallow fresh marshes		Lacustrine	
13. Deep fresh marshes		*Limnetic*	
14. Open freshwater		*Littoral*	
15. Salt flats		Palustrine	
16. Salt meadows			
17. Irregularly flooded salt marshes			
18. Regularly flooded salt marshes			
19. Sounds and bays			
20. Mangrove swamps			

This table is simply a compendium of classification schemes and is not intended to be a comparison.

Marine wetlands include the open ocean overlying the continental shelf and the associated coastline. Estuarine wetlands consist of deepwater tidal flats and adjacent tidal wetlands that are usually mostly enclosed by land but have at least sporadic access to the open ocean. The water associated with these wetlands is at least occasionally diluted by freshwater and generally extends from a point upstream where the salinity level is 5 parts per thousand (ppt) to the seaward limit of wetland emergent species (Cowardin et al. 1979).

Riverine wetlands include all wetlands and deepwater habitats found within a river channel, with the exception of wetlands dominated by trees, shrubs, persistent emergent species, emergent mosses, and lichens. Palustrine wetlands include all nontidal wetlands dominated by trees, shrubs, persistent emergent species, emergent mosses, or lichens. Palustrine wetlands are bounded by uplands or any other type of wetlands and may be situated shoreward of lakes or river channels or in floodplains. Lacustrine wetlands include wetlands and deepwater habitats found in topographic depressions or dammed river channels, which lack trees, shrubs, emergent species, mosses, or lichen and exceed 20 acres in size. Riverine, palustrine, and lacustrine wetlands are all generally freshwater systems (Cowardin et al. 1979).

Several more detailed classification systems have been developed, particularly for use in the wetlands regulatory arena. One published system (Brinson 1993) divides wetlands into a series of categories solely based on the geomorphic setting. These types include riverine, fringe, depressional, and peatland. This system is different from most others in that it does describe certain functions as part of the classification process.

Under Brinson's system, depressional wetlands are wetlands located in a depression in the landscape so that catchment area for surface runoff is generally small. Depressional wetlands are usually located at the headwater of a local drainage. Depressional wetlands include kettles, potholes, vernal pools, and Carolina bays. Riverine wetlands form as linear strips throughout the landscape along rivers, creeks, streams and other moving bodies of water. Fringe wetlands occur in estuaries where tidal forces dominate or in lakes where water moves in and out of the wetlands from the effects of wind and waves. Peatlands are wetlands dominated by a peat substrate. These types of wetlands include blanket bogs and tussock tundra.

Dennison and Berry (1993) define commonly used terminology for describing various types of wetlands. Those terms are as follows:

Marshes are wetlands frequently or continually inundated with water, characterized by emergent soft-stemmed vegetation adapted to saturated soil conditions. Many different kinds of marshes exist, ranging from the prairie potholes to the Everglades, coastal to inland, freshwater to saltwater. All receive most of their water from surface water, but many are also fed by groundwater. Nutrients are plentiful, and the pH is usually neutral, leading to an abundance of plant and animal life. This publication divides marshes into two primary categories: tidal and nontidal.

Tidal marshes are found along coastlines in middle and high latitudes. They are most prevalent in the United States on the eastern coast from Maine to Florida and continuing on to Louisiana and Texas along the Gulf of Mexico. Some wetlands are characterized by freshwater. Some others are brackish, and still others are saline, though the motion of ocean tides influences both of them. These are generally categorized into two distinct zones, the lower or intertidal marsh and the upper or high marsh.

Nontidal marshes are the most prevalent and widely distributed wetlands in North America. They are mostly freshwater, although some are brackish. They frequently occur along streams in poorly drained depressions and in the shallow water along the boundaries of lakes, ponds, and rivers. Water levels in these wetlands generally vary from a few inches to 2 or 3 feet, and some marshes, like prairie potholes, may periodically dry out completely.

Easy to recognize, nontidal marsh have highly organic, mineral-rich soils of sand, silt, and clay with emergent plant species such as cattails, rushes, and sedges. They provide excellent habitat for wildlife such as red-winged blackbirds (*Agelaius phoeniceus*) and great blue herons (*Ardea herodias*) and small mammals such as river otters (*Lutra canadensis*) and muskrats (*Ondatra zibethica*). Prairie potholes, playa lakes, vernal pools, and wet meadows are all examples of nontidal marshes.

Swamps are any wetland dominated by woody plants. There are many different kinds of swamps, ranging from the forested red maple swamps of the Northeast, to the widespread bottomland hardwood forests found along the rivers of the Southeast. Swamps are characterized by saturated soils, and standing water during certain times of the year. Organic soils of swamps form a thick, black, nutrient-rich environment for the growth of water-tolerant trees such as bald cypress (*Taxodium distichum*), Atlantic white cedar (*Chamaecyparis thyoides*), and black gum (*Nyssa sylvatica*). Swamps have two major classes, shrub swamps and forested swamps. Many species of plants, birds, fish, and invertebrates require swamp habitats. Rare species, such as the American alligator (*Alligator mississippiensis*), depend on these swamps.

Shrubs such as buttonbush (*Cephalanthus occidentalis*) or speckled alder (*Alnus rugosa*) dominate some swamps. Since forested and shrub swamps are similar, they are often found adjacent to one another. The soil is often saturated for much of the year and covered by as much as a few feet of water at other times. Shrub swamps are commonly found along slow-moving streams and in floodplains. Mangrove (*Rhizophora* sp.) swamps are a type of shrub swamp dominated by mangroves that covers much of southern Florida.

Forested swamps exist throughout the United States. These systems often receive floods from nearby rivers and streams such that they are sometimes covered by many feet of very slowly moving or standing water. In dry years they may represent the only shallow water, and they become critical to the survival of wetland-dependent species. Common trees in forest wetlands are red maple (*Acer rubrum*) and pin oak (*Quercus palustris*) in the northern United States, overcup oak (*Quercus lyrata*) and bald cypress in the South, and willows and western hemlock (*Tsuga heterophylla*) in the Northwest. “Bottomland hardwood swamp” is a name commonly given to forested swamps in the south-central United States.

Bogs are North America's most distinctive kind of wetlands (Figure 1-4). Characterized by spongy peat, acidic waters, and thick sphagnum moss, bogs receive all or most of their water from precipitation rather than from runoff, groundwater, or streams. Correspondingly, bogs are low in the nutrients. Bogs can form as sphagnum moss grows over a lake or pond and slowly fills it ("terrestrialization"), or they can form as sphagnum moss blankets on dry land that prevents water from leaving the surface ("paludification").

Over time, many feet of acidic peat deposits build up. The uniquely demanding physical and chemical characteristics of bogs result in plant and animal communities, which demonstrate special adaptations to low nutrient levels, saturated conditions, and acidic waters.

Figure 1-4. Example of a bog (courtesy Charles Harman, AMEC Earth & Environmental).

Fens are peat-forming wetlands that receive nutrients from sources other than precipitation, usually from up-slope drainage, surrounding mineral soils, and groundwater movement. Fens are less acidic and have higher nutrient levels than bogs. Consequently, they are able to support a more diverse plant and animal community. Grasses, sedges, rushes, and wildflowers often cover these wetlands. Some are characterized by parallel ridges of vegetation separated by less productive hollows. Ridges of these patterned fens form perpendicular to the downslope direction of water movement. Over time, peat may build up and separate the fen from its groundwater supply. When this happens, the fen receives fewer nutrients and may become a bog.

2. WETLAND MITIGATION OVERVIEW

Compensatory wetland mitigation requires the permittee to "replace aquatic resource functions unavoidably lost or adversely affected by authorized activities" (USACE 2002). However, the concept of wetland mitigation is frequently misunderstood. Literally, "to mitigate" means "to make less severe or painful, to moderate." The Council on Environmental Quality has defined mitigation in regulation at 40 CFR 1508.20 to include avoiding impacts, minimizing impacts, rectifying impacts, reducing impacts over time, and compensating for impacts. In a practical sense, mitigation of wetland impacts follows the following sequence (called "mitigation sequencing") ("Memorandum of Agreement between the Environmental Protection Agency [EPA] and the Department of the Army Concerning the Determination of Mitigation under the Clean Water Act Section 404(b)(1) Guidelines," 1990):

1. **Avoidance—**Allows permit issuance for only the least environmentally damaging practicable alternative.
2. **Minimization**—Appropriate and practicable steps to minimize adverse impacts will be required through project modifications and permit conditions.
3. **Compensatory Mitigation**—Appropriate and practicable compensatory mitigation is required for unavoidable adverse impacts which remain after all appropriate and practicable minimization has been required. Compensatory mitigation includes
   a. **restoration** of existing degraded wetlands through either reestablishment or rehabilitation; if impractical then
   b. **enhancement** of an existing wetland to improve its physical, chemical or biological characteristics to heighten, intensify, or improve specific wetland function; if impractical then
   c. **preservation** of a wetlands site by removing the threat to, or preventing the decline of, a wetland by an action in or near a wetland; and finally and only under special circumstances
   d. **establishment** (creation) of a wetland in an upland or deepwater site where a wetland did not previously exist.

In some states establishment is the preferred practice before considering preservation; however, there are circumstances where preservation benefits are significant (e.g., in highly populated areas of New Jersey, attempting to create an upland or deepwater wetlands yields less functional value than preserving a nearby wetlands and ensuring no further development occurs.)

USACE or a state with an EPA-approved program is vested by the CWA with the authority to issue permits requiring mitigation of wetlands damage or losses (NRC 2001). Nationally, the goal is to achieve no net loss of the value and function of the nation's natural wetlands. The permitted action must demonstrate the practicality of establishing appropriate compensatory mitigation wetlands to replace the functional losses to aquatic resources. Recently, and as a result of a review by the National Research Council (NRC 2001), USACE—along with many federal, state, tribal representatives, and other interested parties—developed a National Mitigation Action Plan (MAP) to further achieve the no-net-loss goal and undertake actions to improve ecological performance at mitigation sites.

2.1 National Mitigation Action Plan

The MAP developed the goals and implementation schedule for 17 action items, including development and publication of a Regulatory Guidance Letter (RGL) 02-2 (USACE 2002), replacing RGL 01-1 (USACE 2001). RGL 02-2 includes the following major issues:

- using a watershed approach,
- increasing use of functional assessments methods for impacts and mitigation,
- stream mitigation,
- revised definitions of mitigation,
- preservation and buffers as mitigation,
- list of issues to be included in mitigation plans, and
- use of NRC criteria (see USACE 2002, Appendix B).

The basic premise of the watershed approach is to consider the entire system, in this case the watershed, and the interrelated parts to protect the aquatic resource within. The basis for defining the watershed remains the Hydrologic Unit Codes (HUC) maintained by the U.S. Geological Survey (USGS). Compensatory mitigation is determined based on an assessment at the watershed level including a variety of impacts such as corridors, hydrology, mixed habitat, etc. There are some current drawbacks leading to additional needs to fully recognize the value of this broad approach. A geographic information system (GIS) database is required to fully implement the watershed-based mitigation approach, and it is 3–5 years away (USACE 2004).

A functional assessment should be used when and where available to assess the impact and to establish the mitigation requirements. When a functional assessment is unavailable or the results are suspect, the conventional acreage surrogate (mitigation ratio) should continue to be used. A functional assessment retains the objective that, at a minimum, a 1:1 functional replacement with an adequate margin of safety be established. RGL 02-2 notes that qualified professionals should determine the impacts and compensatory mitigation requirements and should score the wetland's function using aquatic site assessment techniques such as hydrogeomorphic assessment or Wetland Rapid Assessment Procedure (Schneider and Sprecher 2000). These serve only as examples and are not universally recommended or adopted. Assessment techniques should be generally accepted by experts in the field, rely on best professional judgment, and consider ecological functions included in 404(b)(1) Guidelines (see NRC 2001, Appendix H).

When a functional assessment of a watershed is employed, it makes sense—if not requires—that stream mitigation be included. However, when a functional assessment is unavailable, a 1:1 minimum ratio based on linear feet of impacts with an adequate margin of error is the surrogate.

USACE does its best to discuss compensatory mitigation proposals with applicants during preapplication consultation (USACE 2002). The permit process should be initiated at the lowest authorized government level and begin prior to plan development, thus encouraging adequacy in mitigation design schedule. This approach will likely reduce cost and streamline the schedule.

2.2 When to Mitigate

When there is a proposal to discharge dredged or fill material into a wetland, the CWA expects USACE, in cooperation with other authorities, to consider the public interest consequences of issuing a permit. In practical terms, implementation of Section 404 and related programs has followed a general policy that the deliberate discharge of materials must be avoided where possible or minimized when unavoidable. Then if a permit is issued and wetland function is compromised, a compensatory mitigation wetland may be required to replace the loss of the wetlands functions in the watershed (NRC 2001). District USACE can account for functional changes by recording them as site-specific credits and debits (functional change) as follows:

- Functional credit—a unit of measure, e.g., functional capacity unit in the Hydrogeomorphic Assessment Method, representing the gain of aquatic function at a compensatory mitigation site; the measure of function is typically indexed to the number of acres of resources restored, established, enhanced, or protected as compensatory mitigation.

- Functional debit—a unit of measure, e.g., a functional capacity unit in the Hydrogeomorphic Assessment Method, representing the loss of aquatic function at a project site; the measure of function is typically indexed to the number of acres impacted by issuance of a permit.

Regulations require appropriate and practical compensatory mitigation to replace functional losses to aquatic resources, including wetlands (USACE 2002). USACE considers the following to determine the practicality of compensatory mitigation:

- availability of suitable locations,
- constructability,
- overall costs,
- technical requirements, and
- logistics.

Focusing on the functionality of a wetlands relative to its interrelationships in a watershed and establishing functional goals for compensatory mitigation in most cases provides a more accurate and effective method to achieve the no-net-loss environmental performance objectives.

2.3 Types of Mitigation

Mitigation is the restoration, enhancement, preservation, or creation of wetland functions lost through dredging or fill. Compliance may require that more acres be restored, enhanced, preserved, or created to compensate for the loss at the impacted wetlands. This practice is referred to as the "mitigation ratio" and is defined by USACE as follows: "[M]itigation should provide, at minimum, 1:1 functional replacement (i.e., no net loss of values), with an adequate margin of safety to reflect the expected degree of success associated with the mitigation plan. This ratio may be greater where the functional values of the area being impacted are demonstrably high and the replacement wetlands are of lower functional value or the likelihood of success of the mitigation project is low." California ratio guidelines incorporate these principles in its guidelines for mitigation impacts to streams as described in Table 2-1.

Table 2-1. California Department of Fish and Game, South Coast Region guidelines for wetlands mitigation

Ratio	Valuation	Example
1:1	Low-value habitat	Isolated freshwater marsh, unvegetated stream
2:1	Medium-value habitat	Disturbed mulefat scrub, highly disturbed willow riparian
3:1	High-value habitat	Willow riparian, possibly with some exotics, rare/unique habitats
5:1	Endangered species habitat	Mature willow riparian with least Bell's vireo
5:1	Impacts beyond permitted in the SAA/violations	This can vary, depending on the quality, temporal loss, location, etc., but should have a compensatory factor in addition to the above guidelines of 1:1 to 5:1

Source: NRC 2001, contribution by William Tippets, Habitat Conservation Supervisor, California Department of Fish and Game, South Coast Region.

2.3.1 Wetlands Restoration

Restoration is the manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural or historic functions to a former or degraded wetland. For the purpose of tracking net gains in wetland acres, restoration is divided into categories:

- Reestablishment—The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural or historic functions to a former wetland. Reestablishment results in rebuilding a former wetland and results in a gain in wetland acres.
- Rehabilitation—The manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing natural or historic functions of a degraded wetland. Rehabilitation results in a gain in wetland function but does not result in a gain in wetland acres (USACE 2002, 2004).

If a wetland has been affected so that it no longer functions as a wetland, it can be restored to its original condition. For every acre of impacted wetland, the functional equivalent of that impact must be restored. This approach is generally expected to be more successful than wetland creation because the area once served as a wetland. Soil characteristics, water levels, elevations and other factors favor wetland restoration. Project planning begins with the formulation of goals and objectives, ensuring that those actions that are most likely to achieve restoration success will be implemented.

2.3.2 Wetlands Enhancement

The manipulation of the physical, chemical, or biological characteristics of a wetland (undisturbed or degraded) site to heighten, intensify, or improve specific function(s) or to change the growth stage or composition of the vegetation present is wetland enhancement. Enhancement is undertaken for specified purposes such as water quality improvement, flood water retention, or wildlife habitat. Enhancement results in a change in wetland function(s) and can lead to a decline in other wetland functions but does ***not*** result in a gain in wetland acres. This term includes activities commonly associated with enhancement, management, manipulation, and directed alteration (USACE 2002).

In this type of mitigation, the environmental value of a previously impacted wetland can improve. This goal is often achieved by removing exotic plant species, which pose a threat to natural systems by destroying positive or native wetland habitats, reducing wildlife food sources, and altering fire and drainage patterns.

2.3.3 Wetland Establishment

Establishment (creation) is the manipulation of the physical, chemical, or biological characteristics of a site where a wetland did not previously exist. Establishment results in a ***gain*** in wetland acres (USACE 2002). Establishment of a wetland is currently receiving wide attention in the United States as an important tool for mitigating the impact of development in many situations, such as coastal wetland.

2.3.4 Wetland Preservation

Protection/maintenance (preservation) is the removal of a threat to, or preventing the decline of, wetland conditions by an action in or near a wetland. This term includes the purchase of land or easements, repairing water control structures or fences, or structural protection such as repairing a barrier island. Preservation does **not** result in a gain of wetland acres and is used only in exceptional circumstances. However, this type of mitigation offers improved protection of important ecosystems. Preservation can include land donations and conservation easements that prohibit activities harmful to the resource or other comparable land-use restrictions of wetlands, other surface waters, or uplands. Since preservation alone is not enough to offset adverse impacts, it is most frequently used in combination with establishment or restoration types of mitigation.

2.3.5 Upland Buffers

Upland buffers are upland or riparian areas that separate wetlands or other aquatic resources from development or agricultural areas. They should be used as mitigation when they protect or enhance the functions of the adjacent wetlands or aquatic areas. In limited application upland buffers can be used as the sole basis for mitigation but are generally included in an overall mitigation strategy. Buffers typically consist of native plant communities that reflect the local landscape and ecology. They provide a variety of habitat functions for wildlife and other organisms, runoff filtration (ITRC 2003), moderation of water temperature changes, and detritus for aquatic food webs (USACE 2002).

USACE districts may require upland buffers to ensure that the overall mitigation protect performs as expected.

2.4 On-Site, Off-Site Mitigation and Credit

Compensatory mitigation should first be considered adjacent to or contiguous with the compromised wetland site and within the same watershed where practicable. This arrangement is considered on-site mitigation. On-site mitigation is important to compensate for local flood control, unique wildlife habitat, or other locally important functions of the wetland. However, off-site compensatory mitigation can be used when it is otherwise impractical to attempt on-site compensatory mitigation or on-site mitigation doesn't appear beneficial or doesn't improve the ecological condition of the site. Off-site mitigation should be in the same general vicinity or close to the impacted wetlands site. A mixture of on-site and off-site compensatory wetlands can be considered as well; however, the functional scoring should be the basis for the type and amount of on-site and off-site compensatory mitigation. Choosing between the two or establishing the appropriate mix should consider

- the likelihood of success,
- ecological sustainability,
- practicality of long-term monitoring,
- maintenance or operation and maintenance, and
- the relative cost of mitigation alternatives (USACE 2002).

2.5 In Kind and Out of Kind

"Districts may require in-kind, out-of-kind, or a combination of in-kind and out-of-kind, compensatory mitigation to achieve functional replacement within surrounding watersheds. In-kind compensation for a wetland loss involves replacement of a wetland area by establishing, restoring, enhancing, or protecting and maintaining a wetland area of the same physical and functional type. In-kind replacement generally is required when the impacted resource is locally important. Out-of-kind compensation for a wetland loss involves replacement of a wetland area by establishing, restoring, enhancing, or protecting and maintaining an aquatic resource of different physical and functional type. Out-of-kind mitigation is appropriate when it is practicable and provides more environmental or watershed benefits than in-kind compensation (e.g., if greater ecological importance to the region of impact)" (USACE 2002). See the following links for more information: http://www.epa.gov/owow/wetlands/pdf/RGL_02-2.pdf and http://www.epa.gov/owow/wetlands/pdf/map1226withsign.pdf.

2.6 Buffers

Buffers are upland or riparian areas that separate wetlands or aquatic resources from surrounding upland areas. Buffers provide a variety of habitat functions for wildlife as well as runoff filtration, moderation of water temperatures, and development of detritus for aquatic food chains. Buffers serve to protect wetlands and wetland mitigation sites. Certain states require the incorporation of buffers into the design of mitigation projects. RGL 02-2 (USACE 2002) recommends that individual USACE districts consider the use of wetland buffers in mitigation projects as a means of ensuring the overall success of the project. As of November 2004, USACE was in the process of developing guidance on how wetland buffers could be incorporated into compensatory mitigation projects.

2.7 Mitigation Banking

Mitigation banking is a method of achieving wetland mitigation in advance of permitted impacts. Mitigation banks are generally large wetlands that are restored, enhanced, or created to provide mitigation for smaller wetland impacts. Permittees can purchase wetland credits from an established bank in lieu of doing the mitigation themselves. By purchasing existing credits, permittees do not have any responsibility for the monitoring or maintenance of the wetland.

2.8 Mitigation Fund

In some states money can be collected and deposited into the in-lieu-fee program. The program is responsible for the management and disbursement of dollars from the in-lieu-fee program to finance mitigation projects. The program with those funds has the power to purchase land to provide areas for enhancement or restoration of degraded wetlands, to engage in the enhancement or restoration of degraded wetlands, and to preserve wetlands and transition areas determined to be of critical importance in protecting wetlands.

3. PREDESIGN ASSESSMENT

The first step in mitigation planning and design is to develop a detailed understanding of the functions offered by the wetland for which the permitted action is planned. A functional understanding of the baseline conditions of the wetland will allow for mitigation actions to replicate those functions at some point in the future. The goal of the mitigation is to ensure that the result of the project is no net loss of wetland functions (USACE 2002).

The next step is to determine whether a wetland is present and the total size of the potentially impacted area. Wetland delineation generally defines the boundaries of the wetland using a three-parameter process that focuses on the presence of plants, soils, and hydrology that are typical to wetlands. A complete discussion of delineation is beyond the scope of this document, but information is available from USACE (1987) and Federal Interagency Committee for Wetland Delineation (1989).

In the event that an unavoidable impact to a wetland must occur, a detailed understanding of the entire wetland (in particular the section to be impacted) must be developed to lay the foundation for sound mitigation planning. Dennison and Berry (1993) suggest that the development of a successful wetlands mitigation program include the completion of a functional assessment of the wetlands to be impacted and the preparation of plans based on a detailed understanding of site conditions and project objectives. The ability to successfully restore, enhance, or create wetlands, whether on or off site, is dependent upon a detailed characterization of the wetland to be impacted. The characterization should include not only the physical features of the wetlands, but by extension, the functions that the wetland offers.

The failure to define goals and objectives of a mitigation project and the failure to state quantifiable measures of success can lead to the failure of mitigation. Lack of baseline information on the historic wetlands being disturbed or impacted is often central to such failures. Another common cause of failure is a problem with site hydrology. As hydrology is a defining parameter in wetlands, an understanding of the hydrology of the mitigation site is essential to the success of the project. A review of mitigation projects in south Florida notes that 63% of 40 completed projects had hydrologic problems as a result of design and/or construction deficiencies (Reed and Brown 1992).

This section outlines activities that should be conducted in the early stages of planning a wetlands mitigation project. These activities are intended to be consistent with those requirements and recommendations of USACE (2002) and NRC (2001), as well as with various state guidance programs. Identifying site-specific planning requirements is recommended for sites in discussion with appropriate state and federal agencies at the beginning of the permitting process for the proposed regulated activity.

3.1 Desktop Data Collection

To develop a thorough understanding of the characteristics and functions of a wetland prior to impact and mitigation planning, readily available information from public and private sources should be collected and reviewed:

- aerial photographs;
- topographic maps;
- soil maps;
- flood hazard maps;
- National Wetlands Inventory maps and state wetland maps;
- tax maps (land ownership, easements, etc.);
- stream data from STORET or other sources regarding water flow, depth, and quality; and
- Natural Heritage information regarding rare, threatened, and endangered species.

Critical evaluation of these data will give the assessor an understanding of the potential extent of the wetlands, the watershed in support of the wetlands, and the type of wetland to be found in the area of interest.

3.2 Functional Evaluation of the Wetlands

Wetland functions are those biogeochemical processes that are inherent to a wetland. These functions derive from the hydrological, geological, biological, and chemical characteristics of a wetland (Kent 2001). In some instances, a functional assessment also evaluates values afforded by the wetlands—the societal and ecological benefits provided by wetland functions. Wetland functions that are crucial to the current setting or ecosystem, such as flood flow alteration and sediment stabilization aside from the mitigation wetlands, should be considered in the project.

As noted by Adamus et al. (1987), typical wetland functions include the following:

- Groundwater recharge—Wetlands characterized by large inputs of surface water that pools or saturates at the surface can function as vehicles for significant groundwater recharge. In regions with little rainfall or large areas of impervious surfaces, a wetland that performs this function is considered highly valuable to the groundwater resource.

- Groundwater discharge—Wetlands that exist due to high water tables and/or the presence of springs may be of significant value in performing groundwater discharge functions. In areas where groundwater discharge is important to maintaining downstream channel flow (and perhaps resulting fisheries), wetlands responsible for groundwater discharge are important.

- Flood flow alteration—Some wetlands, such as those located on wide, riverine floodplains, have certain critical physical characteristics that facilitate floodwater diversion and retention.

- Sediment stabilization—Wetlands that are effective at binding soil and dissipating erosion forces due to the presence of substantial rooted vegetation and appropriate hydrology are highly valuable in erosion-prone areas.

- Sediment/toxicant retention—Because of their standing vegetation and slow water flow rates, some wetlands are particularly suited to trapping and retaining inorganic sediments and/or chemical substances. The filtering function provided by these wetlands improves water quality by removing substances that may be toxic to aquatic life.

- Nutrient removal/transformation—In areas where the input of nutrients is high, wetlands that exhibit physical and chemical characteristics that enable them to extract suspended nutrients from the water can be of significant value.

- Production export—Some wetlands provide a net annual production and distribution of plant or other organic material to downstream waters. While this function is potentially beneficial in terms of food supply, it is also a potential detriment, as high production export may result in degraded water quality downstream.

- Wildlife habitat—Wetlands exhibit physical and vegetative characteristics that make them attractive to wildlife, particularly to waterfowl. These characteristics include abundant food sources, protection, climate, etc.

- Aquatic habitat—Wetlands that contain significant areas of open water with varying depths, significant food supplies, and a variety of different vegetative types are often characterized by abundant and diverse aquatic communities. Such wetlands support valuable recreational and commercial fisheries.

- Recreation—Wetlands in which hunting, fishing, bird watching, and other related activities occur can be considered socially significant in terms of their recreational value.

A large number of published methodologies that can be used for evaluating the functions of a wetland are available, but there is no single and universally applicable procedure for all wetlands functional assessments. The method of choice depends on the scope and complexity of the wetland mitigation project and the requirements of the associated state and/or federal agencies involved with the project. In some states, the functional assessment methodology may be stipulated by the permitting agency. For example, Pennsylvania suggests the Wetland Evaluation Technique and/or the Habitat Evaluation Procedure as acceptable methodologies for evaluating wetland functions (PADEP 1995).

Some of the more commonly used methodologies for assessing wetland functions include the following:

- Wetland Evaluation Technique (WET, Adamus et al. 1987)—Developed by USACE, WET provides an economical and reproducible methodology for the assessment of wetland functions and values in terms of social significance, effectiveness, and opportunity. The limitation of this system is that all answers are qualitative and may vary due to the subjectivity inherent in many of the questions. Additionally, results are not estimates of magnitude but rather an estimate of the probability that a function or value actually exists.

- Rapid Assessment of Wetlands (RAW, Kent, Reinmold, and Kelly 1990)—This assessment methodology is a macroscale wetland function and value assessment technique designed for land-use planning efforts.

- Method for the Comparative Evaluation of Nontidal Wetlands in New Hampshire (Ammann and Stone 1991)—This method was designed as a planning tool intended, among other uses, to collect basic information regarding wetlands in a study area. The procedure is based on the collection of field information and the calculation of a functional value index using the size of the wetland as a weighting factor.

- Wetlands Integrated Monitoring Condition Index (Kent et al. 1992)—This assessment methodology was intended to serve as a cost-effective tool for evaluating functions and values as part of wetlands mitigation projects.

- Evaluation for Planned Wetlands (Bartoldus, Garbisch, and Kraus 1994)—This assessment methodology is a rapid assessment procedure to be used in determining whether a mitigation wetland has been adequately designed to achieve wetland function goals through the assessment of six wetland functions.

- The Highway Methodology Workbook Supplement, Wetland Functions and Values, A Descriptive Approach (USACE New England District 1995)—This methodology provides guidance on how to identify and display wetland functions and values acceptable to the USACE New England District.

- An Approach for Assessing Wetland Functions Using Hydrogeomorphic Classification, Reference Wetlands, and Functional Indices (Smith et al. 1995)—This assessment methodology is based on the hydrogeomorphic (HGM) wetland classification system that divides wetlands into a series of categories solely based on the geomorphic setting: riverine, fringe, depressional, and peatland (Brinson 1993). This system is different from most others in that it does describe certain functions as part of the classification process (Smith 1993).

- A Rapid Procedure for Assessing Wetland Functional Capacity (Magee 1998)—This assessment methodology is also based on the HGM wetland classification system developed by Brinson (1993).

A more detailed listing of function evaluation techniques can be found in Schneider and Sprecher 2000 and Bartoldus 1999. Bartoldus' book provides an overview of 40 different functional assessment techniques used throughout the country. State-specific wetland functional requirements can be found at the Association of State Wetlands Managers (ASWM) Web site.

An understanding of the functional aspects of both the existing wetlands and the proposed wetlands is often a determining factor in the amount of wetlands that are considered for mitigation. Wetlands mitigation should not be viewed as simply a 1:1 swap on an area basis, meaning wetlands mitigation is not always functionally equal to an acre of wetlands impacted. Wetlands are viewed as a critical component of the environment because of the unique functions they serve, not just because they are "wet." The wetland's function—not necessarily the acreage—is critical. Wetlands that are being restored, enhanced, or created should mimic the functions of the wetlands being impacted.

3.3 Collection of Field Data in Support of Wetlands Characterization

Figure 3-1. Mitigation site planting (courtesy Charles Harman, AMEC Earth & Environmental).

Detailed characterization of the wetlands should be conducted in the field. The characterization of the wetland can be conducted on either a qualitative or a quantitative basis, depending on the size of the wetlands, the scope of the anticipated mitigation, and permit requirements requested by the associated state or federal agency. In general, the wetland characterization focuses on the evaluation of the three basic parameters used for wetlands delineation, vegetation, hydrology, and soils. Technical approaches for conducting these assessments can be found in USACE 1987 and Federal Interagency Committee for Wetland Delineation 1989. The following sections briefly describe the characterization of wetlands in support of the development of a mitigation plan.

3.3.1 Characterization of Wetland Vegetation

In advance of the preparation of a wetlands mitigation plan, the existing vegetation found within the wetland to be disturbed should be detailed as it relates to wetlands functions. Standard vegetative assessment techniques should be used in conducting either qualitative or quantitative assessments of the vegetative communities within the existing wetlands. Depending on the permit and mitigation requirements, the vegetative parameters that should be considered and evaluated include the following:

- species composition;
- description of community stratification (e.g., number of vegetative layers in the community and their percent cover);
- relative frequency, dominance, and abundance of each individual species; and
- presence of exotic or invasive species.

In addition, the wetland indicator for each species in the wetland should be identified. FWS has compiled data on the habitat characteristics of plants of the United States. This list categorizes plant species by their frequency of occurrence in a wetland habitat, and these categories are as follows:

- obligate wetland plants (OBL) are species that occur almost exclusively in wetlands (>99% of the time),
- facultative wetland plants (FACW) are species that usually occur in wetlands (67%–99%),

- facultative plants (FAC) are species that are equally likely to occur in wetland or nonwetland (34%–66%),
- facultative upland plants (FACU) are species that usually occur in nonwetlands (67%–99%), and
- upland plants (UPL) are species that occur almost exclusively in uplands (>99%).

The wetland communities within the projected wetland to be impacted should be categorized in accordance with wetland classification schemes such as in Cowardin et al. 1979. Vegetative assessment techniques can be found in Bonham 1989 and Kent and Coker 1992. Vegetative assessment techniques specific to wetlands are described in EPA 2002.

3.3.2 Characterization of Wetland Hydrology

The existing hydrology of a wetland to be impacted must be characterized, especially for mitigation projects based on restoration or enhancement that intend to duplicate an existing hydrological regime. The hydrologic state of a wetland can be represented by a hydrologic budget, which is essentially the difference between the volumes of water moving into and out of the wetland. Wetland water budgets are influenced by the balance between inflows and outflows of water, surface contours of the landscape and subsurface soil, geology, and groundwater condition (Mitsch and Gosselink 1993).

The water budget for a wetland can be calculated using several methods, including that described by Pierce (1993). He defines the hydrology of a wetland as the water input per unit time, minus the water output per unit time. To support a viable wetland, the storage change of the wetland generally needs to be positive (more input than output) over the unit time. It is particularly important that storage be positive over the period of the growing season.

The formula for water budget calculation, as volumetric rate for the wetland area, is as follows:

$$P + SWI + GWI = ET + SWO + GWO + S ,$$

where

P = precipitation,
SWI = surface water input,
GWI = groundwater input,
ET = evapotranspiration,
SWO = surface water outflow,
GWO = groundwater outflow,
S = change in storage.

As part of this calculation, detailed information on the following hydrological parameters should be calculated:

- water sources,
- seasonal water depth,

- seasonal water duration,
- timing of inundation and/or saturation,
- percent open water,
- water flow,
- depth of surface water, and
- watershed.

Characterization of the water budget for a wetland can be estimated through modeling and the collection of desktop information from sources such as the National Climatic Center and USGS. Quantitative data regarding subsurface water conditions can be collected through the use of piezometers or monitoring wells. Sprecher (2000) provides a detailed description regarding the construction of monitoring wells in wetlands, as well as recommendations on categorizing wetland water budgets.

3.3.3 Characterization of Wetland Soils

Baseline characterization of the soils of a wetland should include the following:

- soil types and profiles,
- soil classification,
- soil series,
- soil structure,
- soil texture,
- organic content, and
- permeability.

This information can be developed specifically through field observations or generally through county soil surveys published by the National Resource Conservation Service.

3.3.4 Characterization of Existing Fauna

The existing fauna at a wetland site should be noted and recorded to document present and potential wildlife use. This evaluation should extend outward to the wetland buffers and even the surrounding uplands. Whereas some wildlife species are limited to wetland environments, others use a gradient of habitat types, of which wetlands are just one integral component. The role of this information in wetland characterization for mitigation is that it can assist the designer in selecting some of the physical characteristics of the wetland. For example, the presence of certain species may influence the type of stream channel morphology created, the degree of habitat or substrate heterogeneity, the type of vegetation community to be established, the rate and degree of tidal flushing, and the placement and shape of the mitigation wetland within the context of surrounding habitats.

While designing a wetland for a particular species or type of wildlife community should not always be the focus of mitigation, it often gives a good starting point for going through the iterative thought processes. The designer can use this process as an exercise for considering how the various functions of wetlands will interact with each other and which functions are the most important for the wetland.

Table 3-1 summarizes the predesign baseline requirements that should be collected for a mitigation program. This checklist is based on USACE New York District 2003 and therefore may be modified depending upon site location and applicable state and/or federal requirements for that location.

Table 3-1. Checklist of baseline information required for impacted wetlands and/or mitigation areas

Required Baseline Information	
Location	
a. Latitude and longitude	
b. Site address/property location	
c. Section, block, lot	
d. Township/city/village	
e. County	
f. Hydrologic Unit Code (HUC) number	
Maps and photos	
a. Detailed site map with contours and delineated wetland boundaries	
b. Area of proposed impacts indicated on site map	
1. Areas of fill	
2. Grading	
3. Structures	
c. Detailed vicinity map	
d. Project location map showing resources within watershed	
e. National Wetlands Inventory map	
f. Soils map	
g. Aerial/satellite photographs	
h. Site photographs and photograph location map	
i. State wetland maps	
j. Other agency jurisdictional wetland map	
Wetland classification	
a. Cowardin	
b. Hydrogeomorphic	
c. Rosgen stream type	
d. Natural Resource Conservation Service classification	
e. Special aquatic sites	
Quantify aquatic resources	
a. Size of impact are in acres	
b. Impacts to stream resources (linear feet and morphological impacts)	
Functional assessment method	
a. Assessment completed	
b. Assessment type	

Existing hydrology	
a. Water budget	
b. Hydroperiod	
c. Spring high tide elevation for tidal waters	
d. Mean high water elevation for tidal waters	
e. Mean low water elevation for tidal waters	
f. Location of existing monitoring wells and stream gauges on site map	
g. Historic hydrology of site if different then present conditions	
h. Contributing drainage area in acres	
i. Data on surface water	
j. Data on groundwater	
k. Data on tides for tidal waters	
l. pH	
m. Redox	
n. Nutrients	
o. Total suspended solids	
p. Dissolved oxygen	
q. Percent open water	
r. Cross section of existing hydrology	
s. Existing monitoring data	
t. Bank full elevation for streams	
u. Normal pool elevation for canals and reservoirs and other standing water bodies	
Existing dominant vegetation of wetlands and buffer zones	
a. Map showing location of all plant communities	
b. Percent cover	
c. Community structure (stratification, density, abundance, frequency)	
d. Wetland indicator status of all vegetative species	
e. Vegetation age and health	
f. Invasive status	
Existing soils	
a. Soil profile description	
b. Soil survey classification	
c. Soil series	
d. Stream substrate	
e. Location of any soil samples on site map	
f. Percent organic matter	
g. Structure	
h. Texture	
i. Permeability	
Site information	
a. Type and purpose of water at each impact site	
b. Describe/quantify impacts to resource size, functions, types and values by proposed action	
c. Describe proposed temporary and permanent impacts to the aquatic environment	

d. Surrounding land use	
e. Impairment status and impairment type of aquatic resource	
f. Percent agriculture, forested, wetland, developed, etc.	
g. Size and width of buffers	
h. Current owners	
i. Adjacent property owners	
j. Existing wildlife usage	
k. Historic and current land use	
l. Known listed hazardous waste sites	
m. Contaminants in water and sediments	
Watershed	
a. Description of landscape connectivity	
b. Describe aquatic resource concerns in the watershed	
c. Proximity and connectivity of existing aquatic resources and natural upland areas	
d. Amount of aquatic resource area that the impact site represents for the watershed and/or region	
e. Documentation of local coordination	

4. MITIGATION DESIGN AND PLANNING

One of the overriding goals behind the compensatory mitigation program managed by USACE is to ensure that a goal of "no net loss of wetlands" is met (NRC 2001, USACE 2002). In its special public notice regarding draft compensatory guidelines, the USACE New York District (2003) notes basic requirements for successful wetlands mitigation projects based on the findings of NRC (2001):

- Consider the hydrogeomorphic and ecological landscape and climate in designing the mitigation project. Locate the wetlands mitigation site in similar landscape positions and hydrogeomorphic classes.
- Adopt a dynamic landscape perspective. Consider both current and future watershed hydrology, and select sites that are resistant to disturbance from the surrounding landscape.
- Restore or develop naturally variable hydrological conditions.
- Whenever possible, choose wetland restoration over creation as this form of mitigation has been shown to be more feasible and sustainable.
- Avoid overengineered structures, and design the mitigation project for minimal maintenance.
- Pay close attention to appropriate planting elevation, depth, soil type, and seasonal timing.
- Provide heterogeneous topography.
- Pay close attention to subsurface conditions such as soil and sediment geochemistry and physics, groundwater quality and quantity, and infaunal communities.
- Consider complications associated with creation or restoration in seriously degraded or disturbed sites.

Simply put, wetlands mitigation projects will not be successful unless they are adequately planned. For a wetlands mitigation project to be successful, the following project attributes must be at least be adequately defined:

- well-defined broad goals and refined objectives;
- measurable and specific success criteria incorporated into the project;
- functional value and biological integrity criteria used to evaluate the functional equivalency of the mitigated wetlands to the undisturbed, nonimpacted wetlands;
- long-term management plans incorporated with details of operations, responsibilities, and funding; and
- adequate monitoring established over a sufficient time frame (>5 years), with defined goals and established methods for evaluating the results.

The wetlands mitigation plan is the primary tool used in the successful completion of the mitigation action. For the wetlands project to be successful, the wetlands mitigation plan must be as complete and thorough as possible. As described in various documents, a wetlands mitigation plan should conceptually include the following:

- a statement of intent and goals,
- a description of the site to be restored/created before project,
- a description of the steps to be used in area preparation,
- the plant materials to be used,
- a detailed grading plan,
- a description of the soil to be used,
- a schedule/construction timetable,
- a maintenance plan,
- monitoring/assessment procedures, and
- performance guarantees.

This section outlines recommended procedures for planning a successful mitigation project.

4.1 Mitigation Ratios for Design Purposes

The science of wetlands mitigation is not exact, and the ability to replicate the functions of natural wetlands by a mitigation project is not always assured. Kruczynski (1990) states that an uncertainty factor should be incorporated into mitigation projects to ensure that the functional values of the mitigated wetlands equal those of the impacted wetlands. The goal of the mitigation, therefore, is to ensure that the result of the project is no net loss of wetland functions. As a result, many states require that the mitigation site be larger than the impacted site.

The size of the mitigation project will in most cases be a function of the permit requirements of the appropriate state or federal agencies involved with the action. It is recommended that the appropriate regulatory agencies be consulted prior to commencement of mitigation planning to determine the appropriate mitigation ratios. USACE (2002) indicates that a wetland replacement ratio of 1:1 may be used as a reasonable surrogate for no net loss of functions in the absence of site-specific information. The USACE New York District (2003) identifies the objective of the mitigation as a 1:1 functional replacement, with an adequate margin of safety.

Numerous states maintain their own mitigation replacement ratios that may differ among freshwater, estuarine, saline, nontidal, and tidal wetlands. For example, mitigation ratios in New Jersey vary for freshwater wetlands depending upon the type of mitigation, with two acres of mitigation required for each acre of wetland impacted (2:1) for both restoration and creation projects. For intertidal and subtidal wetlands, New Jersey requires a mitigation ratio of 1:1, with creation as the preferred alternative. States may also offer a codified list of mitigation options from which to choose that ranks the type of mitigation (e.g., restoration, creation, enhancement), their ratios, and their placement in the landscape (e.g., subwatershed, watershed, watershed management area).

Pennsylvania requires a minimum area ratio of 1:1 replacement to impacted wetlands and a minimum functions and values replacement ratio of 1:1 (PADEP 1995). Under circumstances where a 1:1 ratio will not result in an equivalent function and value replacement, Pennsylvania may require a greater wetlands replacement ratio. California has variable mitigation replacement requirements depending upon the value of the habitat. They range from 1:1 for low-value habitats such as isolated freshwater marshes to 5:1 for endangered species habitat (NRC 2001). Minnesota's minimum replacement ratio is based on the percentage of original wetland remaining in the watershed. If 80% of the original wetlands remain, then the minimum ratio is 1:1. If less than 80% remain, then the ratio is 2:1

In addition to acreage or functional replacement requirements, the location of the wetland mitigation must also be addressed in the planning process. As stated above, many states have a prioritized list of where wetlands mitigation should occur relative to the site to be impacted. In general, most states prefer that the mitigation site be located as close to the impacted site as possible without jeopardizing the mitigation site from the same impacts. Typically, the preferred locations for mitigation sites are ranked as follows: within the same wetland system, within the same subwatershed, within the same watershed, within the same watershed management area, etc. Some states, such as Minnesota and Florida, allow flexibility in the siting. These states consider the historic uses of the watershed, the merit of the proposed project, and the long-term effect of the wetland in the watershed.

4.2 General Design Sequencing

As mentioned at several points in this document, the success of the wetlands mitigation project is dependent on careful and complete planning. It is recommended that the design of the mitigation process be sequenced to follow a set series of actions. The following design sequencing is based on Schneider and Sprecher 2000:

1. Mitigation goals and objectives
2. Site selection and suitability
3. Performance standards
4. Mitigation costs
5. Detailed design requirements
6. Construction specifications

7. Monitoring/preventative maintenance plan

4.2.1 Mitigation Goals and Objectives

A recurring theme throughout the literature is that a reason for the failure of wetlands mitigation projects is the lack of a defined objective or purpose. USDA (1992) states that the goals of the mitigation are to restore, enhance, or create one or more of the commonly held wetlands functions. The fulfillment of these goals requires not only an understanding of the conceptual objectives of the mitigation project but also an understanding of the functional attributes of the existing wetlands.

The goals and objectives of a particular project are entirely site specific and must be as comprehensive and as detailed as possible. The goals and objectives should state the amount and types of wetlands and aquatic habitat that are impacted and the amount of compensatory mitigation to be used to offset that impact. The functional assessment of the impacted wetlands should provide a basis for which functions the mitigation is restoring and/or replacing. Too often overlooked, the type of hydrology that is expected to support the mitigation wetland should be encompassed in the statement of goals and objectives.

4.2.2 Site Selection and Suitability

The USACE New York District (2003) notes that several items should be considered in the determination of the potential suitability of a site selected to support a wetlands mitigation project. If the mitigation is a restoration or an enhancement, the evaluation of site suitability will be more straightforward than trying to assess whether a site would support a wetland creation. The items to be considered in site selection include the following:

- availability of suitable sites,
- constructability,
- overall costs,
- technical requirements,
- logistics,
- likelihood of success,
- ecological sustainability, and
- practicability for long-term monitoring and maintenance.

USACE (2002) indicates that watershed considerations and practicability should be considered in selecting a site for wetlands mitigation. It also notes that wetland mitigation projects in the vicinity of airports should evaluate the potential to attract birds that would threaten aircraft per the Federal Aviation Administration Advisory Circular on *Hazardous Wildlife Attractants on or near Airports* (AC No. 150/5200-33, dated May 1, 1997).

Garbisch (2002) advises the following:

- Always clearly understand the hydrology available at a wetland construction site prior to final site selection.

- Always consider the impact that future land development will have on the quality or quantity of water over time.
- When constructing a tidally supported wetlands, the conveyance of tidal water to and from the site must be unrestricted.
- Always determine the composition of soil at various proposed depths prior to final site selection.
- Always consider costs in selecting a site.

Garbisch (2002) also indicates that a wetland construction site to enlarge or connect to an existing wetland should never occur without verifying the prevailing hydrology and cautions that a designer should never assume that there is an endless source of water to support groundwater-driven wetlands.

4.2.3 Performance Standards

Wetlands mitigation projects should identify the performance standards at the initiation of the mitigation planning process. Performance standards are those metrics that will be measured to evaluate whether the mitigation is achieving its planned goals. See Question 27, Appendix C for real examples of project-specific performance measures. The measurements against the performance standards are collected during the wetlands monitoring phase of the project (discussed in Chapter 6).

Performance standards are often a function of both state and federal permit requirements, and many USACE districts maintain their own performance standards. Generally, these standards fall into the following categories:

- hydrological measures,
- vegetative measures,
- faunal measures, and
- soil measures.

Streever (1999) notes that there is a clear need for studies designed to link performance standards required by permits with the ability of created or restored wetlands to replace lost wetland structure and function. Often the goals of these two approaches do not mesh. He suggests the use of reference wetlands in the vicinity of the mitigation site as a means of using comparison standards to assess the progress of wetlands development. This approach may be problematic, however, in highly developed or highly disturbed regions, where adequate reference wetlands may be difficult to locate, access, or even cease to exist.

In NRC 2001, Appendix E "Examples of Performance Standards for Wetlands Creation and Restoration in Section 404 Permits and an Approach to Developing Performance Standards" provides 20 examples of performance standards for wetland creation and summarizes seven sets of performance standard guidelines used by USACE districts and one set under development.

4.2.4 Mitigation Costs

Cost estimation for wetlands mitigation is a complex issue, depending on a variety of variables, including water type (freshwater vs. estuarine), hydrology (surface water vs. groundwater), physical setting (riverine vs. estuarine), and vegetation (emergent vs. forested). The type of mitigation activity that is involved (creation vs. restoration/enhancement) also plays a major role in defining the necessary expenditure. Creation tends to be more expensive because of the construction activities required to adjust the surface topography to an elevation more suitable for wetland establishment. Additionally, because the hydrology of a created wetland is less certain than that of a wetland to be restored or enhanced, the chances for success are less certain. Our case studies were unable to reveal any substantiated information on cost (see Appendix C).

The siting of wetlands mitigation projects also affects project costs. On-site mitigation should be less expensive because the issues of property ownership and access have already been settled. In either case, site selection is the critical action in mitigation, especially if the choice of mitigation is wetlands creation. Success at creating wetlands depends on finding a site where the upland characteristics can be readily modified to allow for the establishment of wetlands characteristics. "Upland" refers to any terrestrial area that is not classified as a wetland (i.e., one of the three wetlands parameters, under normal circumstances, is missing). The success of a project is dependent on the availability of a suitable site or on the ability to overcome the limitations of a less than suitable site.

The selection of a mitigation site is a systematic process in which general areas are screened with respect to topography, geology, soils, hydrology, biological communities, and land ownership. General areas are screened with respect to these criteria and with respect to the general mitigation objectives of the project. Through this process, data are collected and evaluated on the general area, enabling the number of locations to be narrowed through the screening process until a select number of potential locations are identified. These locations are then evaluated to determine which provides the best opportunity for mitigation success (Hammer 1992).

The cost ranges that have been developed in the following tables represent the estimated costs on a per-acre basis to complete the mitigation activity for that particular type of wetlands. Qualifiers have been introduced to allow for an evaluation of certain subcategories within the total range of costs. The costs are considered to include the expenses required to implement the actual project (construction and vegetation). However, there are additional costs that should be considered relative to any wetlands mitigation project. Dennison and Berry (1993) note that, for residential development and industrial construction projects, associated wetlands costs may constitute 3%–7% of the total budget for the project. It is the experience of the authoring team that project management and engineering costs for wetlands construction projects can run as high as 10%–20% of the total budget.

Costs outside of the hard costs to construct and vegetate the created or enhanced wetlands include such items as delineation and functional evaluation of the existing wetlands, development of any permits or permit equivalents, design of mitigation plans, off-site evaluation of possible mitigation sites (if necessary), and post-construction monitoring and maintenance. A project synopsis for a New Jersey Department of Transportation wetlands mitigation project (Drag Island Wetlands Construction) consisting of the creation of 24 acres of *Spartina* salt marsh lists nonconstruction costs as 25% of the total project. This project was completed for a cost of approximately $2.5 million (approximately $104,000/acre).

Table 4-1 presents the generic nonconstruction associated costs that should be applicable to any wetlands mitigation project. Tables 4-2, 4-3 and 4-4 present a summary of wetlands mitigation costs. These costs consider both construction and planting activities. Additionally, land purchase prices for off-site mitigation are also considered. Not included in the following tables is the cost of mitigation banking, which in the northeastern United States can run $150,000–$200,000/acre credit.

Table 4-1. Costs other than mitigation implementation (Dennison and Berry 1993)

Activity	Cost range/acre
Wetland delineation	$500–$750[a]
Functional assessment and evaluation of existing wetlands	$5,000–$20,000/site[b]
Preparation of permit applications (or permit equivalents)	$3,000–$10,000
Development of mitigation plans	$5,000–$15,000
• Conceptual plan	
• Wetland creation plan	
• Restoration/enhancement designs	
• Engineering plans and specifications	
Post-construction monitoring (annual costs)	$1,000–$4,000/site[c]

[a] Variation in cost is the result of the complexity of the wetland system; small, isolated emergent wetlands with obvious boundaries requiring a routine level delineation cost less than a larger, more complex site requiring an intermediate level delineation.
[b] Cost is a function of both the size and complexity of the wetland site; in particular, the more potential functions that the wetland has, regardless of size, the more complex and detailed the functional evaluation will be; a small, single-function wetland costs less to evaluate than a large, multifunction wetland.
[c] Costs do not include the replacement of plants to ensure an 85% survival rate; most monitoring programs last 2–10 years.

Table 4-2. Costs associated with mitigation of emergent freshwater wetlands

Activity	Cost range/acre
General cost range	$15,000–$35,000[a]
Restoration/enhancement of emergent freshwater wetlands	$15,000–$25,000[b]
Creation of emergent freshwater wetlands	$20,000–$35,000[c]
Typical land costs for off-site mitigation	$5,000–$100,000[d,e]

[a] For any emergent freshwater wetlands mitigation activity; includes all wetlands construction costs; costs based on Hammer (1989), Kadlec and Knight (1996), and historic job summary information. However, Jensen and Platts (1990) reported a cost of $40,000/acre for restoration riverine/riparian wetlands in the West. Some wetlands in Minnesota have cost only $5,000/acre.
[b] Costs based on a review of 19 wetlands creation sites by Reed and Brown (1992). Some wetlands in Minnesota have cost only $5,000/acre.
[c] Costs supported in part by Jensen and Platts (1990).
[d] Costs supported in part by Amon and Briuer (1993). Costs assume excavation of no more than 2 feet to develop mitigation grade and moderate access. Difficult access or the requirement for a rock or gravel lining (depending on the potential for water retention, generally used more for wastewater treatment) could result in greater construction costs. Reed and Brown (1992) reported an average cost

of $87,000/acre for lined wetlands. Kadlec and Knight (1996) suggest an average cost of $17,000–$81,000 for gravel-lined wetlands. The greatest cost in the creation of wetlands is the actual movement of soil. An average cost for soil removal for the northeastern and central United States is approximately $10–$15/yard.

[e] Costs to conduct a wetlands mitigation activity are greatly influenced by the cost to purchase land to either create or enhance the wetlands on. The costs can range significantly, depending on the part of the country in which the project is located. The costs presented are based on prices for undeveloped land in New Jersey ($25,000–$42,000/acre) and Massachusetts ($80,000–$100,000/acre), which are typical prices for the industrial Northeast and California (Holland 1990). However, sites in the Southeast and West may cost in the range of only $5,000–$15,000/acre.

Table 4-3. Costs associated with mitigation of forested freshwater wetlands

Activity	Cost range/acre
General cost range	$25,000–$70,000[a]
Restoration/enhancement of forested freshwater wetlands	$25,000–$40,000[b]
Creation of forested freshwater wetlands	$40,000–$70,000[c]
Typical land costs for off-site mitigation	$5,000–$100,000[d]

[a] For any forested freshwater wetlands mitigation activity; includes all wetlands construction costs; costs based on Hammer (1989) and review of historic job information; cost spread will be influenced by the ease of access and the type of activity (creation vs. restoration/enhancement); much of the increased costs associated with forested wetlands versus emergent wetlands is the price of the vegetation.

[b] The majority of forested wetlands are found in the eastern portion of the United States, so these prices are representative of those areas. However, Carothers, Mills, and Johnson (1990) give restoration prices of $2,000–$40,000/acre for forested wetlands along rivers in the Southwest. Primary vegetation was cottonwood (*Populus deltoides*) and willows (*Salix* sp.), neither of which is generally used for revegetation purposes in the Northeast.

[c] Costs assume excavation of no more than 2 feet to develop mitigation grade and moderate access. The greatest cost in the creation of wetlands is the actual movement of soil. An average cost for soil removal for the northeastern and central United States is approximately $10–$15/yard.

[d] Costs to conduct a wetlands mitigation activity are greatly influenced by the cost to purchase land to either create or enhance the wetlands on. The costs can range significantly, depending on the part of the county in which the project is located. The costs presented are based on prices for undeveloped land in New Jersey ($25,000–$42,000/acre) and Massachusetts ($80,000–$100,000/acre), which are typical prices for the industrial Northeast and California (Holland 1990). However, sites in the Southeast and West may cost only $5,000–$15,000/acre.

Table 4-4. Costs associated with mitigation of emergent estuarine/coastal wetlands

Activity	Cost range/acre
General cost range	$15,000–$35,000[a]
Restoration/enhancement of emergent estuarine/coastal wetlands	$15,000–$25,000[b]
Creation of emergent estuarine/coastal wetlands	$25,000–$35,000[b]
Typical land costs for off-site mitigation	$5,000–$100,000[c]

[a] For any emergent estuarine/coastal wetlands mitigation activity; includes all wetlands construction costs; costs based on Broome (1990) and historic job summary information.

[b] Costs supported in part by Amon and Briuer (1993); costs assume excavation of no more than 2 feet to develop mitigation grade and moderate access. Difficult access or the requirement for a rock or gravel lining (depending on the potential for water retention, generally used more for wastewater treatment) could result in greater construction costs. Reed and Brown (1992) reported an average cost of $87,000/acre for lined wetlands. Kadlec and Knight (1996) suggest an average cost of $17,000–$81,000 for gravel-lined wetlands. The greatest cost in the creation of wetlands is the actual movement of soil. An

average cost for soil removal for the northeastern and central United States is approximately $10–$15/yard.

[c] Costs to conduct a wetlands mitigation activity are greatly influenced by the cost to purchase land to either create or enhance the wetlands on. The costs can range significantly, depending on the part of the county in which the project is located. The costs presented are based on prices for undeveloped land in New Jersey ($25,000–$42,000/acre) and Massachusetts ($80,000–$100,000/acre), which are typical prices for the industrial Northeast and California (Holland 1990). However, sites in the Southeast and West may cost only $5,000–$15,000/acre.

4.2.5 Detailed Design Requirements

The following sections discuss the requirements for the design of the individual components of the mitigation wetland. Table 4-5 presents a conceptual checklist recommended to ensure that all of the design parameters are met. This checklist is based on a similar list developed by the USACE New York District (2003) and should be evaluated against site-specific state and/or federal regulatory requirements.

Table 4-5. Checklist of mitigation plan information required for impacted wetlands and/or mitigation areas

Required Mitigation Plan Information	
General	
a. Maps marking boundaries of proposed mitigation actions	
b. Timing of mitigation (before, concurrent with, or after the authorized impact)	
Grading plan	
a. Existing grades and slopes	
b. Describe plans for microtopography	
c. Show representative cross sections	
Construction	
a. Description of construction methods	
b. Construction schedule	
1. Expected start and end dates	
2. Expected date for as-built plan	
c. Water-handling plan	
d. Environmental control measures	
e. Planting/seeding schedule	
Planned hydrology	
a. Source of water	
b. Potential changes to water source from expected future changes in land use	
d. Hydroperiod	
e. Water budget	
f. High-tide elevation (if tidal waters)	
g. Mean high-water elevation (if tidal waters)	
h. Mean low-water elevation (if tidal waters)	
i. Cross section showing proposed hydrology	
j. Proposed monitoring data	
k. Location of monitoring wells and stream gauges	

l. Stream or open-water geomorphic features	
m. Structures requiring maintenance	
Planned vegetation	
a. List of native hydrophytic vegetation	
b. Source of native plant species	
c. Stock type	
d. Plant ages/sizes	
e. Plant zonation/location map	
g. Quantities	
h. Densities	
i. Community structure	
j. Expected natural regeneration from existing seed bank	
Planned soils	
a. Soil profile description	
b. Source of soils	
c. Organic content	
d. pH	
e. Texture	
f. Permeability	
g. Soil amendments	
h. Erosion and soil compaction control measures	
Planned habitat features	

4.2.5.1 Proposed Vegetation

As part of the detailed design, a landscape plan must be submitted to identify the types, locations, and sizes of the proposed vegetative communities and the individual species that will compose the communities. The plan should be accompanied by a tabulated list of species that identifies the plants by common and scientific name, the size and available form (e.g., seed, bare root, rhizome, potted) of the plants to be installed, and the region-specific FWS wetlands indicator for each species. An example list is presented in Table 4-6.

Table 4-6. Sample plant material list

Key	Botanical name	Common name	Quantity	Size/ comments	Region 1 wetlands indicator
Trees					
AR	*Acer rubrum*	Red maple	631	3′–4′ pot	FAC
NS	*Nyssa sylvatica*	Black gum	105	3′–4′ pot	FAC
PR	*Pinus rigida*	Pitch pine	105	3′–4′ pot	FAC
MV	*Magnolia virginiana*	Sweetbay magnolia	52	1′–1.5′ pot	FACW
AS	*Alnus serrulata*	Smooth alder	52	1′–1.5′ pot	OBL
QB	*Quercus bicolor*	Swamp white oak	105	2′–3′ pot	FACW

Key	Botanical name	Common name	Quantity	Size/ comments	Region 1 wetlands indicator
Shrubs					
CA	*Clethra alnifolia*	Coast pepperbush	1473	1.5′–2′ pot	FAC+
VC	*Vaccinium corymbosum*	Common highbush blueberry	1497	1.5′–2′ pot	FACW
RV	*Rhododendron viscosum*	Swamp azalea	1286	1′–1.5′ pot	OBL
Herbs					
JE	*Juncus effusus*	Soft rush	1304	2″ peat pot	FACW
Grasses					
LO	*Leersia oryzoides*	Rice cutgrass	40 lbs/acre	Seed	OBL
PV	*Panicum virgatum*	Switchgrass	40 lbs/acre	Seed	FAC

The list of plants and their placement at the site should be considered on a site-specific basis in consultation with appropriate state and/or federal regulatory agencies responsible for approving the plan. The plan should consider planting species in each of several strata (i.e., canopy, subcanopy, herbaceous) depending upon the desired vegetative communities and their respective physical structure (Figure 4-1). Garbisch (2002) notes that both preferred planting times and alternative planting times should be included to ensure that plants are installed in sufficient time to become established before the onset of winter or a known environmental stressor (e.g., waterfowl migration, cyclical storm events, etc.).

Figure 4-1. Delivering plants for a mitigation project (courtesy Charles Harman, AMEC Earth & Environmental, Inc.).

Plant selection is critical part of ensuring both the ability of the mitigation project to duplicate the functions of the impacted wetland and the survivability of the plants that are installed. For wetlands restoration projects, the baseline characterization will determine which plants are to be replaced in the mitigation area. For wetland enhancement projects, a survey of functioning wetlands in the vicinity or a review of historic records may be necessary to identify which of the target species are to be used in the project. A survey of functioning wetlands in the vicinity of the project area will also be necessary for creation wetlands to identify those species common to wetlands in the region. In addition, all three information-gathering approaches described above may be used collectively to gain a large-scale picture of the wetland systems in the landscape.

The selection of plants must also be tied into the hydrologic basis for the mitigation project. An understanding of the amount of moisture available should be a factor in selecting the appropriate species for a site. For example, in the northeastern United States, if a high water table is anticipated, the selection of silver maple (*Acer saccharinum*), a FACW species, may be more appropriate than red maple (*Acer rubrum*), a FAC species. However, site drainage also plays a role in this equation, and if coarse-textured soils with adequate drainage are anticipated, then red maple would be an entirely appropriate species to use. If periodic or permanent inundation of the mitigation area is expected, the choice of a herbaceous species that is not tolerant to inundation would result in the loss of the planted species and the inability to achieve planting success. In the northeastern United States, a useful planting guide developed by Environmental Concern, Inc. (Thunhorst 1993) provides information on a number of wetland plant species that are commercially available and includes details about each plant such as its rate of growth, wildlife benefits, and a hydrologic range.

Likewise, for coastal mitigation projects, both salt tolerance and moisture regimes must be considered in plant selection. On the East Coast, the selection of low marsh plant community species such as smooth cordgrass (*Spartina alterniflora*) or salt grass (*Distichlis spicata*) is not appropriate if the site circumstance is a high marsh community. For tidally influenced wetlands, Garbisch (2002) notes that plans should clearly state and show that all vegetated areas are well drained to ensure that ponding, which would lead to high water temperatures and hypersalinization, does not occur (unless that is part of the design).

Another consideration in plant selection should be the presence, extent, and proximity of invasive species in the surrounding areas. While maintenance activities during the monitoring phase of the mitigation should be used to control invasive species, some measures can be taken to help minimize the encroachment and establishment of invasive species in the mitigation area. Rapid-growing/spreading plants establish more quickly and help preclude the colonization of invasive species. However, the preferred plant community often includes a slow-growing/ spreading species. In these instances, it is helpful to add a rapid-growing/spreading species in the interim to act as living mulch. Annual rye grass (*Lolium multiflorum)* may be planted as an early cover crop to stabilize the soil. It is also important to take into consideration any allopathic properties a plant may have when developing a soil stabilization and/or planting plan.

Planting density is dependent on the site-specific requirements of the project and the vegetative stratum being planted. Canopy species (trees) are commonly planted at intervals ranging 8–15 feet. Subcanopy species (shrubs) are commonly planted at densities ranging 5–10 feet on center. Herbaceous species are commonly planted at densities ranging 1–3 feet on center. In some instances, the authors have observed projects that have intensive planting densities for trees (<5 feet on center), under the assumption that natural thinning will result in a desired density over time. There are different philosophies for planting: one may prefer larger, less dense plantings, and others may prefer smaller varieties and more dense plantings. However, reliance on natural thinning may be difficult because mortality may not produce the natural community anticipated. The selection of a plant size is often a compromise between cost and planting success. The smaller the plant size, especially the woody species, the less the plants costs on a per unit basis. However, the smaller the plant size, the more susceptible they are to stress, especially during the first winters in temperate areas. Loss of plants then results in a greater expenditure of additional plants for replanting during the monitoring years.

Although a simple grid pattern is often used for planting, this approach has a tendency to result in the homogeneous distribution of plant species. This approach does allow for ease of planting due to exact plant spacing and can allow for easy quality control monitoring to ensure proper initial installation and easier long-term monitoring to ensure planting success. If using this approach, consideration should be given on how heterogeneity may be introduced into the planting scheme (see Section 5.3). A common circumstance that arises in many wetland mitigation projects is the inherent heterogeneity in the landscape resulting from excavation/grading activities. Such heterogeneity is particularly helpful to a mitigation project that utilizes a grid pattern for planting. For example, areas that exhibit slightly different conditions for moisture and light may be planted with more individuals of some species than others, replicating natural processes of selection and recruitment.

Selecting the form of plants (e.g., seed, bare root, rhizome, bagged, plug, potted) can be a complicated process and depends on the size of the plant available from nurseries, the preferences of those conducting the wetlands planting, and site-specific planting and growing conditions. There is no general consensus on the relative merits of the form of plant used, especially with regards to bare root specimens. In some projects bagged or potted woody plants have produced the highest success ratios, provided that the plants were not pot-bound upon delivery.

With respect to herbaceous species, using potted plants allows for a higher success of the herbaceous community and leads to faster targeted development of the community. Consideration should be given to the rate of growth of the herbaceous species that are planted in pots so that plants are installed at distances commensurate with their rate of growth (Garbisch 2002). The faster a plant grows, the greater the distance that can be maintained between planted species. The concern is that bare ground not be left for a long period of time.

The use of seed in establishing the herbaceous layer may be necessary depending upon cost and logistical considerations of the project. Garbisch (2002) notes that wetlands should be seeded during dry periods to allow for proper germination and that some action should be taken after seeding to ensure that the seeds are in contact with the soil. He also notes that planting specifications should state that pure seed is to be used in a project. Seeding is typically recommended at the beginning of the growing season. Seeding at the end of the growing season has been effective as well.

Whenever possible, a local nursery should be used so that the selected plants are already acclimated to the local climate. The choice of a nursery removed from the location may result in the introduction of plants that are not as suitable to survive in the mitigation site and may lead to the introduction of unwanted genetic variability.

Other factors that may should be considered and outlined in the mitigation plan are as follows:

- timing of planting to achieve maximum survival;
- proposed benefit of each plant species;
- methods of planting;
- proposed use of mulch (strongly encouraged in USACE New York District 2003)—certified inert material straw mulch rather than hay, which may bring in noxious weeds;
- potential soil amendment such as organic material or fertilizer; and

- potential supplemental watering (should only be used for the establishment of the plant community and not as a long-term tool to support the mitigation).

In certain instances, natural revegetation of the mitigation wetland, especially for restored wetlands, may be acceptable. The restored wetlands may already have a seed bank available as volunteer vegetation. Also using wetlands soil as the growth substrate encourages natural wetlands establishment faster than trying to produce wetlands soil from an introduced nonwetland soil material. Evaluation of site circumstances and discussions with the appropriate regulatory agencies will be needed for such an action since this approach may result in less compensation for wetlands lost (e.g., an offset of the 1:1 ratio).

4.2.5.2 Proposed Hydrology

As noted in Schneider and Sprecher (2000), the groundwater and surface water regime is critical in general to the success of the vegetation used in the mitigation and specifically to the success of the wetland as a whole. The mitigation plan must detail the grading activities and engineering options necessary to ensure that the hydrologic budget is maintained. For wetlands with surface water components, flow-through rates, velocity, frequency of flooding, and water source must all be considered in the design. For wetlands dependent upon groundwater and precipitation, care must be given that the grade is lowered sufficiently to intercept the groundwater, accounting for mean high-water tables over a protracted period of time and not periodic high-water tables. This action does require the baseline evaluation of the groundwater table to ensure the success of the wetland. In this instance, the more detailed and extensive the information, the more likely that the mitigation project will be successful.

In general, the mitigation design should discuss the approaches needed for establishment of the following factors:

- maintaining appropriate water depth,
- maintaining appropriate water duration,
- maintaining appropriate water flow, and
- ensuring that timing of water levels is appropriate.

Care should be taken to avoid the use of hard engineering structures or the use of supplemental watering to support hydrology. Hard engineering structures include dikes, dams, berms, weirs, and other contrivances used to artificially maintain the hydrology, beyond engineering activities to adjust the topography of the mitigation site. The mitigation wetlands should be allowed to develop naturally and should be maintenance-free with regards to hydrology.

In preparing the detailed designs for a project, it is imperative that plans clearly state the source of water, its availability, and the levels intended for pools and tides (Garbisch 2002).

4.2.5.3 Proposed Soils

The mitigation plan must detail the edaphic conditions of the site that are necessary to support the planned wetlands. Plans must be prepared that detail the following:

- cross-sectional elevations, both existing and final;
- pre- and post-construction grades;
- the location of stockpile areas;
- erosion and sediment control plans or permits;
- stratification of soil layers;
- equipment staging areas; and
- any if used, the location of borrow areas in the vicinity of the site.

The final grade of soil should be topsoil that is capable of supporting the vegetative community that is to be installed. The final topsoil layer should be at least 12 inches in depth and should have a good organic content (3%–12%). The type of topsoil often depends on the availability of soil in the region but should be a loam (tending towards either a sandy or a silty loam, depending on site location and project objectives). Garbisch (2002) states that groundwater-supported wetlands should be constructed using sands to ensure that the groundwater discharges into the wetland and provides the proper hydrodynamic environment for sustainability. However, sand does not make the optimum growth medium.

Depending on the site circumstances, soil amendments may be required to address either organic material or nutrient deficiencies. If an amendment is required, the first choice may be a compost material that could be used as mulch. Otherwise, slow-release chemical fertilizers at low feeding rates may be considered for use.

One aspect of soil grading is the establishment of natural contours or microtopographic aspects to the wetlands. The final grade should not be smoothed flat. Instead, surface sculpting should allow for the development of hummocking and heterogeneous habitat. The development of hummocks can also be established by the placement of mounds of straw covered by topsoil at various locations. In addition, some regulatory agencies require the use of a disc as a final soil action prior to planting to ensure that soil compaction has not occurred during construction.

4.2.5.4 Planned Habitat Enhancement Features

While not critical to the success of the wetlands based on the development of vegetation, soils and hydrology, the installation of habitat enhancement features and/or structures assists in the development of wildlife and aquatic habitat functions. These are simple structures that require no maintenance, yet as the wetland develops, they provide increasing habitat over time. Examples of enhancement features are as follows:

- woody debris such as logs, stumps, brush piles, and snags;
- upland islands (nesting islands should be located farther than 300 feet from shore);
- open-water features such as tidal guts and small pools;
- nesting boxes for waterfowl and roosting structures for other avian species;
- open-water structures such as wing deflectors, boulder clusters, and rock weirs; and
- vegetative buffers.

ITRC has established an Ecological Enhancements Team that will be examining the installation and use of such structures.

4.2.6 Construction Specifications

In addition to the detailed design of the mitigation project, the mitigation plan should also include a set of construction specifications to govern the physical construction aspects of the project. At a minimum, the construction specifications should include the following:

- responsibilities and contact information of all parties involved with the mitigation project;
- sources of plant materials (local sources should be used as much as possible); and
- copies of contracts noting landscaper responsibilities such as fertilizations and irrigation, plant replacement, reseeding, temporary protection of vegetation from wildlife, and the number of site inspections.

4.2.7 Monitoring/Preventive Maintenance Plan

As part of the mitigation plan, a monitoring plan must be included that identifies how the performance standards will be applied to measure the success of the wetlands. Section 6 discusses monitoring plans and procedures in further detail.

4.3 Site Protection

The mitigation plan should also include a written description describing the legal means by which the mitigation site will be protected from development. USACE and most state regulatory agencies require the establishment of some form of real estate instrument by which the property can be preserved as a wetland. The instruments may include conservation easements, deed restrictions, and property transfers to nonprofit conservation organizations, among other actions. These vehicles must be identified and developed during the wetland permit development phase and detailed in the mitigation plan. Appropriate state and/or federal regulatory agencies should be consulted on the type of instrument that is applicable to the site in question.

4.4 As-Built Reports

The mitigation plan should specify the need and schedule for completing as-built reports at the completion of mitigation construction. The as-built reports should identify deviations from the mitigation plan that occurred because of field conditions during construction, as well as presenting final graded contours, cross sections, planting locations, and the construction of any structures or roads (Schneider and Sprecher 2000). In addition, as-built reports should verify the dates that construction was completed, detail problems observed in the construction process, and identify follow-up corrective actions.

5. CONSTRUCTION

Construction of a mitigation wetland requires great attention to detail to ensure that the project is successful. Extremely close attention must be paid to ensure that elevations, grades, and planting materials are completed exactly as shown in the mitigation plan and construction details. Some degree of flexibility does need to be maintained such that field changes can be easily introduced to address site-specific conditions that arise during construction. However, field changes should be evaluated with care to ensure that required hydrology, soil, and vegetative parameters are not compromised.

The construction process (Figure 5-1) is a phased activity that begins with site preparation and finishes with demobilizing staged equipment and allowing for monitoring to occur. The following sections outline some of the salient aspects of the construction process; however, they are not intended to serve as a replacement for standard construction practices that are legally overseen at a given site. Dialog with the construction engineer must be sustained during the design phase to ensure that all aspects and concerns are addressed. Meetings are helpful at various stages during the mitigation process to ensure constant familiarity with the design, design changes, and progress of the construction phase of the wetland. It is also helpful to review the overall goal of the project and to highlight critical construction details. Continued oversight and periodic meetings can ensure that the actual design is being implemented in the field. Table 5-1 is a general checklist for construction.

Figure 5-1. Planting equipment (courtesy Charles Harman, AMEC Earth & Environmental, Inc.).

Table 5-1. Checklist of construction information required for impacted wetlands and/or mitigation areas

Season	
Schedule	
Type of equipment	
Staging areas for equipment	
Spoil disposal	
Grading stakes and other necessary grading controls	
Adjacent upland slopes and grading control	
Quality control efforts (control of invasive plant, grading, compaction, etc.)	

5.1 Soil Erosion and Sediment Control

Prior to beginning construction, which will result in the disturbance of the existing soils, soil erosion and sediment control measures should be constructed in accordance with the appropriate state, county, and/or conservation district standards for soil erosion and sediment control. The objective is to prevent sediment from being washed from excavated areas, where it is needed, into undisturbed areas, where it can result in sedimentation problems. All soil erosion and sediment control measures should be maintained in good condition and left in place until permanent vegetation cover is established.

To ensure that erosion (and construction-related pollution) is not a concern, the following actions should be considered:

- Minimize the area of disturbance.
- Divert runoff from work, storage, and borrow areas.
- Construct roadways on contours to minimize erosion.
- Minimize soil compaction by avoiding unnecessary vehicle traffic on saturated substrates.
- Stage equipment away from areas that are under development as aquatic resources.
- Leave intact as much of the surrounding vegetation as possible.
- Use temporary settling basins, silt fences, and hay bales to filter sediment.
- Control engine fluids associated with heavy equipment.
- Place sanitary facilities away from water sources.
- Prevent the initiation and spreading of fires.
- Comply with all state and federal construction codes.

5.2 Preparation of the Appropriate Grade

Prior to grading or other construction activity, the construction location should be cleared of all unnecessary vegetation and debris. Cleared vegetation can be chipped and temporarily staged with other debris in an upland area. Chipped material can serve as mulch for planting operations depending on site circumstances, the type of material used, and composition of the wood. Nonrecyclable material should be disposed of off site. The boundaries of possible excavation should be marked to limit the potential for indirect or unintentional impacts to surrounding areas (Figure 5-2).

Figure 5-2. Process of developing the grade on a site and (background) example of the equipment used for grading (courtesy Charles Harman, AMEC Earth & Environmental, Inc.).

If the action is an enhancement or creation, the wetlands site should be excavated to the contours outlined in the detailed specifications prepared during the design process. Cross sections and contour drawings showing the current and finished grades should be completed. The cross sections should be located throughout the construction area at 50-yard intervals (recommended minimum) and display the current grade in all directions. Following removal of the topsoil, subsoil should be removed to a rough grade, approximately 12 inches below the final grade and consistent with the planned elevations. Upon completion of the excavation to the rough grade, a final inspection of the grades should be made by spot-checking the elevations. Since small variations in elevation create microtopography, which enhances the final wetland, the grade does not need to be perfectly level (see Figure 5-3). In addition, if groundwater is a source of hydrology for the mitigation wetland, subgrade compaction—which may interfere with the free exchange of water—must be addressed before final grading may commence.

Figure 5-3. Planting grid (courtesy Charles Harman, AMEC Earth & Environmental, Inc.).

Depending on the type of wetlands system, after rough grading, suitable substrate (at least 12 inches deep) is brought in to establish the topographic contours of the wetlands to final grade. The substrate should consist of a soil suitable for supporting plants in the region, contain organic material to meet design specifications, and be readily available. The target pH should be specific to the local environment. Generally, hydric soils need not be used as fill material, although they are often recommended if they are available. Sometimes wetlands will be impacted on the site, and the soil will be used in the wetlands mitigation project. At some sites the original soil is removed and stored for later use. Advantages of using wetland soils include suitable pH, oxygen content, and a viable seed bank. Hydric soils must be chosen carefully to prevent the introduction of undesirable vegetative species into the construction area; however, introduction of undesirable species can be mitigated to some extent, through careful selection and monitoring of the source area of the soil.

With the placement of fill in areas under wetlands hydrologic regimes, hydric parameters develop over time. The organic content typical of wetland soils develop as a function of both above- and belowground plant production, which again is a function of the wetlands hydrology. When placing the final substrate, it is critical that the soil remain uncompacted. Excessive grading to achieve a uniform elevation is unnecessary and counterproductive.

The final action before installation of plants should be some activity, such as discing, to ensure that the soil is not so compacted as to interfere with the intended movement of water through the soil profile. In addition to preventing soil compaction, the use of discing, cultivators, bedding harrows, or other farm implements can develop microtopographic aspects to the mitigation area.

5.3 Plants and Plant Installation

The design specifications identify the vegetative species to be planted. The selection of the particular species is based on the type of wetland, the biogeographic distribution of a species, climate, and desired wildlife habitat or ecological system. Grids (see Figure 5-3) are commonly used for planting spacing, though individual species should be randomly offset from each grid node to create some spatial heterogeneity. See Chapter 4 for a discussion on plant distribution with regards to grid plantings. Broadcast seeding can be used to enhance the herbaceous community and supplement the plantings.

Figure 5-4. Plant staging (courtesy Charles Harman, AMEC Earth & Environmental, Inc.).

All plants should be delivered and staged (Figure 5-4) on site prior to planting. Upon delivery, plants should be inspected to ensure that they are in good health, are not pot-bound, and are the correct species and form. The holes dug for potted species should be sufficiently larger in circumference than the pot so that loose soil can be filled in around the plant. For most species, the depth of the hole should equal the depth of the plant container. Depending upon the hydraulics of the site during planting activities, the plants may need to be watered following their installation. Plants should not be removed from containers until immediately before planting to minimize exposure of the root system to dry air. Roots should be examined to determine if they are pot-bound. Roots that are pot-bound should be gently separated prior to planting. Plants may be mulched with wood chips, straw, hay, or other mulching materials, or may be left unmulched to allow a wetland seed mix to produce a living mulch. After planting, protect the plants from drought, damage from grazers, and human intrusion. If necessary, periodic waterings can help establish the new plants.

5.4 Post-Construction

Following completion of the constructed wetlands, an as-built report detailing all construction activities should be prepared and submitted to the federal, state, or local regulatory agencies overseeing the mitigation project. Notes and observations of the on-site supervising engineer, collected during grading and planting, should be included. The report should include maps, data sheets, photographs, and available water budget data. See Section 4.4 for more details.

6. MONITORING

As initially described in Section 4.2.7, a monitoring plan must be included with the mitigation plan that also describes how performance standards will be applied to measure the success of the wetlands mitigation. The topic of performance standards is discussed in Section 4.2.3.

The monitoring program is a critical portion of the wetlands mitigation project and is usually designed in accord with state and/or federal guidelines specific to the location of the mitigation project. While the performance standards may change from state to state or between USACE districts, in general the focus of the monitoring is over an agreed-upon length of time. Schneider and Sprecher (2000) suggest that items to assess the development of wetland conditions on the mitigation site include the following (measured through an evaluation of wetland hydrology, vegetation, and soils monitored over time):

- surface water and groundwater elevations,
- elevation of wetland floor at critical points,

- physical integrity of inlet/outlet structures (if used),
- vegetative community composition and coverage,
- plant health and vegetative success,
- presence of nuisance species,
- wildlife species present,
- water quality (pH, turbidity, dissolved oxygen, or salinity, as appropriate),
- erosion of buffer zones, and
- evidence of human disturbance.

See Appendix C, Case Studies, for site-specific information on monitoring duration and parameters, and see Appendices D and E for examples.

The monitoring plan should include a detailed description of how each of these activities will be accomplished. As with the mitigation plan in general, the monitoring plan must begin with a description of the goals and objectives of the monitoring activity, which should be based on the performance standards that have been agreed upon with the appropriate regulatory agencies. The monitoring program should also outline the periodicity of the monitoring frequency. Again, this function may fluctuate, depending on the regulatory body for the site. The monitoring program should last a sufficient time to ensure the long-term success of the mitigation site, typically 5–10 years. Monitor the mitigation site twice per year. Some regulatory agencies will allow a shift in monitoring frequency to once a year in the later years of the monitoring program. Consideration should also be given to a preliminary monitoring visit approximately 6 weeks after completion of the mitigation to gauge initial planting success and adaptation to the mitigation area.

The manner in which monitoring is conducted varies depending on the circumstances of the site and the performance standards. A balance must be taken in terms of the data needs for evaluating the performance standards and the cost and effort of conducting the monitoring. For hydrology, the monitoring plan may consider the use of staff gauges for surface water measurement and piezometers for groundwater measurement. For vegetation in small wetlands, the entire vegetative community can be assessed for planting success. For vegetation in large wetlands, consideration may be given to the establishment of discrete monitoring plots that are established in representative wetland communities. A variety of methods can establish planting success, including stem counts (for understory and canopy species) and percent cover of planted vegetation. The addition of pioneering wetland species within the mitigation site can possibly lead to some change in the overall vegetative characteristic of the community. For evaluation of invasive species and herbivorous wildlife, the entire wetland, regardless of size, should be assessed to determine the presence of these factors.

As part of the monitoring program, the presence of invasive and undesirable vegetative species must be strongly controlled. The monitoring program must specify techniques for identifying and removing invasive species that may develop at a mitigation site. Practitioners are encouraged to contact their state or local resource management agencies for a list of invasive species common to their area. Control of the invasive species can be accomplished through the use of manual removal techniques or the application of herbicides.

The results of the monitoring are summarized and submitted to the appropriate agencies at a minimum on an annual basis and occasionally with interim reports for each monitoring visit to support the annual report. The annual report should include the following, at a minimum:

- list of parties responsible for the monitoring and preparation of the annual report,
- results of monitoring activities and quantitative analyses of the data,
- monitoring photographs,
- establishment of reference points,
- maps showing location where monitoring photographs were taken,
- maps showing monitoring areas,
- results of any remedial actions, and
- copies of field data sheets.

Table 6-1 shows a sample assessment form that can be used in support of individual monitoring activities and as documentation of monitoring visits or as an addendum to the annual report.

One of the more important aspects of the monitoring is the contingencies that are in place to correct deficiencies identified by the monitoring. This effort can be as simple as having supplemental plants on hand for replanting lost stock to ensure that vegetative success ratios are met or means by which invasive species identified in the mitigation site are addressed. Should damage by a herbivore be identified as a significant problem at the mitigation area, actions such as fencing or individual plant guards should be considered. Devices to enhance the usage of the site by predators could also be considered. In the event of failure due to hydrologic deficiencies or excesses, then contingency plans should be in effect for a complete redesign and reconstruction of the mitigation area.

Table 6-1. Sample mitigation wetlands assessment form

Mitigation Wetland Assessment Form

Project: ________________________ Date of Assessment: __________________

Location: ____

Wetland Creation: ____ Wetland Restoration: ____ and/or Wetland Enhancement ______

Person(s) Conducting the Assessment: ____

Initial Evaluation: ____ Semiannual: ______ Annual: ____

Hydrology
Has adequate wetland hydrology been achieved? Yes _____ No _____ Partial _________

If partial, what percentage of the assessment area has adequate wetland hydrology? _____ %

What percentage of the assessment area will be inundated or have open water for three weeks or more during the growing season? _______%.

Range of depths of inundation: _______________ to _______________.

Remarks:
____
____
____

Vegetation
Have all disturbed nonaquatic/wetland areas been revegetated? Yes _____ No ________

Approximate areal cover: ____%

Is the assessment area adequately protected from significant erosion? Yes ____ No _____

Is the area sustaining significant herbivory? Yes ____ No _______

Will additional plantings/seedings or actions be necessary to achieve adequate erosion control? Yes _____ No ______

Have hydrophytic plant species volunteered into the assessment area? Yes ______ No ______

Mitigation Wetland Assessment Form, page 2

Vegetation (Continued)
Indicate the results of survival evaluation compared to plantings. Include remarks on volunteer species in assessment area:

What percent of dominants that are FAC, FACW, or OBL species? ______%

Is the plant community a wetland? Yes ____ No _______

Will additional plantings/seedlings be necessary to create a hydrophytic dominated community? Yes ____ No _______

Functions and Values
Indicate the wetland functions currently observable in the mitigation wetland and their relative value in the wetland system.

Dominant species

Percent cover

Wetlands indicator status

Recommendations/Comments

7. WETLAND CREATION IN LAND RECLAMATION

Various circumstances involving large areas of land or substrate issues often lead to the development of wetlands. The following subsections describe wetland mitigation approaches and concerns associated with these special circumstances.

7.1 Mined Land

All land disturbed by mining must now be reclaimed. Specific requirements vary from state to state, but the general requirements are that the land must be left in a state that is safe, stable, and vegetated. Depending on the site, wetland creation may be possible.

Tailings basins, which are constructed containment facilities for ground waste from the mining process, appear to have suitable hydrology for creating wetlands. Tailings are pumped as a slurry into these basins, where the solids settle and the clean water is generally reclaimed. The size of these basins varies depending on the specifics of the mining operation, but some basins associated with iron mining in Minnesota are greater than 100 feet high and cover several thousand acres. Since tailings basins were designed to hold water, it may be possible to convert portions of them to wetlands at the end of operation.

However, tailings are infertile, contain little organic material, and do not provide a suitable substrate to support a diverse vegetative community of desirable wetland species. Tests conducted in Minnesota have shown that, by applying various substrates, vegetative cover and biomass were increased and wetland species were present in areas with suitable hydrology (Eger et al. 2000). Dredge material from Lake Superior was particularly successful in improving vegetation and currently is a waste product that needs a beneficial use (Figures 7.1 and 7.2). A full-scale demonstration project using dredge material to create a wetland in a portion of an iron mining tailings basin is currently being monitored in northern Minnesota (Eger et al. 2004).

Figure 7-1. Test plot, Keewatin, Nashwauk, Minnesota.

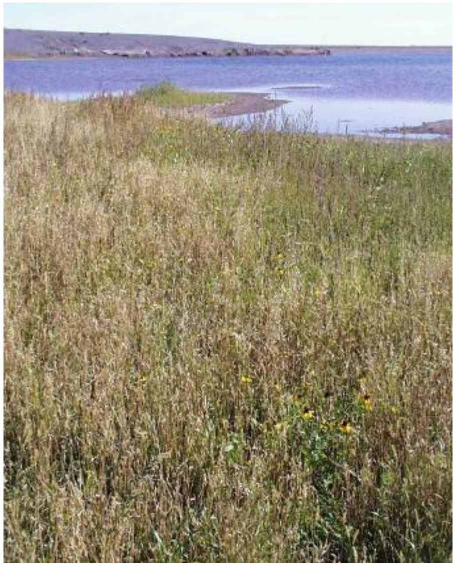

Figure 7-2. Full-scale wetland creation demonstration project, United Taconite, Eveleth, Minnesota.

The Republic Mine in northern Michigan has reclaimed a large portion of its land, including portions of its tailing basin, with the goal of creating a 2300-acre wetland preserve. This wildlife habitat includes about 600 acres of newly created wetlands developed on the tailings (the fine sandy waste product of the concentrating process) and reuse water basins of a former iron ore mine (for more information, go to http://www.nma.org/policy/reclamation/republic.asp).

(Left) **Figure 7-3. The Republic Wetlands Preserve is 2,300 acres of wildlife habitat, including about 600 acres of newly created wetlands.**
(Above) **Figure 7-4. The preserve was developed on the mine tailings and reuse water basins of the former Republic iron ore mine** (courtesy Republic Wetlands Preserve).

Recently there has been interest in creating wetlands over mine waste to control water quality problems. If tailings can be kept permanently submerged or anoxic, oxidation of the tailings and subsequent water quality problems are minimized. Water covers are now the most accepted method of controlling water quality problems relating to mine tailings in Canada. Pilot studies have demonstrated that establishing a wetland with permanently saturated soils is also effective in preventing acidification. Establishing a wetland over such areas when the mining is completed could provide not only successful reclamation but also wildlife habitat (Eger et al. 2000).

The water balance is critical in sustaining any wetland. Although the requirements for saturation in a wetland are usually expressed as a percent of the growing season, for a wetland created over mine waste, saturation must be continual. If the tailings surface dries out, the sulfides present in the tailings could oxidize and produce water quality problems. In a pilot test, tailings that were exposed to air for only a week oxidized sufficiently to drop the pH from 7 to 4 when the surface was reflooded.

Using a substrate over the tailings not only provides a more suitable growing media, but also helps maintain a saturated zone over the tailings. The substrate should be deep enough to maintain saturation even in periods of prolonged drought and to prevent metal migration from the tailings into the overlying wetland vegetation. In northern Minnesota, calculations suggest that a cover of 2 feet should meet these requirements for an emergent marsh wetland created along the perimeter of the tailings area. The center portion of the wetland would be maintained as an open-water wetland.

This approach works best for tailings that have never been allowed to oxidize. If oxidized tailings are flooded, acid and metals are released to the water. This water would need to be treated (typically with lime) to neutralize acid and remove metals before a wetland could be established.

7.2 Oil and Gas Drilling Sites

When wells are drilled for the oil and gas industry, a drilling fluid ("drilling mud"), typically bentonite and water, is required. During drilling, a sump or pit is constructed and the fluids are recirculated through the pit. Solids from the drilling process settle in the pit, and the fluid is reused in the drilling. At the end of drilling the spent fluid must generally be removed. The fluids are usually taken to large off-site disposal facilities, which range from 2 to as much as 4 acres and can contain more than one million gallons of wastewater. The clay settling from the wastewater forms an impervious layer in the bottom of the pond and reduces seepage loss. The higher water-holding capacity of the clay also helps in maintaining saturated conditions in the subsoil during dry periods. As a result, wetland hydrology is established in the pit, wetland vegetation develops and wildlife is attracted to the area (Figure 7-5).

Figure 7-5. Royce Kelley Pit #2 in McClain County, Oklahoma (courtesy Jim Shirazi, Oklahoma Department of Agriculture).

When these sites are full, they must be closed according to the state's requirements. Several disposal facilities in Oklahoma have received an exemption from the standard closure requirement since functional wetlands have developed on the site. In the future, these sites, if properly developed and managed, might provide wetland credit capacity,

7.3 Use of Dredged Material for Wetland Restoration

Several million cubic yards is dredged from U.S. ports/harbors/waterways each year to improve the nation's navigation system for commercial, national defense, and recreational purposes. Use of dredged material as resource material for wetland restoration, wildlife habitat, or fisheries improvement has become a viable option to conventional dredge and dispose. EPA and USACE have jointly presented 33 case studies that demonstrate potential beneficial uses of dredged material for environmental enhancement (wetlands restoration, wildlife habitat, fisheries improvement). The collaborative effort has also demonstrated the use of dredged material for engineered uses (land creation, land improvement, berm creation, etc.) and agricultural and product uses (construction material, aquaculture, topsoil).

Dredged material has been extensively used to restore and establish wetlands, including on mine land (Section 7.1). Factors that must be evaluated when considering the option of use of dredged materials include contaminant status of dredged material, environmental impact assessment, and legal constraints. Site selection and technical and economic feasibility complete the decision matrix.

Techniques for marsh creation have also been developed by USACE to enhance and stabilize dredge spoil materials placed in open water environments. A survey of the results from these projects indicated that there is insufficient evidence to conclude that manmade marshes in the coastal zone function like natural salt marshes or provide the important values of natural marshes.

USACE, EPA, and the U.S. Army Engineer Research and Development Center discuss over 50 case studies throughout the United States where dredged material has been used in a restoration or a wetlands creation project. These studies can be reviewed on the Internet at http://www.wes.army.mil/el/dots/budm/index.html.

8. ISSUES

There are many issues related to mitigation wetlands. They range from the initial question, "What is a wetland?" to the final question, "What is a successfully mitigated wetland?" Some of these issues are being addressed by other groups such as the Association of State Wetland Managers. They have been working to address the issues of wetland assessment and delineation to better answer the question, "What is a wetland?"

Furthermore, federal agencies—including USACE, EPA, and the National Oceanic and Atmospheric Administration (NOAA)—have been charged with developing a National Mitigation Action Plan, which will address a variety of policy issues, including performance standards to define when a mitigation project is a success. This action plan was the result of a report prepared by the National Research Council (NRC 2001), which concluded that—despite progress over the last 20 years—the goal of no net loss of wetland functions was not being met. Other reports have also reported a low success rate for mitigation wetland with only 30%–50% of the projects deemed "successful." Although the purpose of the document was not to solve policy issues, there were several areas that needed discussion and are addressed in this section.

8.1 Oversight

Issue: One of the major issues is the lack of regulatory oversight and follow-up. Several studies found that a high percentage of mitigation projects, although permitted, were never built. Even if projects are built, many of them are not tracked to ensure that annual reports are prepared and reviewed (NRC 2001, p. 3). Existing staff tend to focus on permitting new projects, and insufficient time is allotted for review of old projects. Since each project must be monitored for 3–5 years, the number of annual reports that need review increases each year.

Recommendation: The team recommends that all regulatory agencies, including USACE, be given adequate resources to ensure that they can focus on regulatory oversight of existing and newly established mitigation projects.

8.2 Regulatory

Issue: The regulatory climate is complex since federal, state and sometimes even local permits can be required. In some states authority for the program is given to local units of government, and in others the authority is divided based on the type of action. For example, in Minnesota the authority for most mitigation projects is delegated to local units of government. However, when it comes to projects related to mining, as well as projects which involve impacts to calcareous fens, the state regulates the impact to wetlands and oversees mitigation.

Since federal and state permits are required, conflicts can arise. Several states have entered into agreements with USACE administer the requirements of the 404 permits. The federal agencies then review and comment on the permit.

Recommendation: Where there are multiple oversight authorities in a watershed, we recommend that all agencies communicate and coordinate to the benefit of the watershed. Multiple authorities should also coordinate the mitigation requirements rather than relying on each applicant to coordinate among the various authorized agencies (e.g., New Jersey Meadowlands Interagency Mitigation Advisory Committee [MIMAC], see http://www.epa.gov/owow/estuaries/coastlines/01feb.pdf).

8.3 Incidental Wetlands

Issue: In some states wetlands that are created as the result of incidental actions must be permitted and mitigated if impacted. (Incidental wetlands are defined in Minnesota Rules, Chapter 8420 as wetlands "created solely by actions, the purpose of which was not to create the wetland." Examples include

A. beaver dam construction,
B. blockage of culverts through roadways maintained by a public or private entity,
C. actions by public or private entities that were taken for a purpose other than creating the wetland, or
D. any combination of items A to C.

Since incidental wetlands often are not designed or planted to be permanent, they may have low species diversity. A survey of incidental wetlands developed on lands disturbed by mining indicated that most of them had an inorganic substrate with low organic content and tended to be dominated by cattails with low species diversity (Melchert, Eger, and Jacobson 1995). Minnesota does not require a mitigation plan if these wetlands are disturbed. Other states generally do not have this exemption but may require less mitigation if these wetlands have low functional value.

Some states do not consider these protected wetlands, but USACE would require a permit to fill them if they meet the definition of "waters of the United States." If the wetland is developed on disturbed land that was originally wetland, it may become regulated.

Recommendation: The team recommends that if a wetland is disturbed, whether it resembles a incidental wetlands or not, care should be exercised to evaluate federal and state requirements for mitigation.

8.4 Constructed Treatment Wetlands

Issue: Constructed treatment wetlands built primarily to treat wastewater are not generally considered waters of the United States and therefore are not protected under the 404 program. Wetlands designed solely to treat a waste stream would not require mitigation when taken off treatment service. However some constructed wetlands do create habitat. This fact may be particularly important in arid areas where creation of wildlife habitat is a primary goal.

Constructed treatment wetlands used for habitat generally receive relatively clean water and act as a polishing step in the overall treatment of wastewater. An example would be a wetland built to provide tertiary treatment of municipal wastewater (see ITRC 2003). Several of these systems have been built to encourage public use and include hiking trails and educational activities. An example of this type of wetland is DuPont's Victoria Plant, located along the Guadalupe River, and the Victoria Barge Canal in Victoria, Texas, where industrial wastewater is treated and then released to a wetlands for final polishing before being released back into the Guadalupe River. Go to http://www.dupont.com/corpB420010615/environment/wetland/vctwtlnd.htm for more information and photos of this wetland.

The combination of constructed treatment wetlands and mitigation wetlands offers a method not only to remediate contaminated sites but also to provide important ecological enhancements to these areas. Wetlands built for habitat and treatment and fulfilling wetland functions should require mitigation if disturbed.

Recommendation: In general, the team recommends that constructed treatment wetlands, which are designed and constructed in uplands solely as a wastewater treatment system, should not be considered a natural wetland and mitigation not be required at the end of the treatment and post-closure phase of remediation. If the treatment system was initially designed not only as a wastewater treatment system but also to remain as a created wetland, any disturbance (according to CWA Section 404) should require mitigation.

8.5 Mitigation Banking

Issue: Although mitigation banks have been built and accepted, they are generally located some distance from the impacted wetland. The advantages and disadvantages of mitigation banks are discussed in detail in Section 2.6. To summarize, advantages include assured ecological success; reduced temporal losses usually associated with the standard mitigation process; cost savings due to economy of scale, which are often transferred from the bank to the mitigating party; and higher acceptance by the regulatory community. The primary concern with mitigation banks is that the mitigation site is usually located some distance from the site of the wetland impact and may not be able to replaces in-kind wetlands.

Recommendation: Mitigation banks should remain an option when considering compensatory mitigation, but the team recommends that advantages and limitations be carefully weighed in each circumstance.

8.6 Functional Equivalency

Issue: Mitigation wetlands should provide functional value comparable to the impacted area. In many instances wetlands that are constructed fail to replace all the functions of the wetland that were impacted. This failure occurs for a variety of reasons, including a lack of understanding of the functions the impacted wetlands performed in the watershed.

Recommendations:

- A functional assessment should be performed on the wetlands to be impacted, and the discovered functions must be a goal of the mitigated wetland.
- The team recommends that to further ensure mitigation wetlands' success, objectives and goals should be established in the earliest stages of the application process.
- In addition, the team recommends that sustainability be a factor established as part of the performance criteria of a mitigation project.

8.7 Replacement Ratios and No-Net-Loss

Issue: The goal of the various wetland conservation laws was to ensure that there was no net loss of wetland functions. To replace these natural functions with a mitigation wetland can take on the order of years to decades. Therefore, to replace a specific function may require a larger area of mitigation wetland than the size of the original impacted site. Ratios vary from 1:1 to 100:1 depending on the type of the mitigation and also vary from state to state.

In Minnesota, the replacement ratio is a function of the amount of wetlands remaining in a given area. The state has been divided into a number of regions based on the percentage of original wetlands remaining. In general, the larger the amount of original wetlands, the smaller the replacement ratio. Minimum replacement ratio ranges from 1:1 if >80% original wetlands are present to 2:1 if <80% are present. The minimum ratio increases if mitigation is out-of-kind. Other states have different criteria for determining a replacement ratio.

Recommendation: Regardless of the variability of mitigation ratios, which are based on an acre basis, the team believes that the goal should be to replace the loss of functions and that this should be the parameter used to calculate a mitigation ratio. By determining the ratio based on functions, the goal of no net loss in wetlands function will be more closely achieved.

8.8 In-Kind vs. Out-of-Kind

Issue: In-kind mitigation replaces the wetland functions lost with the same functions, i.e., apples-to-apples mitigation. Out-of-kind replaces the wetland with a different type of wetland, i.e., apples-to-oranges mitigation. Therefore, if a forested wetland is impacted, a forested wetland would be in-kind mitigation, while a prairie pothole would be out-of-kind mitigation (see Section 2.5). In general, USACE and most states require in-kind mitigation but permit out-of-kind mitigation in certain circumstances.

In Minnesota, although a progression of preferred options exists in the rules, the act incorporates flexibility. While on-site mitigation with the same type of wetland is preferred, another type of wetland in the same major watershed can also be accepted as in-kind mitigation. (Minnesota has been divided into 81 major watersheds). The rationale behind this approach includes both a desire for good projects and a desire to replace lost wetland types. Historically. Minnesota has lost some of each type of wetland, with the largest losses in the agricultural areas of the state. If the impact is to a wetland type with a historically low percentage loss, a good replacement to a wetland of a type that has a high historic loss may be acceptable.

Recommendation: The team maintains that functionality of wetlands should be preserved to the greatest extent possible. Out-of-kind wetlands should be allowed only under special circumstances when out-of kind wetlands mitigation provides functional benefits equal to or greater than an in-kind mitigation. Out-of-kind mitigation may also be considered on a case-by-case basis when there are watershed issues such as preventing invasive species introduction or when the overall environmental benefits are greater than the in-kind mitigation

8.9 Off Site vs. On Site

Issue: On-site mitigation is important to compensate for local flood control, unique wildlife habitat, or other locally important functions of the wetland. However, off-site compensatory mitigation can be used when it is otherwise impractical to attempt on-site compensatory mitigation or when on-site mitigation doesn't appear beneficial or improve the ecological condition of the site.

Recommendation: The team maintains that functionality of wetlands should be preserved on site to the greatest extent possible. Off-site wetlands should be allowed only when on-site wetlands are demonstrated to be impracticable or other environmental benefits are considered on a case-by-case basis. Cost should not be the only determining factor.

9. STAKEHOLDER ISSUES

A basic understanding of wetland ecology suggests that wetland functions in a created wetland will not mirror those of a wetland that has been established naturally. The no-net-loss policy is often compromised because follow-up inspections of compliance with monitoring requirements are not conducted.

9.1 Ecological Considerations Surrounding Wetland Mitigation

Though wetlands are now valued in the letter of the law and in the theory of policy, in practice, wetlands are not sufficiently protected by traditional mitigation or mitigation banking. Both approaches accept as legitimate the replacing of a natural wetland with a manmade wetland. Mitigated wetlands are not likely to be functionally equivalent to the natural wetland they replaced, at least in the near term. Fennessy and Roehrs (1997) concluded that a temporal loss of wetland function is generally guaranteed by the mitigation approach. Some functions, such as flood storage, can be replaced.

9.2 Mitigation Banking

The mitigation banking method was devised and accepted because it addresses the concerns of isolation, oversight, and maintenance. In practice, wetlands are not sufficiently protected by either traditional mitigation or mitigation banking. The fact remains that both approaches accept as legitimate the replacing of a natural wetland with a mitigation wetland. Mitigation banking should be considered as a last effort and reviewed to see whether it is meeting established goals.

9.3 Monitoring Duration

Mitigated wetlands should be monitored for 5–10 years (20 years for forested and similar wetlands systems), and midcourse corrections should be required. To support and ensure long-term monitoring and maintenance, the applicant should establish a long-term fund (e.g., an escrow account) or other financial assurances for long-term management/repairs/noxious weed control, etc. This step enables mitigated wetland sites to be protected in perpetuity, which the law requires.

9.4 Wetland Buffers

Regulators and everyone else involved in wetland mitigation need to realize the importance of buffers surrounding a mitigated wetland. ***Buffers increase the likelihood of mitigation success.*** They are beneficial for the wetland and also for the surrounding area, including land and all forms of wildlife and native plants. Buffers must be considered for all mitigation wetland projects. This attention must begin with the planning stage and continue throughout design, construction, and monitoring.

9.5 Small Wetland Exclusion

A wetland is a wetland whether large or one tenth of an acre. In certain states small wetlands have little or no regulatory protection. Since small wetlands help protect the diversity of species (Semlitsch 2000), their destruction wetlands can result in the collapse of wetland species, particularly amphibians. In the coastal Carolina bays, small wetlands are crucial to maintaining the regional biodiversity of the area; therefore, small wetlands are not expendable and should not be excluded from the permitting process simply based on size. The value of a wetland is intimately tied to its position in the landscape. Mitigating practices should take small wetland source sinkholes into account. For example, loss of many small wetlands must not be replaced by one large wetland. That would in itself destroy what had been. We should continue to analyze biodiversity relationships to wetland size, spatial distribution, connectedness, and how the loss of small wetlands affects the region’s natural process

9.6 Deed Restrictions and Conservation Easements

Deed restrictions are not a reliable mechanism in all states for protecting the mitigation wetland in perpetuity because new owners can sometimes remove the restriction from their deeds without notifying the original owner who placed the deed restriction. Conservation easements provide a more permanent solution to restriction of the use of a mitigated site to preserve the permanence of the wetland.

9.7 Performance Standards

Wetland mitigation success has been jeopardized for a variety of reasons, including ineffective site selection, incomplete knowledge of a mitigation site's hydrology, exotic plant invasion, catastrophic flooding and drought, human impacts during construction, poor use of construction equipment, and lack of maintenance. There is growing concern that restoration and creation projects do not consistently replace lost wetland structure and function (see Society of Wetland Scientists, http://www.sws.org/wetlandconcerns/Performance.html).

The fact that restoration projects are not replacing lost wetland function consistently underscores the importance of developing appropriate performance standards. Performance standards may differ by geographical region and/or wetland function. We suggest that standards and the duration of monitoring be developed during the permitting process. Performance standards should take account of the following factors:

- survival of planted stock,
- plant density,
- plant diversity,
- hydrology,
- nutrient inputs,
- monitoring different performance standards over time as the project matures,
- limiting the occurrence of exotic or nuisance plant species,
- monitoring for a minimum of five years or until the standards have been met for at least three consecutive years and until survival of the wetland is ensured, and most importantly,
- use of natural wetlands as a benchmark should be used to measure function (i.e., reference wetlands).

9.8 Public Considerations and Public Involvement

Acting without regard to a community's beliefs or values can seriously damage goodwill and delay the project, especially if wetland plans have already been implemented. Public involvement must begin at the initiation of the project. It is vitally important that the states, local governments, and EPA recognize that the benefits and positive effect of increased public involvement. Following are some of the issues that should be addressed during wetland permitting, mitigation, construction and monitoring:

- public education efforts,
- protection of water supplies,
- protection of ecological resource,
- restoration of resources,
- limiting the time between disturbance and mitigation,
- costs,
- implementation oversight,
- health risks,
- property values,

- noise during construction,
- aesthetically pleasing visuals during construction, and
- flooding/lowered water table.

10. BIBLIOGRAPHY

Adamus, P. R., E. J. Clairain, R. D. Smith, and R. E. Young. 1987. *Wetland Evaluation Technique (WET), Vol. II: Methodology* (Operational Draft). Washington, D.C.: Wetlands Research Program, U.S. Army Corps of Engineers, Environmental Laboratory.

Ammann, A. P., and A. L. Stone. 1991. *Method for the Comparative Evaluation of Nontidal Wetlands in New Hampshire*. Concord, N.H.: New Hampshire Department of Environmental Services.

Amon, J. P., and E. Briuer. 1993. "Groundwater Is Hydrology Source in Ohio Fen Creation." In *The Wetlands Research Program Bulletin*. Vicksburg, Miss.: U.S. Army Corps of Engineers.

ASWM (Association of State Wetlands Managers). 2004. "State Wetlands Protection Status." Available on the Internet at http://www.aswm.org/swp/states.htm.

Balzano, S., A. Eartman, L. Brancheau, W. Smejkal, and A. S. Greene. 2002. "Creating Indicators of Wetland Status (Quantity and Quality) Freshwater Wetland Mitigation in New Jersey." New Jersey Department of Environmental Protection, Division of Science Research and Technology.

Bartoldus, C. C. 1999. *A Comprehensive Review of Wetland Assessment Procedures: A Guide for Wetland Practitioners.* St. Michaels, Md.: Environmental Concern, Inc.

Bartoldus, C. C., E. W. Garbisch, and M. L. Kraus. 1994. *Evaluation for Planned Wetlands (EPW): A Procedure for Assessing Wetland Functions and a Guide to Functional Design*. St. Michaels, Md.: Environmental Concern, Inc.

Bolen, E. G., L. M. Smith, and H. L. Schramm, Jr. 1989. "Playa Lakes: Prairie Wetlands of the Southern High Plains." *Bioscience* **39**: 615–23.

Bonham, C. D. 1989. *Measurements for Terrestrial Vegetation*. New York: Wiley.

Brinson, M. M. 1993. *A Hydrogeomorphic Classification for Wetlands*. Wetlands Research Program Technical Report WRP-DE-4.

Broome, S. W. 1990. "Creation and Restoration of Tidal Wetlands of the Southeastern United States," in *Wetland Creation and Restoration: The Status of the Science*, J. A. Kusler and M. E. Kentula, eds. Washington, D.C.: Island Press.

Carothers, S. W., G. S. Mills, and R. R. Johnson. 1990. "The Creation and Restoration of Riparian Habitat in Southwestern Arid and Semiarid Regions," in *Wetland Creation and Restoration: The Status of the Science*, J. A. Kusler and M. E. Kentula, eds. Washington, D.C.: Island Press.

Christensen, N. I., R. B. Wilbur, and J. S. McLean. 1988. *Soil-Vegetation Correlations in the Pocosins of Croatan National Forest, North Carolina*. Fort Collins, Colo.: U.S. Fish and Wildlife Service.

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. *Classification of Wetlands and Deepwater Habitats of the United States*. FWS/OBS-79/31. Washington, D.C.: Office of Biological Services, U.S. Fish and Wildlife Service.

Dahl, T. E. 2000. *Status and Trends of Wetlands in the Conterminous United States 1986 to 1997*. Washington, D.C.: U.S. Fish and Wildlife Service.

Dennison, M. S., and J. F. Berry. 1993. *Wetlands: Guide to Science, Law, and Technology*. Park Ridge, N.J.: Noyes Publications.

DeWeerdt, S. 2004, "Reflections on the Pond." *Conservation Practice* **5**(1): 20–27.

Eger, P., Melchert, G., Antonson, D., Wagner, J., and Folman, J. 2000. "Creating Wetlands on Acid Generating Tailings—Maintenance-Free Reclamation," pp. 1149–58 in *Proceedings, Fifth International Conference on Acid Rock Drainage*. Denver, Colo., May 21–24.

Eger, P., D. Antonson, A. Johnson, and J. Folman. 2004. *Mined Land Reclamation with Dredge Material from Duluth-Superior Harbor*. St. Paul, Minn.: Minnesota Department of Natural Resources, Division of Lands and Minerals.

Eggers, S. 2004. Presentation at ITRC Mitigation Team Meeting, Orlando, Fla.

EPA (U.S. Environmental Protection Agency). 1990. "Guidelines for Specification of Disposal sites for Dredge and Fill Material." Section 404(b)(1), 40 CFR Part 230.

EPA. 1995. *America's Wetlands: Our Vital Link Between Land and Water*. EPA843-K-95-001.

EPA. 2002. *Methods for Evaluating Wetland Condition, #10 Using Vegetation to Assess Environmental Conditions in Wetlands.* EPA-822-R-02-020. Washington, D.C.: Office of Water.

EPA. 2003. "Wetland Types." Available on the Internet at http://www.epa.gov/owow/wetlands/types

Federal Interagency Committee for Wetland Delineation. 1989. *Federal Manual for Identifying and Delineating Jurisdictional Wetlands*. Cooperative Technical Publication. Washington D.C.: U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Fish And Wildlife Service, and USDA Soil Conservation Service.

Fennessy, S., and J. Roehrs. 1997. *A Functional Assessment of Mitigation Wetlands in Ohio: Comparison with Natural Systems*. Columbus, Ohio: EPA Division of Surface Water.

Firehock, K., J. V. Middleton, K. D. Starinchak, C. Williams, and L. Geoff. 1998. *Handbook for Wetlands Conservation and Sustainability*. Gaithersburg, Md.: Izaak Walton League of America.

Garbisch, E. W. 2002. *Dos and Don'ts of Wetland Construction Creation, Restoration, and Enhancement*. St. Michaels, Md.: Environmental Concern, Inc.

Golet, F. C., and J. S. Larson. 1974. "Classification of Wetland and Deepwater Habitats." Available on the Internet at http://www.npwrc.usgs.gov/resource/1998/classwet/table4.htm.

Haukos, D. 1997. "Management of Playas for Wildlife Enhancement," in *Proceedings of the Playa Lake 1994 Symposium.*

Hammer, D. A. 1989. *Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural*. Boca Raton, Fla.: Lewis.

Hammer, D. A. 1992. *Creating Freshwater Wetlands*. Boca Raton, Fla.: Lewis.

Holland, G. G. 1990. "Regional Analysis of the Creation and Restoration of Kettle and Pothole Wetlands," in *Wetland Creation and Restoration: The Status of the Science*, J. A. Kusler and M. E. Kentula, eds. Washington, D.C.: Island Press.

ITRC (Interstate Technology & Regulatory Council). 2003. *Technical and Regulatory Guidance Document for Constructed Treatment Wetlands*. WTLND-1. Washington, D.C.: Interstate Technology & Regulatory Council, Constructed Wetlands Team. Available on the Internet at http://www.itrcweb.org.

Jensen, S. E., and W. S. Platts. 1990. "Restoration of Degraded Riverine/Riparian Habitat in the Great Basin and Snake River Regions, in *Wetland Creation and Restoration: The Status of the Science*, J. A. Kusler and M. E. Kentula, eds. Washington, D.C.: Island Press.

Kadlec, R. H., and R. L. Knight. 1996. *Wetlands for Wastewater Treatment*. Boca Raton, Fla.: Lewis.

Kent, D. M. 2001. "Evaluating Wetland Functions and Values," in *Applied Wetlands Science and Technology*, D. M. Kent, ed. Boca Raton, Fla.: Lewis.

Kent, M., and P. Coker. 1992. *Vegetative Description and Analysis, A Practical Approach*. Boca Raton, Fla.: CRC Press.

Kent, D. M., R. J. Reinmold, and J. M. Kelly. 1990. "Macroscale Wetlands Delineation and Assessment." Technical Report to the Connecticut Department of Transportation. Metcalf and Eddy, Inc.

Kent, D. M., R. J. Reinmold, J. M. Kelly, and C. E. Tammi. 1992. "Coupling Wetland Structure and Function: Developing a Condition Index for Wetlands Monitoring," in *Ecological Indicators*, D. H. McKenzie, D. E. Hyatt, and V. J. McDonald, eds. London: Elseveir Applied Science.

Kruczynski, W. L. 1990. "Options to Be Considered in Preparation and Evaluation of Mitigation Plans in Wetland Creation and Restoration," in *Wetland Creation and Restoration: The Status of the Science*, J. A. Kusler and M. E. Kentula, eds. Washington, D.C.: Island Press.

Magee, D. W. 1998. *A Rapid Procedure for Assessing Wetland Functional Capacity, Based on Hydrogeomorphic (HGM) Classification*. Association of State Wetland Managers.

Maughan, J. T. 1993. *Ecological Assessment of Hazardous Waste Sites*. New York: Van Nostrand Reinhold.

Melchert, G., P. Eger, and M. Jacobson. 1995. *A Survey of Wetlands Created on Lands Disturbed by Iron Mining in Northeastern Minnesota*. Minnesota Department of Natural Resources, Division of Minerals.

Mitsch, W. J., and J. G. Gosselink. 1992. *Wetlands*. New York: Van Nostrand Reinhold.

Mitsch, W. J., and J. G. Gosselink. 1993. *Wetlands*. New York: Wiley and Sons, Inc.

"National Wetlands Mitigation Action Plan." 2002. Available on the Internet at http://www.usace.army.mil/inet/functions/cw/hot_topics/Mit_Action_Plan_24Dec02.pdf.

Niering, W. A. 1998. *Wetlands*. New York: Knopf.

NJDEP (New Jersey Department of Environmental Protection). 2002 "Creating Indicators of Wetlands Status Report."

NJDEP. 2003. "Freshwater Wetlands Protection Act Rules." N.J.A.C. 7:7A.

NRC (National Research Council). 2001. *Compensating for Wetlands Losses under the Clean Water Act*. Washington D.C.: National Academy Press.

NWPF (National Wetlands Policy Forum). 1988. *Protecting America's Wetlands: An Action Agenda*. Washington, D.C.: The Conservation Foundation.

PADEP (Pennsylvania Department of Environmental Protection). 1995. *Design Criteria for Wetland Replacement*. Harrisburg, Pa.

Pierce, G. J. 1993. *Planning Hydrology for Constructed Wetlands*. Poolesville, Md.: Wetland Training Institute.

Reed, S. C., and D. S. Brown. 1992. "Constructed Wetland Design: The First Generation." *Water Environment Research* **64**: 776–81.

Schneider, C. B., and S. W. Sprecher. 2000. *Wetlands Management Handbook*. ERCE/EL SR-00-16. Vicksburg, Miss.: U.S. Army Engineer Research and Development Center.

Semlitsch, R. D. 2000. "Size Does Matter: The Value of Small Isolated Wetlands." *National Wetlands Newsletter* January-February: 5–13.

Sipple, W. S. 1999. *Days Afield*. Baltimore, Md.: Gateway.

Smith, R. D. 1993. *A Conceptual Framework for Assessing the Functions of Wetlands*. Wetlands Research Program Technical Report WRP-DE-3. Vicksburg, Miss.: U.S. Army Engineer Research and Development Center.

Smith, R. D., A. Ammann, C, Bartoldus, and M. Brinson. 1995. *An Approach for Assessing Wetland Functions Using Hydrogeomorphic Classification, References Wetlands, and Functional Indices*. Wetlands Research Program Tech Report WRP-DE-9. Vicksburg, MS: U.S. Army Corps of Engineers, Waterways Experiment Station. Available on the Internet at http://www.wes.army.mil/el/wetlands/wlpubs.html.

Sprecher, S. W. 2000. "Installing Monitoring Wells/Piezometers in Wetlands." WRAP Technical Notes Collection, ERDC TN-WRAP-00-02. Vicksburg, Miss.: U.S. Army Engineer Research and Development Center.

Steiert, J. 1995. *Playas: Jewels of the Plains*. Lubbock, Tex.: Texas Tech University Press.

Streever, B. 1999. *Examples of Performance Standards for Wetland Creation and Restoration in Section 404 Permits and an Approach for Developing Performance Standards*. Wetlands Research Program Technical Report WRP WG-RS-3.3. Vicksburg, Miss.: U.S. Army Engineer Research and Development Center.

Thunhorst, G. A. 1993. *Wetland Planting Guide for the Northeastern United States Plants for Wetlands Creation, Restoration, and Enhancement*. St. Michaels, Md.: Environmental Concern, Inc.

Tiner, R. W. 1998. *In Search of Swampland: A Wetland Sourcebook and Field Guide*. New Brunswick, N.J.: Rutgers University Press.

USACE (U.S. Army Corps of Engineers). 1987. *Corps of Engineers Wetlands Delineation Manual*. Wetlands Research Program Technical Report Y-87-1. Vicksburg, Miss.: U.S. Army Engineer Research and Development Center.

USACE. 2001. "Guidance for the Establishment and Maintenance of Compensatory Mitigation Projects Under the Corps Regulatory Program Pursuant to Section 404(a) of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899." Regulatory Guidance Letter No. 01-1.

USACE. 2002. "Guidance on Compensatory Mitigation Projects for Aquatic Resource Impacts Under the Corps Regulatory Program Pursuant to Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899." Regulatory Guidance Letter 02-2. (Reproduced in Appendix G.)

USACE. 2004. Presentation by Alan Miller on the National Mitigation Action Plan.

USACE, New England District. 1995. *The Highway Methodology Workbook Supplement, Wetland Functions and Values, A Descriptive Approach*. NEDEP-360-1-30a.

USACE, New York District. 2003. "Draft Compensatory Mitigation Guidelines and Mitigation Checklist for Review of Mitigation Plans." Special Public Notice.

USDA (U.S. Department of Agriculture). 1992. "Wetland Restoration, Enhancement or Creation," Chap. 13 in *National Engineering Field Book*. EFH-1A.

USFWS (U.S. Fish and Wildlife Service). 1956. Circular 39.

USFWS. 1982. *The Ecology of Southeastern Shrub Bogs (Pocosins) and Carolina Bays: A Community Profile*. FWS/OBS-82/04. U.S. Department of Interior.

USFWS. 1983. *Pocosins: A Changing Wetland Resource*. FWS/OBS-83/32. U.S. Department of Interior.

USFWS. 1987. *The Ecology of Peat Bogs of the Glaciated Northeastern United States: A Community Profile*. Biological Report 85(7.16). U.S. Department of Interior.

Welsch, D. J., D. L. Smart, J. N. Boyer, P. Minkin, H. C. Smith, and T. L. McCandless. 1995. *Forested Wetlands: Functions, Benefits and the Use of Best Management Practices*. NA-PR-01-95. U.S. Department of Agriculture.

Wilen, B. O., and R. W. Tiner. 1993. "Wetlands of the United States," pp. 515–636 in *Wetlands of the World*, Vol. I, D. F. Whigham, D. Dykyjova, and S. Hejny, eds. Dordrecht, Netherlands: Kluwer Academic Publishers.

11. OTHER RESOURCES

http://www.fs.fed.us/r8/boone/vernal.pdf
A Guide to Creating Vernal Wetland—All the Information You Need to Build and Maintain an Ephemeral Wetland

http://ser.org/content/ecological_restoration_primer.asp
The SER Primer on Ecological Restoration—Ecological restoration is an intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity, and sustainability. Frequently, the ecosystem that requires restoration has been degraded, damaged, transformed, or entirely destroyed as the direct or indirect result of human activities. In some cases, these impacts to ecosystems have been caused or aggravated by natural agencies such as wildfire, floods, storms, or volcanic eruption, to the point at which the ecosystem cannot recover its predisturbance state or its historic developmental trajectory.

http://ser.org/content/guidelines_ecological_restoration.asp
"A Society for Ecological Restoration Publication: Guidelines for Developing and Managing Ecological Restoration Projects," June 2004, by Andre Clewell, John Rieger, and John Munro—These guidelines are suggested for conceiving, organizing, conducting, and assessing ecological restoration projects.

http://www.sws.org/wetlandconcerns/banking.html
"Wetland Mitigation Banking"—The Society of Wetland Scientists supports wetland mitigation banking to improve mitigation success and contribute to the goal of no net loss of wetlands. Banked wetlands are systems that have been restored or created for compensatory mitigation in advance of those unavoidable impacts to wetlands permitted by regulatory authorities. The banked wetlands should be managed, protected in perpetuity, functionally similar to the altered systems and within defined geographical areas.

Appendix A

Acronyms

ACRONYMS

ASWM	Association of State Wetlands Managers
CFR	Code of Federal Regulations
CWA	Clean Water Act
EPA	U.S. Environmental Protection Agency
FAC	facultative plants
FACU	facultative upland plants
FACW	facultative wetland plants
FWS	U.S. Fish and Wildlife Service
GIS	geographical information system
HGM	hydrogeomorphic
HUC	Hydrologic Unit Code
ITRC	Interstate Technology & Regulatory Council
MAP	Mitigation Action Plan
NOAA	National Oceanic and Atmospheric Administration
OBL	obligate wetland plants
RAW	Rapid Assessment of Wetlands
RGL	Regulatory Guidance Letter
UPL	upland plants
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
WET	Wetland Evaluation Technique

Appendix B

Glossary

GLOSSARY

ambient monitoring—Monitoring within natural systems (e.g., lakes, rivers, estuaries, wetlands) to determine existing conditions.

created wetland—A wetland at a site where it did not formerly occur. Created wetlands are designed to meet a variety of human benefits including, but not limited to, the treatment of water pollution discharges (e.g., municipal wastewater, storm water, etc.) and the mitigation of wetland losses permitted under Section 404 of the Clean Water Act. This term encompasses the term "constructed wetland" as used in other EPA guidance and documents.

adjacent—Bordering, contiguous, or neighboring. Wetlands separated from other waters of the United States by manmade dikes or barriers, natural river berms, beach dunes, and the like are adjacent wetlands (33 CFR 328).

artificial reef—A structure constructed or placed in navigable waters of the United States or in the waters overlying the outer continental shelf for the purpose of enhancing fishery resources and commercial and recreational fishing opportunities. The term does not include activities or structures such as wing deflectors, bank stabilization, grade stabilization structures, or low-flow key ways (33 CFR 322).

baseline—Generally, where the shore directly contacts the open sea, the line on the shore reached by the ordinary low tides constitutes the baseline from which the distance of 3 geographic miles is measured. The baseline has significance for both domestic and international law and is subject to precise definitions. When offshore rocks, islands, or other bodies exist, the baseline may have to be drawn seaward of such bodies (33 CFR 329).

brush—Scrub vegetation.

clear—To remove unwanted growth or items.

compaction—Breaking down soil particles by mechanical means, resulting in loss of soil macropores and leading to a lack of oxygen and water in the soils. A major cause of death of tree roots. See soil compaction.

compensatory mitigation—Compensating for the impact by replacing or providing substitute resources or environments (40 CFR 1508).

contaminant—A chemical or biological substance in a form that can be incorporated into, onto, or be ingested by and that harms aquatic organisms, consumers of aquatic organisms, or users of the aquatic environment and includes but is not limited to the substances on the 307(a)(1) list of toxic pollutants (40 CFR 230).

cultivating—Physical methods of soil treatment employed within established farming, ranching, and silviculture lands on farm, ranch, or forest crops to aid and improve their growth, quality, or yield (33 CFR 323).

de minimis—Of, affecting, or concerning a very small or trifling matter. The de minimis doctrine states that the law does not concern itself with very small or trifling matters.

denial without prejudice—Means that there is no prejudice to the right of the applicant to reinstate processing of a permit application if subsequent approval is received from the appropriate federal, state and/or local agency on a previously denied authorization and/or certification. Even if official certification and/or authorization is not required by state or federal law, but a state, regional, or local agency having jurisdiction or interest over the particular activity comments on the application, due consideration shall be given to those official views as a reflection of local factors of the public interest (33 CFR 320).

dike or dam—Any impoundment structure that completely spans a navigable water of the United States and that may obstruct interstate waterborne commerce. The term does not include weirs (33 CFR 321).

discharge of dredged material—Any addition of dredged material into U.S. waters. The term includes, without limitation, the addition of dredged material to a specified discharge site located in U.S. waters and the runoff or overflow from a contained land or water disposal area. Discharges of pollutants into U.S. waters resulting from the onshore subsequent processing of dredged material that is extracted for any commercial use (other than fill) are not included within this term and are subject to Section 402 of the Clean Water Act even though the extraction and deposit of such material may require a permit. The term does not include plowing, cultivating, seeding, and harvesting for the production of food, fiber, and forest products. The term does not include de minimis, incidental soil movement occurring during normal dredging operations (33 CFR 323).

discharge of fill material—The addition of fill material into U.S. waters. The term does not include plowing, cultivating, seeding and harvesting for the production of food, fiber, and forest products. The term generally includes, without limitation, the following activities:

a. placement of fill that is necessary for the construction of any structure in U.S. waters;
b. building any structure or impoundment requiring rock, sand, dirt, or other material for construction;
c. site-development fills for recreational, industrial, commercial, residential, and other uses;
d. causeways or road fills;
e. dams and dikes;
f. artificial islands;
g. property protection or reclamation devices such as riprap, groins, seawalls, breakwaters, revetments;
h. beach nourishment;
i. levees;
j. artificial reefs; and

k. fill for structures such as sewage treatment facilities, intake and outfall pipes associated with power plants, and subaqueous utility lines (33 CFR 323).

discharge point—The point within the disposal site at which the dredged or fill material is released (40 CFR 230).

disposal site—That portion of U.S. waters where specific disposal activities are permitted and consisting of a bottom surface area and any overlying volume of water. In the case of wetlands on which surface water is not present, the disposal site consists of the wetland surface area (40 CFR 230).

dredged material—Material that is excavated or dredged from U.S. waters (33 CFR 323).

emergency—A situation which would result in an unacceptable hazard to life, a significant loss of property, or an immediate, unforeseen, and significant economic hardship if corrective action requiring a permit is not undertaken within a time period less than the normal time needed to process the application under standard procedures. USACE Division Engineers are authorized to approve special processing procedures in emergency situations (33 CFR 325).

enforcement—The policy of regulating the waters of the United States by discouraging activities that have not been properly authorized and by requiring corrective measures, where appropriate, to ensure those waters are not misused and to maintain the integrity of the regulatory program (33 CFR 326).

enhancement—An activity increasing one or more natural or artificial wetland functions, for example, the removal of a point source discharge impacting a wetland.

excavate—To dig out and remove or to form a cavity or hole.

federal project—A USACE project (work or activity of any nature for any purpose which is to be performed by the Chief of Engineers pursuant to Congressional authorizations) involving the discharge of dredged or fill material into waters of the United States or transportation of dredged material for the purpose of dumping it in ocean waters subject to Section 404 of the Clean Water Act or Section 103 of the Marine Protection, Research, and Sanctuaries Act (33 CFR 327).

fill material—Any material used for the primary purpose of replacing an aquatic area with dry land or of changing the bottom elevation of a water body. The term does not include any pollutant discharged into the water primarily to dispose of waste (33 CFR 323).

forested—Covered with trees and underbrush.

functions—The role wetlands serve which are of value to society or the environment.

general permit—A Department of the Army authorization issued on a nationwide or regional basis for a category or categories of activities. This refers to both those regional permits issued by USACE District or Division Engineers on a regional basis and to nationwide permits which are issued by the Chief of Engineers through publication in the Federal Register (33 CFR 325).

grassland—Land on which the dominant plant forms are grasses and herbs.

habitat—The environment occupied by individuals of a particular species, population, or community.

harvesting—Physical measures employed directly upon farm, forest, or ranch crops within established agricultural and silvicultural lands to bring about their removal from farm, forest, or ranch land, not including the construction of farm, forest, or ranch roads (33 CFR 323).

headwaters—The point on a nontidal stream above which the average annual flow is less than 5 cubic feet per second (cfs). The USACE District Engineer may estimate this point from available data by using the mean annual area precipitation, area drainage basin maps, and the average runoff coefficient, or by similar means. For streams that are dry for long periods of the year, district engineers may establish the headwaters as that point on the stream where a flow of 5 cfs is equaled or exceeded 50% of the time (33 CFR 330).

herb—A seed-producing plant that does not develop persistent woody vegetation but dies down at the end of a growing season.

herbaceous—Having little or no woody tissue and persisting usually for a single growing season.

herbage—The succulent parts of herbaceous plants.

high-tide line—The line of intersection of the land with the water's surface at the maximum height reached by a rising tide. The high-tide line may be determined, in the absence of actual data, by a line of oil or scum along shore objects, a more or less continuous deposit of fine shell or debris on the foreshore or berm, other physical markings or characteristics, vegetation lines, tidal gages, or other suitable means that delineate the general height reached by a rising tide. The line encompasses spring high tides and other high tides that occur with periodic frequency but does not include storm surges in which there is a departure from the normal or predicted reach of the tide due to the piling up of water against a coast by strong winds (33 CFR 328).

historic properties—Any property listed or eligible for listing in the National Register of Historic Places (33 CFR 325).

hydrology—The science dealing with the properties, distribution, and circulation of water both on the surface and under the earth.

individual permit—A Department of the Army authorization issued following a case-by-case evaluation of a specific project in accordance with the procedures of the applicable regulation and 33 CFR Part 325 and a determination that the proposed structure or work is in the public interest pursuant to 33 CFR Part 320 (33 CFR 322).

joint procedures—Those procedures developed jointly with states and other federal agencies with ongoing permit programs for activities also regulated by the Department of the Army. Such procedures may be substituted for the procedures in 33 CFR Part 325.2, paragraphs (a)(1) through (a)(5) provided that the substantive requirements of those sections are maintained (33 CFR 325).

jurisdiction—bays and estuaries—Section 10 jurisdiction extends to the entire surface and bed of all water bodies subject to tidal action. Jurisdiction thus extends to the edge of all such water bodies, even though portions may be extremely shallow or obstructed by shoals, vegetation, or other barriers. Marshlands and similar areas are considered navigable in law, but only so far as they are subject to inundation by the mean high waters (33 CFR 329).

jurisdiction—lateral limits—Waters of the United States may be divided into three categories of jurisdiction. The categories are the territorial seas, tidal waters, and nontidal waters. Jurisdictions are defined as follows:

a. **territorial seas**—The limit of jurisdiction in the territorial seas is measured from the baseline in a seaward direction a distance of 3 nautical miles.

b. **tidal waters of the United States**—The landward limits of jurisdiction in tidal waters extend:
   (1) to the high tide line or
   (2) when adjacent nontidal waters of the United States are present, to the limits for the nontidal waters.

c. **nontidal waters of the United States**—The limits of jurisdiction in nontidal waters extend
   (1) in the absence of adjacent wetlands, to the ordinary high-water mark; or
   (2) when adjacent wetlands are present, beyond the high-water mark to the limit of the adjacent wetlands; or
   (3) when the water of the United States consists only of wetlands, to the limit of the wetland (33 CFR 328).

jurisdiction—oceanic and tidal waters—The navigable waters of the United States over which jurisdiction extends include all ocean and coastal waters within a zone 3 geographic (nautical) miles seaward from the baseline. Wider zones are recognized for special regulatory powers exercised over the outer continental shelf (33 CFR 329).

jurisdiction—rivers, lakes, and marshlands—Section 10 jurisdiction extends laterally to the entire water surface and bed of a navigable water body, which includes all the land and waters below the ordinary high-water mark. Jurisdiction thus extends to the edge of all such water bodies, even though portions of the water body may be extremely shallow or obstructed by shoals, vegetation, or other barriers. Marshlands and similar areas are thus considered navigable in law but only so far as the area is subject to inundation by the ordinary high waters. Ownership of a river or lake bed or of the lands between high- and low-water marks will vary according to state law; however, private ownership of the underlying lands has no bearing on the existence or extent of the dominant federal jurisdiction over a navigable water body (33 CFR 329).

jurisdiction—shifting boundaries—Permanent changes of the shoreline configuration result in similar alterations of the boundaries of the navigable waters of the United States. Gradual changes which are due to natural causes constitute changes in the bed of a water body which also change the shoreline boundaries of the navigable waters of the United States. However, an area will remain navigable in law even though no longer covered with water whenever the change has occurred suddenly or was caused by artificial forces intended to produce that change (33 CFR 329).

jurisdiction—shoreward limit—Section 10 jurisdiction in coastal areas extends to the line on the shore reached by the plane of the mean (average) high water. Where precise determination of the actual location of the line becomes necessary, it must be established by survey with reference to the available tidal datum, preferably averaged over a period of 18.6 years. Less precise methods, such as observation of the apparent shoreline, which is determined by reference to physical markings, lines of vegetation, or changes in type of vegetation, may be used only where an estimate is needed of the line reached by the mean high water (33 CFR 329).

lake—A standing body of open water that occurs in a natural depression fed by one or more streams from which a stream may flow, that occurs due to the widening or natural blockage or cutoff of a river or stream, or that occurs in an isolated natural depression that is not a part of a surface river or stream. The term also includes a standing body of open water created by artificially blocking or restricting the flow of a river, stream, or tidal area. The term does not include artificial lakes or ponds created by excavating and/or diking dry land to collect and retain water for such purposes as stock watering, irrigation, settling basins, cooling, or rice growing (33 CFR 323).

land—The surface of the earth and all its natural resources.

letters of permission—A type of individual permit issued through an abbreviated processing procedure which includes coordination with federal and state fish and wildlife agencies, as required by the Fish and Wildlife Coordination Act, and a public interest evaluation, but without the publishing of an individual public notice (33 CFR 325).

mean high water—The average (arithmetic mean) position of the high water mark.

mechanized—To provide with mechanical power.

mechanical—Produced or operated by a machine or tool.

minor drainage in waters of the United States—Drainage which is limited to drainage within areas that are part of an established farming or silviculture operation. It does not include drainage associated with the immediate or gradual conversion of a wetland to a nonwetland or conversion from one wetland use to another (for example, silviculture to farming). In addition, minor drainage does not include the construction of any canal, ditch, dike, or other waterway or structure which drains or otherwise significantly modifies a stream, lake, swamp, bog, or any other wetland or aquatic area constituting waters of the United States.

minor drainage—The discharge of dredged or fill material

a. incidental to connecting upland drainage facilities to waters of the United States, adequate to effect the removal of excess soil moisture from upland croplands;
b. for the purpose of installing ditching or other such water control facilities incidental to planting, cultivating, protecting, or harvesting of rice, cranberries or other wetland crop species, where these activities and the discharge occur in waters of the United States which are in established use for such agricultural and silvicultural wetland crop production;
c. for the purpose of manipulating the water levels of, or regulating the flow or distribution of water within, existing impoundments which have been constructed in accordance with applicable requirements of CWA, and which are in established use for the production of rice, cranberries, or other wetland crop species; or
d. incidental to the emergency removal of sandbars, gravel bars, or other similar blockages which are formed during flood flows or other events, where such blockages close or constrict previously existing drainage ways and, if not promptly removed, would result in damage to or loss of existing crops or would impair or prevent the plowing, seeding, harvesting or cultivating of crops on land in established use for crop production. Such removal does not include enlarging or extending the dimensions of, or changing the bottom elevations of, the affected drainage way as it existed prior to the formation of the blockage. Removal must be accomplished within one year of discovery of such blockages in order to be eligible for exemption. (33 CFR 323)

minor road crossing fill—A crossing that involves the discharge of less than 200 cubic yards of fill material below the plane of ordinary high water. The crossing may require a permit from the U.S. Coast Guard if located in navigable waters of the United States (33 CFR 330).

modification—A modification of the terms or conditions of the permit requires by public interest, as determined by the District Engineer (DE). A modification may be initiated upon request by the permittee or as a result of reevaluation of the circumstances and conditions of a permit. The DE shall consult with resource agencies before modifying any terms or conditions, that would result in greater impacts, for a project about which that agency expressed a significant interest in the term, condition, or feature being modified prior to permit issuance (33 CFR 325).

mowing—Cutting or knocking down standing herbage.

nationwide permits—A type of general permit representing Department of the Army authorizations that have been issued by the regulation for certain specified activities nationwide. If certain conditions are met, the specified activities can take place without the need for an individual or regional permit (33 CFR 330).

navigable waters of the United States—Those waters that are subject to the ebb and flow of the tide and/or are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce. A determination of navigability, once made, applies laterally over the entire surface of the water body and is not extinguished by later actions or events which impede or destroy navigable capacity. Precise definitions of navigable waters of the United States or navigability are ultimately dependent on judicial interpretation and cannot be made conclusively by administrative agencies (33 CFR 329).

ocean waters—Those waters of the open seas lying seaward of the base line from which the territorial sea is measured, as provided for in the Convention on the Territorial Sea and the Contiguous Zone (33 CFR 324).

ordinary high-water mark—That line on the shore established by the fluctuations of water and indicated by physical characteristics such as

a. a clear, natural line impressed on the bank;
b. shelving;
c. changes in the character of soil;
d. destruction of terrestrial vegetation;
e. the presence of litter and debris; or
e. other appropriate means that consider the characteristics of the surrounding areas (33 CFR 328 and 329).

permit action—The evaluation of and decision on an application for a Department of the Army (DA) permit pursuant to Sections 9 or 10 of the Rivers and Harbors Act of 1899, Section 404 of the Clean Water Act, or Section 103 of the Marine Protection, Research, and Sanctuaries Act, as amended, or the modification, suspension, or revocation of any DA permit (33 CFR 327).

plowing—All forms of primary tillage, including moldboard, chisel, or wide-blade plowing, discing, harrowing, and similar physical means utilized on farm, forest, or ranch land for the breaking up, cutting, turning over, or stirring of soil to prepare it for the planting of crops. It does not include the redistribution of soil, rock, sand, or other surficial materials in a manner which changes any area of the waters of the United States to dry land (33 CFR 323).

pollutant—Dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials not covered by the Atomic Energy Act, heat, wrecked or discarded equipment, rock, sand, cellar dirt, and industrial, municipal, and agricultural waste discharged into water (40 CFR 230).

pollution—The manmade or man-induced alteration of the chemical, physical, biological, or radiological integrity of an aquatic ecosystem (40 CFR 230).

practicable—Possible to practice or perform, i.e., feasible. Federal regulations further state it means available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes (40 CFR 231).

programmatic permits—A type of general permit founded on an existing state, local, or other federal agency program and designed to avoid duplication with that program (33 CFR 325).

public hearing—A public proceeding conducted for the purpose of acquiring information or evidence which will be considered in evaluating a proposed DA permit action or federal project and which affords the public an opportunity to present their views, opinions, and information on such permit actions or federal projects (33 CFR 327).

public notice—The primary method of advising all interested parties of the proposed activity for which a permit is sought and of soliciting comments and information necessary to evaluate the probable impact on the public interest. The notice must, therefore, include sufficient information to give a clear understanding of the nature and magnitude of the activity to generate meaningful comment (33 CFR 325).

publicity—The USACE District Engineer (DE) establishes and maintains a program to ensure that potential applicants for permits are informed of the requirements of 33 CFR and of the steps required to obtain permits for activities in waters of the United States or ocean waters. Whenever the DE becomes aware of plans being developed by either private or public entities which might require permits for implementation, he advises the potential applicant in writing of the statutory requirements and the provisions of this regulation. Whenever the DE is aware of changes in Corps of Engineers regulatory jurisdiction, he issues appropriate public notices (33 CFR 325).

regional permit—A type of general permit. May be issued by a Division or District Engineer. The issuing authority determines and adds appropriate conditions to protect the public interest. When the issuing authority determines on a case-by-case basis that the concerns for the aquatic environment so indicate, he may exercise discretionary authority to override the regional permit and require an individual application and review. No regional permit shall be issued for a period of more than five years (33 CFR 325).

restoration—An activity returning a wetland from a disturbed or altered condition with lesser acreage or functions to a previous condition with greater wetland acreage or functions. For example, restoration might involve the plugging of a drainage ditch to restore the hydrology to an area that was a wetland before the installation of the drainage ditch.

riparian—Area next to or substantially influenced by water. May include areas adjacent to rivers, lakes, or estuaries. These areas often include wetlands.

scrub—A stunted tree or shrub.

Section 10—Section 10 of the Rivers and Harbors Act (33 CFR 320).

Section 404—Section 404 of the Clean Water Act (33 CFR 320).

seeding—The sowing of seed and placement of seedlings to produce farm, ranch, or forest crops, including the placement of soil beds for seeds or seedlings on established farm and forest lands (33 CFR 323).

shrub—A low, usually several-stemmed, woody plant.

soil compaction—Compression of soil particles that may results form the movement of heavy machinery and trucks, storage of construction material, structures, paving, etc., within the tree drip line (for additional discussion of soil compaction, please go to http://www.regional.org.au/au/roc/1984/roc198425.htm).

standard permit—A permit which has been processed through the public interest review procedures, including public notice and receipt of comments (33 CFR 325).

structure—Includes, without limitation, any pier, boat dock, boat ramp, wharf, dolphin, weir, boom, breakwater, bulkhead, revetment, riprap, jetty, artificial island, artificial reef, permanent mooring structure, power transmission line, permanently moored floating vessel, piling, aid to navigation, or any other obstacle or obstruction (33 CFR 322).

tidal waters—Those waters that rise and fall in a predictable and measurable rhythm or cycle due to the gravitational pulls of the moon and sun. Tidal waters end where the rise and fall of the water surface can no longer be practically measured in a predictable rhythm due to masking by hydrologic, wind, or other effects (33 CFR 328).

transport or transportation—The conveyance and related handling of dredged material by a vessel or vehicle (33 CFR 324).

unacceptable adverse impact—Impact on an aquatic or wetland ecosystem which is likely to result in significant degradation of municipal water supplies (including surface or groundwater), or significant loss of or damage to fisheries, shell fishing, or wildlife habitat or recreation areas (40 CFR 231).

upper limit of navigability—The character of a river, at some point along its length, changes from navigable to nonnavigable. Very often that point is at a major fall or rapids or other place where there is a marked decrease in the navigable capacity of the river. The upper limit is therefore often the same point traditionally recognized as the head of navigation but may be at some point yet farther upstream (33 CFR 329).

upland—Any area that does not qualify as wetland because the associated hydrologic regime is not sufficiently wet to elicit development of vegetation, soils, and/or hydrologic characteristics associated with wetlands, or is defined as open waters.

utility line—Any pipe or pipeline for the transportation of any gaseous, liquid, liquefiable, or slurry substance, for any purpose, and any cable, line, or wire for the transmission for any purpose of electrical energy, telephone and telegraph messages, and radio and television communication (33 CFR 330).

waters of the United States—Include the following:

a. All waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide.
b. All interstate waters including interstate wetlands.
c. All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation or destruction of which could affect interstate or foreign commerce including any such waters

(1) which are or could be used by interstate or foreign travelers for recreational or other purposes, or
(2) from which fish or shellfish are or could be taken and sold in interstate or foreign commerce, or
(3) which are used or could be used for industrial purpose by industries in interstate commerce.

d. All impoundments of waters otherwise defined as waters of the United States under the definition.
e. Tributaries of waters.
f. The territorial seas.
g. Wetlands adjacent to waters (other than wetlands).
h. EPA has clarified that waters of the United States also include the following waters:
   (1) which are or would be used as habitat by birds protected by migratory bird treaties, or
   (2) which are or would be used as habitat by other migratory birds which cross state lines, or
   (3) which are or would be used as habitat for endangered species, or
   (4) used to irrigate crops sold in interstate commerce.

Waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of the CWA (other than cooling ponds as defined in 40 CFR 123.11(m) which also meet the criteria of this definition), are not waters of the United States. It should be noted that we generally do not consider the following waters to be waters of the United States. However, USACE and EPA reserve the right on a case-by-case basis to determine that a particular water body within these categories of waters is a water of the United States.

a. Nontidal drainage and irrigation ditches excavated on dry land.
b. Artificially irrigated areas which would revert to upland if the irrigation ceased.
c. Artificial lakes created by excavating and/or diking dry land to collect and retain water and which are used exclusively for such purposes as stock watering, irrigation, settling basins, or rice growing.
d. Artificial reflecting or swimming pools or other small ornamental bodies of water created by excavating and/or diking dry land to retain water for primarily aesthetic reasons.
e. Water-filled depressions created in dry land incidental to construction activity and pits excavated in dry land for the purpose of obtaining fill, sand, or gravel unless and until the construction or excavation operation is abandoned and the resulting body of water meets the definition of waters of the United States (33 CFR 328 and Supplementary Information).

wetlands—Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, and bogs. For official determination whether or not an area is classified as a wetland, contact USACE (33 CFR 328).

work—Includes, without limitation, any dredging or disposal of dredged material, excavation, filling, or other modification of a navigable water of the United States (33 CFR 322).

For additional definitions please go to http://www.laparks.org/dos/forest/pdf/Definition.pdf.

Appendix C

Case Study Survey

MITIGATION WETLANDS CASE STUDY SURVEY

ITRC Points of Contact:
The ITRC Mitigation Wetlands Team is collecting case studies to use in the development of a Technical & Regulatory Guidance for *Design, Construction and Monitoring Mitigation Wetlands*. Case studies form the basis for understanding the state of the science in the field applications and allow the team to identify gaps or barriers imposed by site characteristics, misunderstanding or maturity of the technique. ***Mitigation Wetlands historically have a high rate of failure.*** This information allows the team to formulate appropriate solutions encouraging more predictable and successful mitigation of wetlands.

Mitigation wetlands compensate for lost natural wetlands and are not designed to remediate contaminants. However, this ***is*** a follow-up guidance to the team's previous document, *Technical and Regulatory Guidance Document for Constructed Treatment Wetlands* (2003). Constructed wetlands treat contaminants, and mitigation wetlands create, restore or enhance habitat. The ITRC is also investigating the possibility of designing treatment wetlands that result in ecological enhancements (ITRC Ecological Enhancements Team). While this is known to occur, it is not a planned outcome nor are there mechanisms for recognizing the benefit or credit of the final wetlands function.

The team has designed this online questionnaire to obtain information specific to a mitigation wetlands site. The state and federal program who oversees wetlands mitigation is very often not the same agency or even department as solid or hazardous waste management or cleanup. We are asking you, as the ITRC State POC, to deliver this questionnaire to the appropriate agency in your state. Our test indicates that it is time-consuming for the state personnel to complete the document; therefore, they should ***send the questionnaire to the appropriate practitioners, site owners, consultants, or contractors*** who have designed, constructed, and monitored mitigation wetlands in your state. We understand the level of effort may still be high but feel that the early connection with your state's mitigation wetlands authority will also streamline the preconcurrence and concurrence review phase of our guidance. We are also contacting other practitioners through our team members and distribution to vendor lists from District U.S. Army Corps of Engineers public Web lists and the Association of State Wetlands Managers (ASWM).

The time you spend distributing the attached questionnaire will allow the team to collect field-supported and practical information into the pool of information used during the development of the guidance document. There may be follow-up; however, we will minimize use of everyone's time.

Please go to http://www.itrcweb.org/common/surveys.asp?en=SU357678&vw=reset and complete the questionnaire as accurately as possible.
Please return the questionnaire by April 23rd, 2004.
Refer questions to Steve R. Hill at srhill1@mindspring.com, T 208-653-2512.
For more information about ITRC, please go to www.itrcweb.org.

Regards:

Paul Eger, MN	&	Dib Goswami, WA
Wetlands Team Co-Leader		Wetlands Team Co-Leader

#	Question	Case Study #1	Case Study # 2	Case Study # 3	Case Study #4
1	Your name?	Leslie Stovring	Jan-W. Briedé, Ph.D.	Eric Nelson	Eric Nelson
2	What is your company or agency name?	City of Eden Prairie	MSA, PC	Savannah River National Lab, WSRC	Savannah River National Lab, WSRC
3	What is your telephone number?	(952) 949-8327	(757) 490-9264	(803) 725-5212	(803) 725 5212
4	What is your e-mail address?	lstovring@edenprairie.org	jan_briede@msaonline.com	eric.nelson@srs.gov	eric.nelson@srs.gov
5	What is your mitigation wetlands site location (nearest city and state)?	Eden Prairie, MN	Chesapeake, VA	Aiken, SC	Aiken, SC
6	What is your Mitigation Wetland site name?	Glenshire	Libertyville	Pen Branch	Lost Lake Restoration
7	What was the site previously used for?	Open space, ditched, part separated out for development	Overflow for a junkyard	Reactor cooling water discharge	Overflows of the M-Area Seepage Basin
8	Name the site principal contact name if different from above.				
9	What is the site principal contact telephone number?				
10	What is the site principal contact e-mail address?				
11	What is the regulatory authority overseeing the mitigation?				
12	Provide any government regulatory agency contact name.				
13	What is the government regulatory agency contact telephone number?				
14	What is the government regulatory agency contact e-mail address?				
15	Please provide the mitigation wetlands area in acres.				

#	Question	Case Study #1	Case Study # 2	Case Study # 3	Case Study #4
16	What is the mitigation ratio of the site?				
17	What type of wetland are you mitigating?	Marsh	Salt marsh	Other	Tidal flat
18	Describe or name the other type of wetland not listed above.	Mixture of Type 2, 3 and 6 wetland		Riparian	
19	What type of mitigation is this?	Off site	Off site	On site	On site
20	What was the length of the design and planning phase of the mitigation? Days	1825	500	365	1000
21	After a complete application was submitted to the regulatory agency, what was the length of time for permit development and approval? Days	90	300		
22	What was the length of time used for wetlands construction? Days	180	in progress		
23	What year was construction completed?	2003	2004		
24	What month was construction completed?				
25	If planting was involved, what year was it completed?	2003	2004	1995	1995
26	What month was the planting completed?	August	October	February	February (Winter)
27	Please describe the performance standards for this site.	Standard MnDOT specifications primarily	80% cover compared to adjacent natural area, with native *Spartina*	Restoration of a diverse bottomland hardwood floodplain ecosystem	Restore a Carolina Bay to a functional wetland
28	What are the monitoring parameters for this site?	Annual for 5 years	Cover, diversity, vigor, exotic species	Species composition and density, floral and faunal diversity	Quantitative ecological monitoring

#	Question	Case Study #1	Case Study # 2	Case Study # 3	Case Study #4
29	What is the monitoring frequency for this site?	Over summer months	Yearly	Anticipate 5-year intervals	
30	What is the monitoring duration of this site?	5 years	5 years	Anticipate 10 years	
31	At the end of the monitoring period, were/are follow-up visits required?	Yes	No	Yes	Yes
32	During the mitigation, was a corrective action required?	Yes	No	Yes	Yes
33	If you answered yes to the previous question, please describe the corrective action.	Herbicide and reseeding	Replanting portions of the project due to seedling predation by wild hogs	Metal-contaminated soil removal	
34	What has been the total cost of the mitigation?				
35	Relative to the total cost above, what was the percentage used for delineation?				
36	Relative to the total cost above, what was the percentage used for design and engineering?			10	
37	Relative to the total cost above, what was the percentage used for construction?				
38	Relative to the total cost above, what was the percentage used for monitoring?			20	
39	Did the mitigation fail?	No		No	No
40	Who made the determination that the mitigation failed?	Site Consultant			
41	If the mitigation failed; which of the following best describes the cause?				
42	Please briefly describe the failure.				

#	Question	Case Study #1	Case Study # 2	Case Study # 3	Case Study #4
43	At the end of the monitoring period, is the mitigation wetlands sustaining itself with no further maintenance			Yes	Yes
44	Please provide a brief explanation of your answer to the previous question.	The monitoring period is not over yet		Planted seedlings are well established, and new seedlings are appearing from seed germination, well-established herbaceous component in the project area	Herpotofauna are established, and amphibians are successfully utilizing the site for breeding
45	Is this still a successful mitigation 10 years after the completion of construction?				
46	Please explain your basis for success determination to the previous question.	It has been only one year			Herpotofauna are established, and amphibians are successfully utilizing the site for breeding
47	Please provide any further comments you would like to include on this mitigation site.	So far, so good! We basically are restoring previous wetland and have regraded the ditch and removed areas of historical fill. This will help make it a success.	Large-scale project with a variety of hydrological regimes, from small stream and floodplain to swamp. Approximately 15 hardwood species used as planting stock, depending on anticipated hydrology.		

Appendix D

Sample Conceptual Wetlands Mitigation Plan: Restoration Site

CONCEPTUAL WETLANDS MITIGATION PLAN

RESTORATION SITE
GREAT STINKY MARSH
MONMOUTH COUNTY, NEW JERSEY

MARCH

Prepared for:

Valerie Development Group
New Jersey

Prepared by:

AMEC Earth & Environmental
Somerset, New Jersey

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CONCEPTUAL WETLANDS MITIGATION PLAN: RESTORATION SITE, GREAT STINKY MARSH, MONMOUTH COUNTY, NEW JERSEY

1. INTRODUCTION

The objective of this plan is to provide a conceptual approach for the restoration of the tidal marsh associated with Stinky Creek, located in Monmouth County, New Jersey. Large portions of this intertidal estuarine wetland are dominated by the invasive plant species common reed (*Phragmites australis*). A smaller portion of this wetland is dominated by smooth cordgrass (*Spartina alterniflora*).

In contrast to the existing wetland system at Stinky Creek, undisturbed estuarine wetlands in New Jersey typically possess distinct vegetation communities resulting from the interaction of the oceanic tides upon the landscape. Under certain geological and topographical conditions, these environmental factors support a salt marsh community. Salt marshes in New Jersey occur from the area of the Passaic and Hackensack river valleys southward along the coastal mainland, on the bay side of offshore islands, along the southern coast of the State, and along the tidal area of the Delaware River (Robichaud and Buell 1973). These communities are dominated by two grasses, smooth cordgrass and salt hay (*Spartina patens*). Smooth cordgrass typically dominates the area below the mean high-water line, referred to as "low marsh," and salt hay typically dominates the area above the mean high-water line, referred to as "high marsh." Furthermore, the intertidal zone (the area between the mean high-water line and the mean low-water line) also possesses two very distinct communities. In general, the upper two-thirds of the intertidal zone is dominated by smooth cordgrass and is typically referred to as "low marsh." The lower one-third of the intertidal zone is an area devoid of vegetation and is typically referred to as "mudflat."

Collectively, all of these areas form a properly functioning salt marsh system with ecological values that include, but are not limited to, (1) supporting a diverse aquatic and terrestrial food web, (2) exhibiting high primary productivity, (3) providing a substantial export of organic material, and (4) playing a vital role in nutrient cycling and water quality. Furthermore, these ecological values are linked to societal values such as landscape aesthetics, recreation, and commercial use. A well functioning salt marsh is an integral component of coastal productivity for vegetation, fish, and wildlife. A change in the functional value of a salt marsh, such as that caused by invasive plant species, diminishes the functional values of wetland and terrestrial systems that depend upon the salt marsh. This restoration plan therefore proposes the replacement of *Phragmites*-dominated low marsh and high marsh areas with a community that would offer greater taxonomic and structural diversity and improve this wetland's functional role in the Stinky Creek estuary.

1.1 Site Description

Stinky Creek is a tidally influenced stream located in the northeastern portion of Monmouth County, New Jersey (Figures 1 and 2). The headwaters of this stream are located in a high-density residential area. The surrounding land use downstream of the headwaters is a mix of rural and residential development. Stinky Creek's net flow is to the east/southeast for approximately 4.5 miles before it empties into the Wandering River.

1.2 Statement of the Problem

The marsh vegetation community includes an expansive monotypic stand of the invasive plant common reed (*Phragmites australis*, hereinafter "*Phragmites*"). A relatively smaller and more desirable stand of smooth cordgrass (*Spartina alterniflora*, hereinafter "*Spartina*") is present on the upstream and downstream sides of River Road. This stand, believed to be a remnant of a much larger population, currently appears to be restricted to below the mean high-water line near the tidal channel. Figure 3 presents the New Jersey Department of Environmental Protection's (NJDEP) false infrared (IR) aerial photograph of the site area. As depicted on the figure, the darker hue in the marsh (northern portion) corresponds to the *Phragmites* community, whereas the lighter hue (southern portion) corresponds to the *Spartina* community. Color photographs of the site are presented in Attachment A.

It was speculated that anthropogenic disturbances to the wetland system provided the opportunity for *Phragmites* to colonize the high marsh. These disturbances included the rate of high-intensity residential development at the headwaters of Stinky Creek and roadway/bridge construction and improvements. These disturbances allowed *Phragmites* to initially colonize the high marsh. This is a predictable colonization pattern that has been observed, and continues to be observed, throughout the east coast region. *Phragmites* traps sediment more readily than other plant species (e.g., salt hay) and forms (e.g., thin grasses, sedges, salt marsh shrubs). This sediment-trapping ability, coupled with its low decomposition rate, allowed for a high degree of sediment accretion and subsequent marsh elevation. The elevated marsh then facilitated the outward spread of *Phragmites* into the surrounding areas, which comprised both high marsh and low marsh. Similarly, the same sequence of events involving sediment accretion and substrate elevation in the high marsh is believed to be currently operating in the low marsh and will continue if not halted.

1.3 Restoration Approach

To meet the objective of this project, the following technical approach was used to gather the baseline data for developing a site-specific restoration plan:

- Conduct an evaluation of the historical land use in the area to determine if changes in the vegetation community are correlated with changes in surrounding land use.
- Collect in situ water quality measurements at varying tides to determine whether certain water quality parameters may be limiting or contributing factors to the present system.
- Conduct an evaluation of the marsh soils to determine whether historical deposition of sediment is apparent, to reconstruct the sequence of events that led to the current vegetation community and marsh elevation, and to characterize the available substrate for restoration.
- Collect ground-truthed elevational data to extrapolate against existing topographic data.
- Characterize the vegetation community to describe the current plant species assemblage, to identify potential neighboring plant communities as sources for dispersal, to determine the

potential seed bank in the marsh soils, and to identify any unusual landscape features or anomalies.
- Conduct a fisheries survey to characterize the aquatic wildlife use of the marsh, and to steer restoration options towards improvements for fish and wildlife habitat.

The restoration plan utilized the above data in concert with a comprehensive literature review to develop the following major components of this restoration plan:

- coordination of all restoration activities with the tidal cycle,
- construction of a temporary access road,
- eradication of the existing *Phragmites* community,
- excavation of the *Phragmites* root mat,
- grading to achieve the final desired elevation,
- erection of goose control fencing,
- planting of species assemblages based on tidal zone,
- a cost estimate on a unit basis to allow for the restoration to be conducted in phases or sections if desired, and
- assessment of the restored wetland and fulfilling any regulatory reporting requirements.

Section 2 presents a narrative that describes the rationale for this restoration within the context of environmental and public need. This section also describes the current regulatory framework that governs restoration activities. Section 3 presents the results of the baseline assessment of the marsh and describes its existing environmental and ecological features. Section 4 describes the scope of work for the restoration including the engineering aspects of the project, methods for *Phragmites* removal, and the planting scheme for the marsh. Section 5 discusses monitoring and reporting requirements, and Section 6 presents a cost estimate for all of these tasks.

2. WETLAND IMPACTS VERSUS RESTORATION OBJECTIVES

Implementing the proposed restoration plan would replace the existing *Phragmites* wetland with a low marsh community. However, there are characteristics associated with *Phragmites* wetlands that justify their replacement with a wetland of greater ecological and aesthetic value when the opportunity exists. Often, this replacement involves the reestablishment of a *Spartina*-dominated wetland.

The conversion of a *Spartina* marsh to a *Phragmites* marsh alters the detritus cycle because of the slower decomposition rate for *Phragmites* relative to *Spartina*. The detritus cycle is one of the fundamental energy exchange processes that drives and sustains the salt marsh; therefore, conditions that disrupt this process threaten the overall functioning of the marsh. The slower decomposition rate of *Phragmites* results in a large amount of undecomposed plant material to accumulate on the marsh substrate, thereby raising the elevation of the marsh. This change decreases the land area that can be inundated by tidal flushing, thus allowing even further invasion by *Phragmites* (Niedowski 2000).

Although *Phragmites* marshes can also be very productive, high productivity associated with these types of marshes tend to increase soil oxygenation (Bart and Hartman 2000). The aeration of a normally anaerobic marsh substrate, such as in a *Spartina* marsh, causes oxidation of the system through increased organic matter decomposition and reduction of sulfates to sulfides. Both of these processes reduce the pH of the substrate and the overlying water, altering the water chemistry and potentially releasing inorganic compounds into the water column. *Phragmites* also has the ability to "pressure ventilate" its rhizosphere through its dead culms (stems), further contributing to processes that aerate the marsh substrate (Yamasaki 1987; Armstrong, Armstrong, and Beckett 1992).

The restoration plan for Stinky Creek therefore focuses on enhancing wetland functions by replacing the existing *Phragmites* marsh with a community that provides greater taxonomic and structural diversity. This improvement will increase the use of this marsh by fish and wildlife and will contribute to an improvement in the water quality of the estuary. This plan presents the information so that restoration activities may be conducted in phases, in sections, or in their entirety.

For simplicity, except where noted, the overall description of the restoration throughout the remainder of this report is based on conducting the effort <u>across the entire study area</u>. However, the restoration site plan (Attachment K) divides the total restoration area into four subareas hereinafter referred to as "Sections I to IV." The site plan may therefore be used in conjunction with the unit cost breakdown presented in Section 6 to develop pricing estimates for conducting the restoration in part, in phases, or in its entirety.

2.1 Acreage Requirements

The total area of the salt marsh is approximately 20 acres. The area of existing *Phragmites* wetland to be replaced is approximately 19 acres. All of the approximately 1 acre of existing *Spartina* wetland will remain undisturbed, as well as two relatively small (combined, less than 0.2 acres) forested deciduous wetland communities adjacent to the marsh (discussed in Section 3.2).

2.2 Regulatory Framework

The Clean Water Act (CWA) defines wetlands as "those areas that are inundated or saturated by surface or groundwater at a frequency or duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas." Regulated activities under the CWA are governed by the Section 404 Permit Program administered by the United States Army Corps of Engineers (USACE). In February 1994, the New Jersey Department of Environmental Protection (NJDEP) assumed total regulatory authority of most wetlands in New Jersey from USACE. For coastal wetlands, the NJDEP Land Use Regulation Program (LURP) administers the Section 404 Permit Program through the Coastal Zone Management Act Rules (N.J.A.C. 7:7E) under the Coastal Area Facility Review Act (CAFRA) (N.J.S.A. 13:19-1 et seq.), the Wetlands Act of 1970 (N.J.S.A. 12:5-3), Water Quality Certification (Section 401 of the CWA), and Federal Consistency Determinations (Section 307 of the Federal Coastal Zone Management Act). For freshwater wetlands, the NJDEP LURP administers the Section 404 Permit Program through the Freshwater Wetlands Protection Act Rules (N.J.A.C. 78:7A) under the Freshwater Wetlands Protection Act (N.J.S.A. 13:9B-1 et seq.) and the New Jersey Water Pollution Control Act (N.J.S.A. 58:10A-1 et seq.).

Because this project site is located adjacent to a body of water subject to the ebb and flow of the tides, the Section 404 permit program under USACE, as administered through the NJDEP, is still in place. Under the Regulatory Guidance Letter (RGL) dated March 14, 1994, USACE retains regulatory authority over wetlands partially or entirely within 1,000 feet of the ordinary high-water mark of all water bodies which are subject to the ebb and flow of the tide. This does not exclude the regulatory authority of the NJDEP LURP for this wetland, nor does it exclude other regulatory agencies or municipalities from providing recommendations or guidance for regulated activities in wetlands. Based on the current regulatory framework, the following agencies, departments, boards, and commissions are anticipated to have either a regulatory obligation, notification requirement, or a vested interest in reviewing proposed activities in wetlands or open waters:

Federal Level
- U.S. Army Corps of Engineers
- U.S. Department of the Interior, Fish and Wildlife Service (FWS)
- U.S. Environmental Protection Agency
- U.S. Department of Agriculture, Natural Resource Conservation Service (NRCS)
- National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS)

State Level
- NJDEP, Land Use Regulation Program
- NJDEP, Bureau of Coastal Zone Management
- NJDEP, Bureau of Stream Encroachment
- NJDEP, Division of Fish and Wildlife

County/Municipal Level
- Monmouth County Soil Conservation District
- Environmental Commission

Other
- Utility companies and authorities (including, but not limited to, petroleum, natural gas, electric, cable, telecommunications, and sewer)
- Neighboring landowners

This restoration is anticipated to require the following permits and approvals; however, additional permits and approvals may become necessary during the project review process. In addition, the following list also includes regulatory agencies and organizations that may be appropriate partners to the restoration. Partnering with an agency or organization is highly recommended for this restoration because of its large scope and public visibility. Partnering also provides additional resources, technical input, and avenues for the dissemination of information.

- NJDEP LURP Statewide General Permit No. 16, “Habitat Creation and Enhancement Activities”
- NJDEP LURP Waterfront Development Permit
- NJDEP LURP CAFRA Permit
- NJDEP LURP Coastal Wetlands Permit
- Approval from the U.S. Army Corps of Engineers (NY District)
- Approval from the U.S. Fish and Wildlife Service
- Approval from the NOAA National Marine Fisheries Service
- Potential partnership with the U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, and the National Marine Fisheries Service.

3. EXISTING SITE CONDITIONS

This section describes the existing site conditions observed or measured during a series of data-gathering efforts during the period of July 2001 to March 2002. The objective of these data-gathering efforts was to characterize the existing wetland system and to investigate any unique environmental or landscape features of the marsh. These data were then used to develop the site-specific restoration plan that would best utilize the existing environmental and landscape features, and to determine which of these features should be altered.

3.1 Elevation and Landscape Description

The tidal data presented in this section were obtained from NOAA and are based on the National Geodetic Vertical Datum (NGVD). Attachment B presents a copy of these data.

As of November 2001, the mean high water (MHW) based on the NGVD as reported by NOAA for the Wandering River was 3.62 feet above mean sea level (msl) (hereinafter, “+3.62 feet”). The intertidal portion of the marsh exhibited very little elevational relief and ranged from slightly less than +4 feet at the Hobbit Road Bridge to slightly above +2 feet at the Wandering River Road Bridge, over a distance of approximately 1,700 feet (0.3 miles). This is consistent with the target slope range of 1%–3% recommended for salt marsh restoration projects in the northeast U.S. (Broome, Seneca, and Woodhouse 1988).

The *Spartina*-dominated areas typically ranged in elevation from +2 to +2.5 feet, whereas the *Phragmites*-dominated areas typically ranged in elevation from +2 to +6 feet. As described earlier, the spatial distribution of *Spartina* was limited to the areas by Wandering River Road, therefore, these *Phragmites*-dominated areas occurring from +2 to +6 feet were found near the Hobbit Road bridge and included both low marsh and high marsh.

Very steep slopes form the eastern and western boundaries of the restoration area between Hobbit Road and Wandering River Road. The ridgetops along these steep slopes typically range from +20 to +40 feet. Single-family residential properties and undeveloped land occupy these areas.

Two linear drainage features, apparent on the topographic survey, were mapped to be present on the eastern side of the restoration area. One feature was mapped to be located approximately 300 feet to the south of Hobbit Road and appears to drain into one of the existing tidal guts. A field survey of the area did not reveal the presence of a distinct stream or channel; however, a swampy area was discovered at the approximate location where the mouth of this drainage feature was mapped. This area exhibited a plant community characteristic of a forested deciduous wetland. The second linear drainage feature was mapped to be located approximately 100 feet to the north of Wandering River Road and appeared to drain directly into the existing *Phragmites* community immediately north of Wandering River Road. Similar to the other drainage feature, a field survey of the area did not reveal the presence of a distinct stream or channel; however, a forested deciduous wetland community was observed at the location where the mouth of the drainage feature was mapped. These forested wetland communities are described in the following section.

3.2 Vegetation

The United States Fish and Wildlife Service (USFWS) National Wetland Inventory (NWI) map for the project area indicates the restoration area to be an estuarine, intertidal, aquatic bed wetland (E2AB) and an estuarine, intertidal, flat wetland (E2FL) (Figure 4). The area immediately upstream of Hobbit Road is mapped as an estuarine, intertidal, emergent wetland (E2EM). The Wandering River is mapped as an estuarine, subtidal, open water (E1OW).

The NJ Freshwater Wetlands Map for the project area indicates the restoration area to be a tidal, intermittently flooded, and saturated system (UWB). Small portions of the stream are also mapped as a palustrine, emergent, persistent, seasonal wetland (PEM1C).

The results of the on-site vegetation characterization revealed the presence of two distinct marshes. One community is dominated by *Spartina alterniflora* and the other by *Phragmites australis*. The distribution of these two species was similar to that depicted in the infrared (IR) aerial photograph of the site; however, the current *Spartina* community appeared to be smaller in area than that depicted in the IR image. As described previously, small portions of the *Spartina* community also occurred on the downstream side of the Wandering River Road bridge. The *Spartina* community overall appeared to be restricted to those areas immediately adjacent to the tidal channel and of low elevation relative to the *Phragmites*-dominated areas. This finding is consistent with its tendency to be limited to the wettest portions of salt marshes that have been invaded by *Phragmites*. The *Phragmites* occurred along the periphery of the *Spartina* community and in areas of relatively higher elevation, extending upwards beyond the mean high-water elevation. The upstream (northward) extent of the *Phragmites* community continued well beyond the Hobbit Road bridge.

Few other plant species were observed in intertidal zone of the marsh. Of those that were observed, their occurrence was characteristic of a freshwater marsh community rather than that of a marine or estuarine community. Such species included red maple (*Acer rubrum*), common arrowhead (*Sagittaria latifolia*), skunk cabbage (*Symplocarpus foetidus*), jewelweed (*Impatiens capensis*), Asiatic dayflower (*Commelina communis*), silky dogwood (*Cornus amomum*), lady thumb (*Polygonum persicaria*), and black willow (*Salix nigra*). These species were typically observed as individual specimens scattered throughout the high marsh system.

The two relatively small forested wetland communities associated with the down-gradient end of the mapped linear drainage features was composed of a mix of red maple (*Acer rubrum*), black willow, black gum (*Nyssa sylvatica*), black walnut (*Juglans cinerea*), skunk cabbage, and smartweed (*Polygonum* sp.). A complete list of all plant species observed on this site is presented in Attachment C.

3.3 Protected Natural Resources

To ensure that the proposed restoration activities will not adversely impact protected natural resources, a Natural Heritage Database search was requested from the NJDEP Office of Natural Lands, Natural Heritage Program. A database search for the following resources was requested:

- listed federal endangered species
- listed state endangered plant species
- listed state endangered wildlife
- additional plant species of concern
- additional nongame animal species
- rare and exemplary natural communities

The results of the database search are presented in Attachment D. There were no records for any of the above-listed natural resources on or within the vicinity of the project area; therefore, the proposed restoration activities are not anticipated to affect these resources.

3.4 Archaeological, Cultural, Historical Resources

To insure that the proposed restoration activities will not adversely impact archaeological, cultural, or historical resources, a search for these records was conducted at the NJDEP Historic Preservation Office (HPO). The results of this records search indicate no mapped archaeological, cultural, or historical resources on or within the immediate vicinity of the project area.

In addition to the records search at the NJDEP HPO, an additional request was submitted to the New Jersey State Museum to verify that the project area was not listed as a candidate for the State Register of Historical Places. The results of this request indicate that the project area is not listed as a candidate site.

3.5 Soils

The United States Department of Agriculture (USDA), Soil Conservation Service (SCS) Soil Survey for Monmouth County, New Jersey indicates the site to be situated in the Tinton-Phalanx-Urban Land soil association. This association includes soils that are nearly level to steep, deep, well-drained loamy soils and Urban land, mostly on uplands. This association composes approximately 4% of the county, with most areas used for woodland and community development.

The soil survey also indicates that the site occurs primarily on one soil mapping unit, Sulfaquents and Sulfhemists, frequently flooded (SS) (Figure 5). This mapping unit consists of poorly drained and very poorly drained soils in tidal marshes and estuaries that are subject to tidal flooding. Permeability of these soils is moderate or moderately rapid in the substratum. The available water capacity is high, and the water table fluctuates with the tides. Runoff is very slow, and organic matter content is high. When wet, these soils are slightly acid to mildly alkaline. When dry, they become extremely acid.

A soils evaluation was conducted during a series of site visits at various locations within the tidal marsh. Soil borings were collected in all areas that could be safely traversed on foot during low tide. A bucket auger was used to collect a total of twenty-eight (28) soil borings from the *Spartina* community, the *Phragmites* community, and the transitional zones between these two. The distribution of these soil borings is depicted on Figure 6 and a description of each soil boring is presented in Attachment E.

Soil borings collected from areas dominated by *Spartina* typically exhibited a thick (16- to 20-inch) surface horizon of muck, underlain by an unconsolidated mix of muck and fine sand. Refusal was met at depths ranging from 36 to 48 inches. The *Spartina* root mat was typically encountered at a depth ranging from 10 to 16 inches below ground surface (bgs). Some of the soil borings collected from *Spartina*-dominated areas within close proximity to the Wandering River Road bridge were found to be occurring on fill material. These borings typically exhibited a thin (4- to 5-inch) surface horizon of medium to coarse sand with varying amounts of organic matter, underlain by medium sand and small quartzose pebbles, also with varying amounts of organic matter.

Soil borings collected from areas dominated by *Phragmites* were markedly different between the Hobbit Road bridge area and the Wandering River Road bridge area. Those collected from the Wandering River Road bridge area typically exhibited a thick (10- to 24-inch) muck surface horizon underlain by muck and silty sand to medium sand. The root mat varied from 4 to 8 inches thick at relatively shallow depths, ranging from 6 to 12 inches bgs. In contrast, soil borings collected from *Phragmites*-dominated areas by the Hobbit Road bridge typically exhibited a thin (3-inch) fibric layer with a medium to fine sand surface horizon ranging from 3 to 5 inches. This was typically underlain by a subsoil of medium to fine sand. A 4-inch *Phragmites* root mat was observed at shallow depths of 8 to 10 inches bgs. Overall, the *Phragmites*-dominated areas exhibited a root mat that was thinner and less dense than anticipated and was relatively easy to penetrate with a hand auger.

Soil borings collected from transitional areas between the *Spartina* and *Phragmites* communities typically exhibited a thin (3-inch) surface horizon of fibric silty sand, underlain by muck and medium sand to silt. Standing water was present above the root mat, which was typically observed at depths extending from 14 to 18 inches bgs. A muck horizon was typically found beneath the root mat, underlain by medium sand to depths exceeding 40 inches bgs.

The soil borings collected from the *Phragmites*-dominated areas and the transition zones between *Phragmites* and *Spartina* exhibited a mineral layer and root mat between two muck layers. This finding suggests that a mineral layer may have been historically deposited onto the muck surface through a mechanism such as sedimentation. This mineral layer facilitated the establishment of *Phragmites* onto the marsh substrate. The *Phragmites* likely facilitated further sedimentation as the root mat and dense stems trapped more sediment in the marsh. This cyclical series of sediment accretion, marsh substrate elevation, and lateral spread is believed to be the mechanisms that led to the current marsh condition.

Assuming this scenario is accurate as described, the current *Phragmites*-dominated areas of both the low marsh and high marsh are not only a function of historical disturbance and sedimentation, but are also situated at higher elevations than they would normally be if the wetlands were not historically disturbed. That is not to say that the elevation of a *Spartina* marsh does not increase over time. *Spartina* marshes also accumulate sediment as the belowground roots and rhizomes form peat. It is this accumulation of salt marsh peat that raises the *Spartina alterniflora* community to an elevation that allows colonization of the high marsh species such as *Spartina patens*. The assumption with this particular marsh is that the invasion of *Phragmites* following sedimentation has accelerated the normal rate of substrate elevation.

3.6 Hydraulics

Stinky Creek is a tidally influenced water body receiving freshwater input from its upstream headwaters, and likely, the two aforementioned linear drainage features apparent on the topographic survey. A sinuous network of tidal creeks and guts distributes surface water throughout most of this marsh. These channels also serve to distribute wrack, detritus, and aquatic wildlife.

Prior to construction of the two roads, tidal flooding and drainage were unimpeded. The presence of these structures and their associated fill is believed to have modified the tidal flooding regime. These restrictions, coupled with the high-density residential development in the Stinky Creek headwaters, are the major disturbances to the hydraulics of this wetland.

The Hobbit Road bridge and the Wandering River Road bridge restrict and alter the tidal flow and tidal flushing of Stinky Creek. This restriction is caused by a reduction in the size of the inlet by the bridge itself and the large amounts of fill associated with the bridge footings. Typical impacts to salt marshes resulting from tidal restrictions include changes in the frequency, volume, and duration of tidal flooding. Reduced flow volumes also reduce the degree of, or eliminate altogether, salinity stratification (Gibson and Najjar 2000). All of these changes to the tidal regime can alter the marsh vegetation, morphology, rate of elevation or subsidence (lowering in elevation), water quality, salinity, and soil oxidation (Niedowski 2000). In this system, the tidal restrictions disrupt the balance between the saline and tidal influence of the Wandering River and the storm-water-driven freshwater inputs from upstream areas. The effects of the tidal restriction are not limited to the area between the two bridges, but also extend to areas upstream of the Hobbit Road bridge—there is a large degree of sedimentation occurring immediately behind (upstream) the Hobbit Road bridge.

Tidal inundation is the primary characteristic of a salt marsh, and alterations to the tidal regime allow plant species such as *Phragmites* to invade the marsh (Roman, Niering, and Warren 1984; Niering and Warren 1980). Tidal restrictions also tend to inhibit or reduce fish and wildlife movement in and out of the marsh (Burdick et al. 1997), although this is not believed to be the case with Stinky Creek. A reduction in the tidal range allows more of the marsh surface to dry and to become aerobic. Aeration of a normally anaerobic marsh substrate typically results in an increased rate of organic matter decomposition and a conversion of iron sulfide (pyrite) to sulfuric acid. Both of these processes reduce the pH of the marsh, mobilizing potentially bioavailable trace elements into the water column (Niedowski 2000).

Storm water discharges associated with the high density of development in the headwater region of this stream causes sedimentation to occur at greater rates than with natural processes of marsh evolution. This advanced rate of sedimentation results from storm water runoff that contains a large component of sediment picked up from impervious surfaces such as roads and residential properties. Large pulses of storm water discharge carry not only significant sediment loads but also freshwater. The combination of a sediment load in a freshwater pulse serves to benefit *Phragmites* and places the *Spartina* at a competitive disadvantage. A drop in salinity to less than about 18 parts per thousand (ppt) promotes the invasion of *Phragmites* in *Spartina* marshes (Niedowski 2000). However, *Phragmites* has been found in wetlands containing near full-strength seawater (PSE&G 1996) and also has been grown under laboratory conditions at salinity concentrations of 35 ppt (Lee 1990). This situation is believed to be possible because of the ability of *Phragmites* to exclude sodium from entering plant tissues (Matoh, Matsushita, and Takahashi 1988). However, such anomalous communities are not anticipated to sustain themselves if other more salt-tolerant species are present.

3.7 Water Quality

In situ water quality parameters of the surface water were measured at both low and high tides throughout the baseline assessment. These measurements were collected to determine if salinity, or any other water quality parameter, was a factor in the observed plant species distribution. For example, it was speculated that the salinity levels in the up-gradient portions of the marsh were not sufficiently high to provide a competitive advantage to the more salt-tolerant *Spartina*. This is because *Phragmites* typically starts forming monotypic stands in the back marsh areas when salinities are low (Bart and Hartman 2000).

The results of these water quality measurements are presented in Attachment F. These results did not suggest that salinity or any other surface water quality parameter (conductivity, temperature, or pH) was a factor in the observed species distribution. However, qualitative observations of the relatively low depth and short duration of inundation during high tide suggested that these tidal regime factors may be offering a competitive advantage to *Phragmites* over the *Spartina*. The scientific literature reports that although *Phragmites* can survive well under most tidal regimes, there is a threshold of inundation depth and duration at which it cannot survive or compete well with other species. It is speculated that the duration and depth of tidal inundation is not sufficient in this wetland to prevent the *Phragmites* from dominating this plant community.

3.8 Fisheries

A fisheries survey was conducted using a combination of passive (i.e., minnow traps) and active (i.e., otter trawl) methods. At high tide, five standard minnow traps were deployed at regular intervals along the main channel of Stinky Creek from the Wandering River Road to the farthest navigable point up the stream. Each trap was fished along the slope of the channel at middepth for approximately 1.5 hours.

A flat otter trawl was used to sample the bottom fish community. The trawl had a head rope length of 16 feet, a body depth of 12 feet, a body mesh of 3 inches, and a 1-inch mesh/8-foot cod end equipped with a 1/4-inch liner. Four trawls were conducted. Trawls 1 to 3 were conducted from the Wandering River Road bridge to the southeast towards the confluence of Stinky Creek with the Wandering River. Trawl 4 was conducted in the waters immediately upstream of the Wandering River Road bridge to the first large meander, approximately two-thirds of the distance to the Hobbit Road bridge. Shallow waters precluded trawling beyond this point. Each trawl pass was conducted for a period of two minutes from deployment to initiation of recovery.

Fish that were collected by both methods were taxonomically identified, measured for total length, and enumerated. The taxonomic identifications were as per Bigelow and Schroeder (1953), Hildebrand (1963), and Scott and Crossman (1973). All surviving fish were returned to the water.

The following four fish species were collected during this survey: striped killifish (*Fundulus majalis*), mummichog (*Fundulus heteroclitus*), Atlantic silverside (*Menidia menidia*), and sheepshead minnow (*Cyprinodon variegatus*). Other aquatic and terrestrial plant and wildlife species observed during the survey included sea lettuce (*Ulva lactuca*), fiddler crab (*Uca* spp.), mud crab (*Panopeus* sp.), comb jelly (Ctenophora), and grass shrimp (*Hippolyte* sp.). Great blue heron (*Ardea herodias*), Canada goose (*Branta canadensis*), and mallard (*Anas platyrhynchos*) were observed feeding along the edge of the low marsh.

The results of the fisheries survey are presented in Attachment G and summarized in Table 3-1. A total of 247 fish were collected from the minnow traps. Striped killifish were the most abundant species with 198 collected, followed by mummichog (also known as “banded killifish”) with 41 collected, sheepshead minnow with six collected, and Atlantic silverside (known colloquially as “spearing”) with two collected. As anticipated, a larger number of fish were generally collected at the downstream end of the stream; however, species richness was similar at both ends of the stream. A total of 17 Atlantic silverside were collected with the otter trawl, all of which were collected upstream of the Wandering River Road bridge. No fish were collected in the trawls at the mouth of Stinky Creek.

Overall, Stinky Creek appears to be a viable fishery, exhibiting a typical early spring forage fish community. Species richness and abundance were slightly less than anticipated; however, this difference was not considered to be a significant observation. Although forage fish were collected from the main channel only, it can be reasonably assumed that these fish also utilize the shallow tidal creeks. Interviews with local residents revealed that the Stinky Creek/Wandering River estuary support a striped bass fishery during the normal fishing season. Based on this information, it would also be expected that flounder would also utilize this marsh. Observations of a great blue heron and a mallard during the fishery survey suggest that the marsh is used as feeding or resting habitat for piscivorous and herbivorous birds. The presence of sea lettuce, comb jellies, grass shrimp, fiddler crabs, and mud crabs suggest that this area also has great potential to support a diverse salt marsh community. These observations suggest that great improvements can be made to the existing productivity by enhancing the existing low marsh and subtidal waters.

4. RESTORATION PLAN SPECIFICATIONS

This section presents the details of the conceptual restoration plan which includes a discussion of the rationale for the restoration approach**,** two alternatives for the eradication of *Phragmites*, a description of the chemical and environmental properties of the herbicide Rodeo®, and the planting scheme. The objective of the approach is to establish the framework for an estuarine wetland system that will be a more valuable component to the Stinky Creek estuary than the system that currently exists. In addition to enhancements of the vegetation community, this design will also enhance the existing forage fishery, providing a basis for attracting other wildlife such as piscivorous birds (e.g., herons and egrets), and enhancing the use of this system by predatory fish (e.g., striped bass). This restoration will attain the desired habitat complexity that is created by the juxtaposition of an extensive low marsh community with subtidal channels. The end result will be a salt marsh that provides greater ecological and societal functions to the coastal estuary than the current system.

As stated previously, the scope of the restoration plan specifications presented in this section are for conducting the restoration effort across the entire marsh system, excluding the existing *Spartina* community and the forested deciduous wetland communities. However, the conceptual site plan divides the restoration area into four individual sections (Sections I to IV). The purpose of this is so that the restoration effort may be conducted in part, in phases, or in its entirety. To facilitate the description of the overall restoration approach, Section 4 (Restoration Plan Specifications) and Section 5 (Wetlands Monitoring and Reporting) describe the proposed restoration and monitoring effort as if it will be conducted in its entirety. Section 6 (Estimated Costs) presents a unit cost breakdown of the restoration and an estimated cost per section. This will allow the township to select from a number of different restoration options and combinations depending upon available resources.

4.1 Tide Considerations

The restoration activities will involve tasks to be conducted below the mean high-water line such as *Phragmites* removal, excavation, grading, and planting. Many of these tasks will need to be conducted during low tide. This approach will place a significant time constraint on the restoration efforts; however, it is the preferred alternative to constructing a temporary dam on the creek to allow activities during both high and low tides. Constructing a temporary dam is anticipated to result in an unnecessarily high degree of disturbance. Another alternative that allows restoration activities to be conducted during high tide involves the use of barge-mounted machinery; however, the low height of the Hobbit Road and Wandering River Road bridges precludes the use of these vehicles in that access to the project area requires passage beneath these bridges.

The implications of this time constraint will be that the schedule of restoration activities will be extended long term over the course of the restoration effort because the activities will be conducted at roughly 6-hour, low-tide cycles. However, such a time constraint does not preclude the opportunity to conduct those activities associated with areas above the mean high-water line, provided that they will not interfere with future access to the lower portions of the marsh.

4.2 Site Access and Property Ownership

The marsh between Hobbit Road and Wandering River Road occupies parcels belonging to a total of seven property owners. Access to the marsh for earth-moving vehicles, other machinery, field personnel, and supplies will require the construction of temporary earthen roads accessible from Hobbit Road. The large drop in elevation from Wandering River Road to the marsh is believed to be too steep to construct a cost-effective access point. Furthermore, the traffic speed on Wandering River Road is considered to be too high for the maneuvering of construction vehicles.

Two roads are proposed, one on either side of the marsh as depicted on the conceptual site plan. The first road, hereinafter "Haul Road #1," will originate from the south side of Hobbit Road, east of Stinky Creek, and will proceed towards Wandering River Road, following along an elevation roughly between the spring tide line (~+4.5 feet) and +6 feet. Two vehicle and equipment staging areas are proposed for this road to provide a secure location to store earth-moving vehicles, nursery stock, and other equipment and supplies. The staging areas will be located at opposite ends of the haul road, one near Hobbit Road and the other near Wandering River Road. Haul Road #1 is anticipated to occupy approximately 0.7 acres.

The second road, hereinafter "Haul Road #2," will also originate from the south side of Hobbit Road, but west of Stinky Creek. This road will also proceed towards Wandering River Road, following along an elevation roughly between the spring tide line (~+4.5 feet) and +6 feet. Due to a lack of available space, no equipment staging area is proposed for this road. Haul Road #2 is anticipated to occupy approximately 0.33 acres.

Site-specific conditions will dictate the exact placement of the road and staging areas. To minimize disturbance to the most sensitive natural areas, every attempt will be made to avoid the placement of these roads in the low and high marsh areas and will be biased towards upland areas. Erosion control measures (e.g., silt fencing, hay/straw bales) will be placed along appropriate segments of these roads and the staging areas to minimize erosion. The roads will be constructed of clean fill material and be secured at its up-gradient end (by Hobbit Road) with construction fencing to discourage public access.

The access road should remain in place until all large vehicle activities have ceased, whereupon the road will be removed by excavation. Since most of the restoration activities will have occurred while the road was in place, the underlying substrate will contain an intact *Phragmites* root mat that will also be excavated. This excavated area will be backfilled with clean fill material, such as the leftover material remaining from the access roads, and then graded to be consistent with the surrounding elevation and planted with the appropriate species based on the planting scheme for that specific elevation (Section 4.6).

4.3 Phragmites Eradication and Control

Provided that the existing slope is approximately 1%–3%, restoration of *Phragmites*-dominated wetlands in the northeast United States that involve only the removal of a tidal restriction often do not require additional efforts to remove the *Phragmites.* In these cases, restoring the inundation and salinity cycle are sufficient to eliminate and control reinvasion by this species. These marshes tend to recolonize with *Spartina* from the existing seed bank or from adjacent populations. However, in most cases there are a multitude of interacting environmental factors that have resulted in the colonization and persistence of the *Phragmites*. The baseline assessment of the Stinky Creek marsh indicated that the present species distribution is the result of numerous environmental factors, one of which is tidal restriction at the Hobbit Road and Wandering River Road bridges. Therefore, additional *Phragmites* eradication methods are required.

The recommended approach uses a combination of herbicidal application (i.e., glyphosate) and cutting/mowing over the course of two growing seasons. This approach was considered to be sensitive to the landowners immediately adjacent to the marsh and to the surrounding natural resources (e.g., the Wandering River and its fisheries). The combination of mowing and spraying of the *Phragmites* will be initiated at strategic points in the plant's life cycle when those methods would be the most effective. The following is the recommended approach for *Phragmites* eradication at Stinky Creek from below the mean high-water line (+3.62 feet and below) to an elevation of approximately +6 feet, except where noted:

<u>Year 1</u>

- Mowing of the *Phragmites* prior to tasseling (tasseling occurs from July to August), and disposal of the material at an off-site location.[1]

<u>Year 2</u>

- Application of glyphosate to the *Phragmites* at 75%–80% of the recommended concentration following tasseling (September to October).
- Glyphosate application to any *Phragmites* regrowth at 75%–80% of the recommended concentration 15–30 days following the prior application (August to September).

<u>Year 2/3</u>

Removal of the *Phragmites* root mat in conjunction with grading activities during the dormant season (November to February) prior to planting activities in the early spring.

Existing stands of *Spartina* and the forested deciduous communities adjacent to the marsh will be left intact and avoided. Glyphosate application within the proximity of these intact communities

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[1] In the interest of worker safety and to avoid excessive substrate disturbance, mowing should be limited to those areas that can support the weight of mowing equipment. It is anticipated that the central portions of the marsh (Section IV), particularly immediately north of the existing *Spartina* community, will not support this type of weight. Should this be the case, then the *Phragmites* in these areas can be treated with aerial applications of glyphosate without intrusion into the area.

will be conducted with extra caution or will be applied using backpack or hand sprayers to minimize any potential overspray.

The final removal of any standing dead or live *Phragmites* will occur through the excavation and grading activities to be conducted in the early spring of Year 3 (March/April). The purpose of these earth-moving activities is to remove the *Phragmites* root mat and achieve the lower elevation required to establish the low marsh habitat for *Spartina* (see Section 4.4 "Grading").

With the exception of the tasks involving earth-moving equipment (i.e., mowing, excavating, grading), the above glyphosate spraying program will be conducted on a limited basis on the upstream side of the Hobbit Road bridge and the downstream side of the Wandering River Road bridge. The purpose of extending the glyphosate application outside of the formal study area is to eradicate or weaken the *Phragmites* community that will be the greatest threat to reinvasion of the marsh. The extent of the glyphosate application will be approximately 50 feet on each side of the creek.

Niedowski (2000) reports that Rodeo is typically applied at a rate of 4–6 pints per acre. The Public Service Energy and Gas (PSE&G) Company applies Rodeo at a rate of 2–4 pints per acre for its New Jersey and Delaware Estuary Enhancement Program (PSE&G 1996). The following section presents a discussion on the properties of Rodeo. Attachment I also provides additional literature about this product as well as a sample Material Data Safety Sheet (MSDS). Should the above-proposed *Phragmites* eradication procedure be deemed unacceptable by the township, Section 4.3.2 presents an alternative approach.

4.3.1 Chemical and Environmental Properties of Rodeo

Rodeo is the trade name for an aquatic version of the common household weed killer Roundup. Both products were historically manufactured by Monsanto, Inc. (St. Louis, Missouri); however, Rodeo is currently manufactured by Dow Agrosciences (Indianapolis, Indiana). Similar to Roundup, Rodeo is a broad-spectrum, systemic herbicide that readily degrades in soil and water under both aerobic and anaerobic conditions. "Broad-spectrum" refers to the ability of this product to act upon any living plant that it is applied to, other than a target species. "Systemic" refers to its mode of action, which involves an internal disruption of a plant's biochemistry, rather than an external insult.

Rodeo is approved for use in aquatic environments by the U.S. EPA (Cross and Fleming 1989, PSE&G 1996). The demonstrated safety of Rodeo in natural systems, coupled with its effectiveness for weed control, makes it the preferred herbicidal method for wetlands worldwide. It has been used widely in the United States since 1976 and has never been reported to cause any widespread environmental problem. The benign nature of Rodeo has received endorsement as the herbicide of choice from groups including, but not limited to, the U.S. EPA, the National Audubon Society, the U.S. Fish and Wildlife Service, The Nature Conservancy, Quail Unlimited, the Society for Ecological Restoration, various private conservation groups, and numerous municipalities and public works departments (PSE&G 1996).

Rodeo is essentially immobile in soil and is widely accepted as an herbicide that, when applied properly, does not pose an ecological risk to natural environments. The active ingredient in Rodeo is N-(phosphonomethyl)glycine, more commonly referred to as “glyphosate.” Glyphosate is a white, odorless, water-soluble solid with an average half-life of 40 days in soil. It is the active ingredient in Roundup, Roundup Pro, Roundup Ultra, Pondmaster, and Accord—all commonly accepted safe herbicides. Rodeo is a concentrated aqueous formulation of 53.8% glyphosate in the form of an isopropylamine salt. The remaining 46.2% of the formulation is water. Glyphosate does not bioaccumulate and is nonvolatile. There have been no reproductive, teratogenic, mutagenic, carcinogenic, or organ toxicity effects found in either laboratory or field studies. It is classified as a noncarcinogen (Category E) by the U.S. EPA. To date, the only reported acute toxic effect is eye irritation from direct contact.

The effectiveness of Rodeo depends in part upon the ability of this product to adsorb to the foliage and stems of actively growing plants. Unlike Roundup, there are no added surfactants to Rodeo. However, the proper use of Rodeo requires the addition of a nonionic surfactant per manufacturer’s recommendations. The recommended concentrations range from 0.5% to 5.0% by volume, with typical applications using a concentration of 1.5% by volume. The formulation of glyphosate with surfactant reduces the surface tension of the water, allowing the Rodeo droplets to cling readily to the plant’s surface. The surfactant also aids in the penetration and softening of the plant cuticle.

Certain glyphosate mixtures have been reported in the scientific literature to exhibit very low toxicity to some animal systems under laboratory conditions. Paradoxically, it is the surfactants and not the glyphosate that induces the toxic response. Thus, the safe use of Rodeo in aquatic systems is accomplished by following the manufacturer’s recommendation for adding the appropriate amount and type of surfactant.

The recommended application rates for Rodeo are described on the registered product labels; however, these rates vary depending on the target species and the application method. Maximum application rates are typically used for the most resistant target species, such as *Phragmites*. Rodeo may be applied using aerial (e.g., helicopter) or ground-rigged broadcast sprayers, backpack sprayers, or applied by hand. Hand applications typically include hand spraying, wiping with Rodeo-soaked rags, or injection into a cut stem with a laboratory squeeze bottle. Backpack spraying and hand application are the most effective techniques for avoiding impact to nontarget plant species; however, there are significant labor costs associated with hand application.

4.3.2 Alternative Approach to *Phragmites* Eradication

An alternative approach to eradicating the *Phragmites* is presented here in the event that the recommended approach in Section 4.3 is deemed to be unacceptable to Middletown Township. This alternative approach relies solely on mechanical methods to eradicate the *Phragmites* and does not involve the use of any herbicides. There is a reduced probability of removal success when attempting to eradicate *Phragmites* without the use of herbicides because mechanical removal methods rely on the physical destruction of the plant and disruption/removal of the marsh substrate to eradicate the *Phragmites* community. Although both the recommended approach and the alternative approach result in producing *Phragmites* rhizome fragments from which new plants will sprout, the recommended approach has the added advantage of weakening the physiology of the plant prior to fragmenting the rhizome mat. This means that rhizome fragments resulting from the recommended approach are less likely to produce viable sprouts. Nevertheless, the following alternative approach has been developed for this marsh:

- Mowing of the *Phragmites* following tasseling (tasseling occurs from July to August), and disposal of the material at an off-site location.[2]
- Grubbing of the substrate late in the growing season (September to October).
- Removal of the *Phragmites* root mat in conjunction with grading activities during the dormant season (November to February) prior to planting activities in the early spring.

4.4 Excavation and Grading

This section conceptually describes the excavation and grading activities required for this restoration effort. These activities are proposed for the areas currently vegetated with *Phragmites* that lie below the mean high-water line (+3.62 feet) and extending to an elevation ranging to approximately +6 feet.

The elevations used to develop this conceptual approach were based on the hard copy topographic survey provided by the Middletown Township Environmental Commission and limited verification using field spot elevation checks in conjunction with GPS. Although it is possible to conduct a successful restoration using the conceptual approach described here, the development of a grading plan is strongly recommended as a critical component of this restoration. An acceptable grading plan plus engineering and bid specifications will greatly increase the probability of restoration success and will provide the means to more accurately determine project costs.

The marsh generally lies at an elevation ranging from +2 to +6 feet. Elevations below +2 feet are typically limited to the tidal creeks. No pannes (depressions in the marsh substrate exhibiting elevated salinity) were observed in this marsh. As previously described, the existing *Spartina* community occupies areas of the marsh situated at +2 to +2.5 feet near the Wandering River Road bridge. The soils evaluation indicated that the *Phragmites* root mat is typically 4 to 6 inches thick, located at a depth of approximately 12 to 18 inches bgs. The excavation of this root mat will drop the elevation of the substrate approximately 1 to 1.5 feet. The final grade will be achieved by either scraping material to achieve a lower elevation, or adding material to achieve a higher elevation.

Within the restoration area, Stinky Creek is currently a well-defined, relatively wide, and sinuous channel with few small tidal creeks extending into the intertidal marsh. Some widening and deepening of the main channel, tidal creeks, and guts are recommended for the restoration. The specific segments of these features should be field-determined during earth-moving activities. In addition to these enhancements, several new tidal guts are proposed to be excavated in this

[2] As stated in Footnote #1, mowing activities should be limited to those areas that can support the weight of the mowing equipment. See Footnote #1 for more details.

marsh. The purpose of creating these new tidal guts is to deliver tidal flows to the back-marsh areas and to facilitate hydraulic exchange. The effects of this step will include increase in the exchange of nutrients, detritus, and salinity to most areas of the marsh. The location and orientation of these tidal creeks follow along the natural existing contours of the marsh substrate and are therefore anticipated to function properly within the landscape. Creation of these new tidal creeks is vital since this restoration will result in an increase in low marsh acreage, relative to high marsh. A concomitant increase in the tidal flushing from the creation of the tidal guts is required to support the hydraulic needs of the new larger low marsh area.

4.5 Goose Control

Following the above substrate preparation activities, the planting area will need to be secured from herbivorous wildlife. Restoration projects that involve the planting of herbaceous species (e.g., forbs and grasses) typically require a significant amount of predation control for protection from herbivores. Predation by Canada goose (*Branta canadensis*) is a major concern for wetland plantings in the eastern United States. A flock of Canada goose can decimate the majority of a wetland planting in a single feeding. The most effective wetland restoration projects include a goose control element as an integral part of the restoration plan. The proposed goose control method is an effective technique that has been used successfully at numerous restoration sites in the northeast United States notorious for heavy predation by herbivorous wildlife. The construction of the goose control fencing requires a substantial amount of field labor and materials; however, the cost of this effort is offset by the higher success rate that this method has demonstrated in curtailing plant loss.

This method involves establishing a 8-foot by 8-foot grid across the areas to be planted with herbaceous species. For this restoration, this area includes below the mean high-water line to the edge of the tidal creek and upwards to the edge of the marsh (approximately +6 feet). The grid is initially established using 4- to 6-foot wooden stakes driven into the substrate. Three or more lines of heavy-duty twine are extended between each stake both longitudinally and latitudinally to create a network of twine-fences perpendicular to each other. Brightly colored survey flagging is then tied at regular intervals along the upper twine. The perimeter of the entire planted area is then secured with plastic construction fencing or other similar product.

This goose control fencing serves to discourage geese from entering the planted area. The string fence provides a physical barrier to geese, and the movement of the survey flagging in the breeze provides sensory disturbance. Occasionally, an individual animal will enter the planted area and feed; however, the fencing generally discourages groups of animals (e.g., a flock of Canada geese) from entering. The goose control fencing will remain in place for a period of two years following planting. This approach will allow the perennial species sufficient time to attain the size and vigor that can withstand some degree of predation.

4.6 Planting Scheme

The planting scheme developed for this restoration was based primarily on the vegetation community types that would be expected in a similar marsh system which did not include *Phragmites*. New Jersey tidal marshes are well documented and exhibit fairly consistent species assemblages and zonation patterns. From this starting point, the vegetation community proposed for this particular marsh system was refined and adjusted to match those marsh systems that are typically encountered in the Outer Coastal Plain physiographic section of the state. This planting community was then further refined to take into account the site-specific environmental conditions and landscape features of this marsh.

Four species assemblages have been selected for this restoration effort. Three of the four assemblages are associated with specific elevation ranges within the tidal zone and one of the assemblages is to be used on an as-needed basis for upland areas disturbed from restoration activities. The four species assemblages are associated with the following areas:

- low marsh—from below mean high water (less than +3.62 feet) to mean high water (+3.62 feet).
- high marsh—from mean high water (+3.62 feet) to the approximate spring tide line (+4.5 feet).
- marsh/upland transition zone—from the approximate spring tide line (+4.5 feet) to the outer boundary of the restoration area (+6 feet).
- upland—random areas disturbed by restoration activities (e.g., earth-moving equipment, machinery, and personnel).

The proposed planting zones and corresponding species assemblages are discussed below and depicted on the attached plan entitled "Stinky Creek Topography, Existing Conditions, and Planting Scheme." It is important to note that any conceptual restoration plan does not identify all of the microenvironmental features or anomalies present on a project landscape. Although many of these features are known prior to the development of the restoration plan, some are not revealed until implementation of the restoration effort. Flexibility of the planting scheme allows for previously undiscovered landscape features or anomalies to be addressed. The availability of these plants from wetland nurseries may also dictate the final species selection. If certain species are not available at the time of planting, a reasonable substitute will be selected for use. However, two key species identified for this restoration, *Spartina alterniflora* and *Spartina patens*, will not be substituted.

4.6.1 Low Marsh—Below Mean High Water (less than +3.62 feet) to Mean High Water (+3.62 feet)

This intertidal zone is defined here as the top of bank of the tidal creek (less than +2 feet) to an elevation of approximately +4 feet. This upper two-thirds of this zone will be planted with the following three species at the specified approximate percent composition:

- Smooth cordgrass (*Spartina alterniflora*) plugs—100%

This species will be planted at a spacing of approximately 3 feet on center. It is anticipated that the present seed bank will contain viable seeds of the above species, as well as other intertidal plant species. Germination of the seed bank will provide additional species richness to the intertidal zone, although near complete dominance by smooth cordgrass is acceptable and typical for this type of wetland system. It is also anticipated that algae such as rockweed (*Fuscus* *vesiculosus*), *Enteromorpha* spp., and sea lettuce (*Ulva lactuca*) will become established between the *Spartina* stems.

4.6.2 High Marsh—Mean High Water (+3.62 feet) to the Approximate Spring Tide Line (+4.5 feet)

This zone is composed mainly of high marsh, but also includes the upper end of the low marsh and the lower end of the upland. The recommended planting scheme for the high marsh is as follows:

- Salt hay (*Spartina patens*) plugs—85%
- Smooth cordgrass (*Spartina alterniflora*) plugs—5%
- Spikegrass (*Distichlis spicata*) plugs—5%
- Black grass (*Juncus gerardii*) plugs—5%

All of the above plant species should be planted at a spacing of approximately 3 feet on center. Similar to the low marsh, it is anticipated that the high marsh soils will possess a viable seed bank containing those species listed above, as well as sea-lavender (*Limonium carolinianum*), saltmarsh plantain (*Plantago maritima*), seaside gerardia (*Agalinis maritima*), glassworts (*Salicornia* spp.), and smart weeds (*Polygonum* spp.). If this marsh had historically contained permanent pools, seeds of other species such as arrowgrass (*Triglochin maritimum*), widgeon grass (*Ruppia maritima*), glassworts, and short-form smooth cordgrass may also be present.

4.6.3 Upland/Marsh Transition Zone—Approximate Spring Tide Line (+4.5 Feet) to the Outer Boundary of the Restoration Area (+6 Feet)

This zone is a transition between the high marsh and the surrounding upland. This upper limit of this zone also represents the outer boundary of the restoration area. Unlike the low and the high marsh, this community is composed of both herbaceous and woody plant species. And unlike the low and high marsh, most of this zone may be planted independent of the tidal cycle. This zone will be planted with the following species at the specified approximate percent composition:

- Switchgrass (*Panicum virgatum*) plugs—50%
- Bayberry (*Myrica pensylvanica*) (12–18″ pots)—15%
- Red chokeberry (*Pyrus arbutifolia*) (12–18″ pots)—15%
- Groundsel tree (*Baccharis halimifolia*) (12–18″ pots)—15%
- Marsh elder (*Iva frutescens*) (12–18″ pots)—5%

The switchgrass will be planted at a spacing of approximately 3 feet on center. The bayberry, red chokeberry, and marsh elder will be planted at a spacing of approximately 10 feet on center. It is anticipated that the underlying soils will possess a viable seed bank containing a variety of other herbaceous and woody plant species characteristic of both estuarine and freshwater transitional communities. This area will also be readily colonized by the surrounding terrestrial vegetation further upland. Species anticipated to germinate from the seed bank or disperse into this zone include those listed above, as well as sweetgum (*Liquidambar styraciflua*), coast pepperbush

(*Clethra alnifolia*), pin oak (*Quercus palustris*), common elder (*Sambucus canadensis*), and red maple (*Acer rubrum*).

4.6.4 Disturbed Upland Areas

There will be unavoidable impacts to upland vegetation from implementation of this restoration effort. These disturbances will primarily be the result of traffic from earth-moving vehicles. These areas will be replanted as needed with the following species:

- Annual rye (*Lolium annuum*) seed
- Switchgrass (*Panicum virgatum*) plugs
- American holly (*Ilex opaca*) (12–18″ pots)
- Eastern red cedar (*Juniperus virginiana*) (12–18″ pots)

5.0 WETLANDS MONITORING AND REPORTING

The monitoring program is an essential component of a wetland restoration. It is the only mechanism by which (1) the restoration performance can be measured, (2) the performance can be reported to the interested parties, and (3) the restoration design can be reexamined and the appropriate corrective measures taken. A five-year monitoring program is proposed for this restoration.

5.1 Initial Vegetative Response

The initial vegetation response will be evaluated in an initial monitoring visit approximately one to two months following the completion of all planting activities. The purpose of this monitoring is to evaluate the immediate response of the plantings to their new environment. Qualitative descriptions of the overall appearance of the vegetation will be documented. Spot removal of *Phragmites* and any necessary repairs to the goose control fencing will also be conducted during this visit.

5.2 Annual Monitoring Program

A five-year monitoring program will be implemented to evaluate the long-term success of the restoration effort. One monitoring visit per year will be conducted during the later portion of the growing season (e.g., late August to mid September). Three of the four planted communities will be part of the monitoring program—the replanted disturbed upland areas will not be included in the monitoring.

Three transects will be established in the marsh, oriented roughly perpendicular to Stinky Creek (parallel to Hobbit Road and Wandering River Road). A monitoring point will be established for each community type on both sides of the creek. For example, starting from the west, each transect will contain the following monitoring points, interrupted by the creek: marsh/upland zone, high marsh zone, low marsh zone, Stinky Creek, low marsh zone, high marsh zone, marsh/upland zone. The monitoring points will be marked in the field using either wooden stakes or PVC tubing. Since the marsh/upland community will contain a mix of herbaceous and woody species, monitoring of this community will also be on an individual plant basis for the woody species.

The corner of a 1 meter by 1 meter (1 m^2) sampling quadrat will be placed at each monitoring point for data collection. The quadrat corner selected for use (e.g., northeast corner) will remain consistent among all monitoring points and throughout the course of the five-year monitoring period.

Fixed-point photograph locations, indicated with permanent markers (e.g., wooden stakes), will also be established that would best portray a visual depiction of the restoration. Photographs of the restoration will be taken from these fixed-point locations at each monitoring visit, at the same orientation per location (e.g., facing north, facing southeast, etc.). These photographs will supplement the monitoring data as a visual aid for reporting.

Attachment J presents an example of a wetland restoration monitoring data sheet. All relevant observations should also be documented during the monitoring visits. These observations include wildlife species, invasion by nuisance plants, occurrence of woody species in the herbaceous community, disturbances to the landscape, etc.

5.3 Reporting

The results of the restoration monitoring program will be provided to appropriate regulatory agencies on an annual basis, with a final report issued at the end of the five-year period. The interim reports (monitoring years 1 to 4) will be delivered prior to the end of the calendar year of the respective monitoring period. These reports will include the vegetation community metrics data, color photographs from the fixed-point locations, a comparison of the current monitoring results with prior data, general observations of the restoration area and assessment of restoration success, and recommendations for any corrective measures to be taken. The final monitoring report will present an overall assessment of the restoration effort and will also present a chronological summary of all the interim monitoring results.

6. ESTIMATED COSTS AND RESTORATION OPTIONS

This section of the document provides a cost estimate and description per Section (Sections I through IV) for the tasks described in this restoration plan. This information may be used by the township to determine if the restoration effort will be conducted in part, in phases, or in its entirety. These cost estimates are based on typical contractor and consultant labor and material rates as of 2002.

Tables 6-1 to 6-4 present the cost estimates for restoring Sections I through IV, respectively.

6.1 Section I

Section I includes the marsh area to the south of Hobbit Road, east of the main channel of Stinky Creek, and extending southward to a point approximately midway towards Wandering River Road. This midway point is an area where the main channel of Stinky Creek is within the closest proximity to the outer boundaries of the marsh. Section I is approximately 5.59 acres and will include the following major components:

- approximately 1,200 feet of Haul Road #1;
- the construction of Staging Area #1;
- the excavation of several tidal channels;
- approximately 4 acres of low marsh, 1 acre of high marsh, 1 acre of marsh/upland transition, and 0.5 acres of upland; and
- access.

The following table summarizes the estimated costs for the restoration of Section I.

Table 6-1. Cost Estimate for Section I

Activity	Task	Unit Cost	Quantity	Total Cost
Site preparation	Construction of temporary access road and staging area	$100/linear foot	1,200 linear feet	$120,000.00
Phragmites eradication and grading	Option 1			
	Mowing/grubbing	$1,190/acre	5.59 acres	$6,652.10
	Excavation/grading	$30/cubic yard	18,000 cu. yds.	$540,000.00
	Disposal	$23,850/acre	5.59 acres	$133,321.50
	Rodeo application (2X)	$895/acre	11.18 acres	$10,006.10
	Option 2			
	Mowing/grubbing	$1,190/acre	5.59 acres	$6,652.10
	Excavation/grading	$30/cubic yard	18,000 cu. yds.	$540,000.00
	Disposal	$23,850/acre	5.59 acres	$133,321.50
Goose control	Materials	$400/acre	5.59 acres	$2,236.00
	Labor	$1,200/acre		$6,708.00
Planting	Low marsh			
	Materials	$3,200/acre	4 acres	$12,800.00
	Labor	$1,200/acre		$4,800.00
	High marsh			
	Materials	$3,200/acre	1 acre	$3,200.00
	Labor	$1,200/acre		$1,200.00
	Marsh/Upland transition			
	Materials	$2,800/acre	1 acre	$2,800.00
	Labor	$1,200/acre		$1,200.00
	Upland			
	Materials	$1,200/acre	0.5 acres	$600.00
	Labor	$1,200/acre		$600.00

Monitoring and reporting	Materials and labor	$18,000 total	NA	$18,000.00
Grand total for Section I (Option 1) Grand total for Section I (Option 2)				$864,123.70 $854,117.60

6.2 Section II

Section II includes the marsh area to the north of Wandering River Road, east of the main channel of Stinky Creek, and extending northward to a point approximately midway towards Hobbit Road. This midway point is an area where the main channel of Stinky Creek is within the closest proximity to the outer boundaries of the marsh. Section II is approximately 5.51 acres and will include the following major components:

- approximately 2,240 feet of Haul Road #1;[3]
- the construction of Staging Area #2;
- the excavation of at least one tidal channel;
- approximately 4 acres of low marsh, 0.75 acres of high marsh, 0.75 acres of marsh/upland transition, and 0.5 acres of upland; and
- access.

Table 6-2 summarizes the estimated costs for the restoration of Section II.

6.3 Section III

Section III is a narrow area along the western side of the marsh spanning from Hobbit Road to Wandering River Road. In the northwestern half of the marsh, this section includes the marsh area to the west of the main channel of Stinky Creek. In the southeastern half of the marsh, this section includes the marsh area to the west of the secondary channel of Stinky Creek (see Site Plans). Section III is approximately 4.33 acres and will include the following major components:

- approximately 1,600 feet of Haul Road #2;
- approximately 4 acres of low marsh, 1 acre of high marsh, 1 acre of marsh/upland transition; and 0.5 acres of upland; and
- access.[4]

Table 6-3 summarizes the estimated costs for the restoration of Section III.

6.4 Section IV

Section IV includes the area within the central portion of the marsh, depicted on the site plans as "Anticipated to be Unsuitable for Standard Earth-Moving Equipment." It is bound by the main

[3] Although only 1,040 feet of Haul Road #1 occurs within the boundaries of Section II, approximately 2,240 feet of Haul Road will require construction to gain access to Section II from Hobbit Road.
[4] With the exception of one Block and Lot, drainage easements exist on all of the parcels.

channel and secondary channel of Stinky Creek and the existing *Spartina* community. Section IV is approximately 3.38 acres and will include the following major components:

- the use of an amphibious earth-moving vehicle and
- approximately 3.38 acres of low marsh.

Table 6-4 summarizes the estimated costs for the restoration of Section IV.

Table 6-2. Cost Estimate for Section II

Activity	Task	Unit Cost	Quantity	Total Cost
Site preparation	Construction of temporary access road and staging area	$100/linear foot	2,240 linear feet	$224,000.00
Phragmites eradication and grading	Option 1			
	Mowing/grubbing	$1,190/acre	5.51 acres	$6,556.90
	Excavation/grading	$30/cubic yard	17,780 cu. yds.	$533,410.00
	Disposal	$23,850/acre	5.51 acres	$131,413.50
	Rodeo application (2X)	$895/acre	11.02 acres	$9,862.90
	Option 2			
	Mowing/grubbing	$1,190/acre	5.51 acres	$6,556.90
	Excavation/grading	$30/cubic yard	17,780 cu. yds.	$533,410.00
	Disposal	$23,850/acre	5.51 acres	$131,413.50
Goose control	Materials	$400/acre	5.51 acres	$2,204.00
	Labor	$1,200/acre		$6,612.00
Planting	Low marsh			
	Materials	$3,200/acre	4 acres	$12,800.00
	Labor	$1,200/acre		$4,800.00
	High marsh			
	Materials	$3,200/acre	0.75 acres	$2,400.00
	Labor	$1,200/acre		$900.00
	Marsh/Upland transition			
	Materials	$2,800/acre	0.75 acres	$2,100.00
	Labor	$1,200/acre		$900.00
	Upland			
	Materials	$1,200/acre	0.5 acres	$600.00
	Labor	$1,200/acre		$600.00
Monitoring and reporting	Materials and labor	$18,000 total	NA	$18,000.00
Grand Total for Section II (Option 1)				$957,159.30
Grand Total for Section II (Option 2)				$947,296.40

Table 6-3. Cost Estimate for Section III

Activity	Task	Unit Cost	Quantity	Total Cost
Site Preparation	Construction of temporary access road	$100/linear foot	1,600 linear feet	$160,000.00
Phragmites eradication and grading	Option 1			
	Mowing/grubbing	$1,190/acre	4.33 acres	$5,152.70
	Excavation/grading	$30/cubic yard	14,000 cu. yds.	$420,000.00
	Disposal	$23,850/acre	4.33 acres	$103,270.00
	Rodeo application (2X)	$895/acre	8.66 acres	$7,750.70
	Option 2			
	Mowing/grubbing	$1,190/acre	4.33 acres	$5,152.70
	Excavation/grading	$30/cubic yard	14,000 cu. yds.	$420,000.00
	Disposal	$23,850/acre	4.33 acres	$103,270.00
Goose control	Materials	$4000/acre	4.33 acres	$1,732.00
	Labor	$1,200/acre		$5,196.00
Planting	Low marsh			
	Materials	$3,200/acre	4 acres	$12,800.00
	Labor	$1,200/acre		$4,800.00
	High marsh			
	Materials	$3,200/acre	1 acre	$3,200.00
	Labor	$1,200/acre		$1,200.00
	Marsh/Upland transition			
	Materials	$2,800/acre	1 acre	$2,800.00
	Labor	$1,200/acre		$1,200.00
	Upland			
	Materials	$1,200/acre	0.5 acres	$600.00
	Labor	$1,200/acre		$600.00
Monitoring and reporting	Materials and labor	$18,000 total	NA	$15,000.00
Grand Total for Section III (Option 1)				$745,301.40
Grand Total for Section III (Option 2)				$737,550.70

Table 6-4. Cost Estimate for Section IV

Activity	Task	Unit Cost	Quantity	Total Cost
Site Preparation	Construction of temporary access road	NA	NA	NA[5]
Phragmites eradication and grading	Option 1			
	Mowing/grubbing	$1,190/acre	3.38 acres	$4,022.20
	Excavation/grading	$30/cubic yard	5,450 cu. yds.	$163,500.00
	Disposal	$23,850/acre	3.38 acres	$80,613.00
	Rodeo application (2X)	$895/acre	6.76 acres	$6,050.20
	Option 2			
	Mowing/grubbing	$1,190/acre	3.38 acres	$4,022.20
	Excavation/grading	$30/cubic yard	5,450 cu. yds.	$163,500.00
	Disposal	$23,850/acre	3.38 acres	$80,613.00
Goose control	Materials	$400/acre	3.38 acres	$1,352.00
	Labor	$1,200/acre		$4,056.00
Planting	Low marsh			
	Materials	$3,200/acre	3.38 acres	$12,800.00
	Labor	$1,200/acre		$4,800.00
Monitoring and reporting	Materials and labor	$18,000 total	NA	$12,000.00
Grand Total for Section IV (Option 1)				$289,193.40
Grand Total for Section IV (Option 2)				$283,143.20

REFERENCES

Able, K. W., and M. P. Fahay. 1998. *The First Year in the Life of Estuarine Fishes in the Middle Atlantic Bight*. Rutgers Univers. Press, New Brunswick, NJ.

Ailstock, M. S., C. M. Norman, and P. J. Bushmann. 2001. "Common Reed *Phragmites australis*: Control and Effects Upon Biodiversity in Freshwater Nontidal Wetlands." *Restoration Ecol.* **9**(1):49–59.

Angradi, T. R., S. M. Hagan, and K. W. Able. 2001. "Vegetation Type and the Intertidal Macroinvertebrate Fauna of a Brackish Marsh: *Phragmites* vs. *Spartina*. *Wetlands*." **21**(1):75–92.

Armstrong, J., W. Armstrong and P. Beckett. 1992. "*Phragmites australis*: Venturi- and Humidity-Induced Pressure Flows Enhance Rhizome Aeration and Rhizosphere Oxidation." *New Phytol.* **120**:197–207.

Bart, D., and J. M. Hartman. 2000. "Environmental Determinants of *Phragmites australis* Expansion in a New Jersey Salt Marsh: an Experimental Approach." *Oikos* **89**:59–69.

Besitka, M. A. R. 1996. "An Ecological and Historical Study of *Phragmites australis* along the Atlantic Coast." M.S. Thesis, Department of Bioscience and Biotechnology, Drexel University, Philadelphia, PA.

[5] The restoration of Section IV will utilize either Haul Road #1 or Haul Road #2.

Bigelow, H. B., and W. C. Schroeder. 1953. *Fishes of the Gulf of Maine*. Fishery Bulletin 74, Fishery Bulletin of the Fish and Wildlife Service, Volume 53. U.S. Government Printing Office, Washington, DC.

Broome, S. W., E. D. Seneca, and W. W. Woodhouse, Jr. 1988. "Tidal Marsh Restoration." *Aquat. Bot.* **32**:1–22.

Burdick, D. M., M. Dionne, R. M. Boumans, and F. T. Short. 1997. "Ecological Responses to Tidal Restorations of Two Northern New England Salt Marshes." *Wetlands Ecology and Manage.* **4**(2):129–44.

Casagrande, R. A. 1997. "Potential of European Insects to Control North American *Phragmites*." Abstract, *Phragmites* Workshop, Institute of Ecosystem Studies, Millbrook, NY.

CCE. 1998. "Glyphosate. Extoxnet (Extension Toxicology Network) Pesticide Information Profile." Cornell Hobbitative Extension Offices of Cornell University, Ithaca, NY. http://pmep.cce.cornell.edu/profiles/extoxnet.

Cowie, N. R., W. J. Sutherland, M. K. M. Dithlogo, and R. James. 1992. "The Effects of Conservation Management of Reed Beds. II. The Flora and Litter Disappearance." *J. Appl. Ecol.* **29**:277–84.

Cross, D. H., and K. L. Fleming. 1989. "Control of *Phragmites* or Common Reed." U.S. Fish and Wildlife Service, Waterfowl Management Handbook, Fish and Wildlife Leaflet 13.4.12.

Gibson, J. R., and R. G. Najjar. 2000. "The Response of Chesapeake Bay Salinity to Climate-Induced Changes in Streamflow." *Limnol. Oceanogr.* **45**(8):1764–72.

Gries, C., L. Kappen, and R. Losch. 1990. "Mechanism of Flood Tolerance in Reed, *Phragmites australis* (Cav.) Trin. ex Stuedel." *New Phytol.* **114**:589–93.

Hellings, S. E., and J. L. Gallagher. 1992. "The Effects of Salinity and Flooding on *Phragmites australis*." *J. Appl. Ecol.* **29**:41–49.

Hietz, P. 1992. "Decomposition and Nutrient Dynamics of Reed (*Phragmites australis* (Cav.) Trin. ex Steud.) Litter in Lake Neusidl, Austria." *Aquatic Botany* **43**:211–30.

Hildebrand, S. F. 1963. "Family Clupeidae," in *Fishes of the Western North Atlantic*. Sears Foundation for Marine Research, Yale University, New Haven, CT.

Howe, M. A., R. B. Clapp, and J. S. Weske. 1978. *Marine and Coastal Birds*. Marine EcoSystems Analysis (MESA) Program, MESA New York Bight Atlas Monograph 31, New York Sea Grant Institute, Albany, NY.

Lee, S. Y. 1990. "Net Aerial Primary Productivity, Litter Production and Decomposition of the Reed *Phragmites communis* in a Nature Reserve in Hong Kong: Management Implications." *Marine Ecol. Progr. Ser.* **66**:161–73.

Magee, D. W. 1981. F*reshwater Wetlands: A Guide to Common Indicator Plants of the Northeast*. The University of Massachusetts Press, Amherst, MA.

Matoh, T., N. Matsushita, and E. Takahashi. 1988. "Salt Tolerance of the Reed Plant *Phragmites communis*." *Physiologia Pl.* **72**:8–14.

Min, B. M., and J. H. Kim. 1983. "Distribution and Cyclings of Nutrients in *Phragmites communis* Communities of a Coastal Salt Marsh." *Korean J. Bot.* **26**(1):17–32.

Niedowski, N. L. 2000. *New York State Salt Marsh Restoration and Monitoring Guidelines*. Prepared for the N.Y. State Dept. of State, Division of Coastal Resources and the N.Y. State Dept. of Environ. Conserv., Division of Fish, Wildlife and Marine Resources.

Niering, W. A., and R. S. Warren. 1980. "Vegetation Patterns and Processes in New England Salt Marshes." *BioScience* **30**:301–07.

Orson, R. A., R. S. Warren, and W. A. Niering. 1987. "Development of a Tidal Marsh in a New England River Valley." *Estuaries* **10**(1):20–27.

PSE&G. 1996. "Fact Sheet 4: Phragmites Control." Public Service Energy and Gas Company.

Rice, D., J. Rooth, and J. C. Stevenson. 2000. "Colonization and Expansion of *Phragmites australis* in Upper Chesapeake Bay Tidal Marshes." *Wetlands* **20**(2):280–99.

Rilling, C. 1998. "Tidal Wetland Restoration—Use of the Herbicide Rodeo to Control Common Reed." Technical Report of the Connecticut Department of Environmental Protection, Office of Long Island Sound Programs.

Robichaud, B., and M. F. Buell. 1973. *Vegetation of New Jersey, A Study of Landscape Diversity*. Rutgers University Press, New Brunswick, NJ.

Roman, C. T., W. A. Niering, and R. S. Warren. 1984. "Salt Marsh Vegetation Change in Response to Tidal Restriction." *Environ. Manage.* **8**:141–50.

Rozsa, R. 2001. "Tidal Wetland Restoration in Connecticut, Parts 1 to 3." From http://camel2.conncoll.edu/ccrec/greennet/arbo/publications/34/CHP5.htm.

Scott, W. B., and E. J. Crossman. 1973. *Freshwater Fishes of Canada*. Bull. Fish. Res. Board Can. 184.

Smith, L. M., and J. A. Kadlec. 1983. "Seed Banks and their Role During Drawdown of a North American Marsh." *J. Appl. Ecol.* **20**:673–84.

Teal, J., and M. Teal. 1969. *Life and Death of the Salt Marsh*. Ballantine Books, New York, NY.

Tscharntke, T. 1989. "Attack by a Stem-boring Moth Increases Susceptibility of *Phragmites australis* to Gall-making by a Midge: Mechanisms and Effects on Midge Population Dynamics." *Copenhagen* **54**:93–100.

Yamasaki, S. 1987. "Oxygen Demand and Supply in *Zizania latifolia* and *Phragmites australis*." *Aquatic Bot.* **29**:205–15.

Appendix E

Sample Detailed Wetlands Mitigation Plan: Creation Area

DETAILED WETLANDS MITIGATION PLAN

CREATION AREA
OLD BUDDY FARM SITE
BURLINGTON COUNTY, NEW JERSEY

MARCH

VERSION NO. 2

Prepared for:

Valerie Development Group
New Jersey

Prepared by:

AMEC Earth & Environmental
Somerset, New Jersey

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SAMPLE DETAILED WETLANDS MITIGATION PLAN: CREATION AREA, OLD BUDDY FARM SITE, BURLINGTON COUNTY, NEW JERSEY

1. INTRODUCTION

The following Mitigation Plan is a detailed presentation of the proposed creation of freshwater wetlands on the Old Buddy Farm Site ("Site") located in New Jersey. The proposed creation and restoration of wetlands is in response to the disturbance of wetlands at the Site during remedial design activities associated with Operable Unit One (OU1). This plan is being submitted in accordance with the requirements of the Clean Water Act (CWA), Section 404(b)(1) Guidelines (Guidelines), and the New Jersey Pinelands Protection Act (N.J.S.A. 18A-1 et seq.)(PPA).

Disruption of wetlands on the Site is necessary to fulfill remediation requirements established by the EPA under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). These remediation requirements involve the excavation and treatment of soils impacted by chemicals associated with the on-site disposal of wastes. Disruption of on-site wetlands cannot be avoided for three reasons:

1) a portion of the waste material to be remediated is located within the wetland boundary;
2) portions of a road widening project for Site access for remediation were unavoidably located within wetlands; and
3) support facilities for Site remediation were unavoidably located within wetlands.

1.1 Objective

The objective of this wetlands mitigation activity is the creation of approximately 85,260 square feet of Palustrine broad-leafed deciduous forested wetlands consistent in characteristics to the adjacent wetlands areas. In addition, emergent wetlands will be extended from the on-site pond into presently upland area. This Detailed Wetlands Mitigation Plan describes the methodologies for the wetlands creation and extension.

2. SITE LOCATION

The Site is located in Burlington County, New Jersey (Figure 2-1). It is approximately 43 acres in size and is designated as Block 123, Lots 456.78 on the Tax Map. Land use within 1.25 miles of the Site is generally agricultural and single-family residential. Agricultural land use contiguous to the property includes blueberry and sod farming. Residential development, targeting middle to upper-middle income families, is under way immediately northeast and east of the Site.

3. EXISTING CONDITIONS

The wetlands creation will occur in an area noted as Area E (Lot 32.01) located just west of the parking lot and truck marshalling area. The activity will consist of the creation of approximately 85,260 square feet of wetlands. The Wetlands Creation Area is surrounded on the north, south, and west by existing wetlands (the east side is separated from another wetland unit by the Site access roadway. The design of the Creation Area is dependent on the characteristics of these contiguous areas. Most of the wetlands to the north and west are not heavily inundated but are more transitional in character. The wetlands to the south are more classical in character due to the high degree of inundation. A general drawing of the Wetlands Creation Area is shown as Drawing No. C002.

The Wetlands Creation Area is presently vegetated by an old-field community, which is demonstrating secondary successional characteristics. The topography and the vegetative community described in this area indicate that this lot has been disturbed historically by human activity. Several sparsely vegetated areas have been identified throughout the field. The sandy nature of the soil in this area suggests that there is little organic matter to sustain a robust vegetative community. The ground cover in the more densely populated parts of the area consists of various grasses, mosses, sweetfern (*Comptonia peregrina*), goldenrod (*Solidago* spp.) and mountain mint (*Pycnanthemum* spp.). The understory vegetation in the wooded sections grade from densely populated stands along the north side to nonexistent on the south side. The dominant understory species includes pitch pine (*Pinus rigida*), gray birch (*Betula populifolia*), eastern red cedar (*Juniperus virginiana*), and staghorn sumac (*Rhus typhina*). The Conceptual Wetland Mitigation Plan (August 1993) presents a detailed description of the vegetative community surrounding the Wetlands Creation Area.

Surface soil in the Wetland Creation Area varies in character from coarse sand to silty, sandy loam with Munsell Color Chart readings of 2.5 Y 4/4. The deeper soil layer (12–18 inches) generally consists of coarse sandy loam with Munsell Color Chart readings of 10 YR 5/6.

3.1 WET Functional Analysis

A WET functional analysis was prepared. The following is a summary of the findings from that report.

3.1.1 General

The WET functional analysis assesses wetland functions and values in terms of biological, chemical and physical characteristics. The results are expressed with respect to two major categories—Social Significance and Effectiveness/Opportunity. Within each major category a number of functions and values are considered The techniques does not consider all functions and values listed above for each major category. When a function or value is considered, it is given a probability rating of HIGH, MODERATE, or LOW. Probability ratings are determined by answering questions relating to the specific wetland. The evaluation interprets those questions according to available scientific literature. Ultimately, these ratings should aid in determining the overall importance of a specific wetland based on characteristics that make wetlands a beneficial resource.

The on-site wetland was given probability ratings of HIGH for groundwater recharge, groundwater discharge, and uniqueness/heritage, with respect to social significance (Table 3-1). The HIGH probability rating for the groundwater recharge functions stems from the designation of "sole source aquifer" given to the New Jersey Coastal Plan Aquifer System.

Table 3-1. Social Significance Results, Wetland Functional Analysis, Old Buddy Farm Site

Function/Value	Probability Rating
Groundwater Recharge	High
Groundwater Discharge	High
Floodflow Alteration	Low
Sediment Stabilization	Low
Sediment Toxicant Retention	Moderate
Nutrient Removal/Transformation	Moderate
Production Export	Not evaluated
Wildlife Diversity/Abundance (D/A)	Low
Wildlife D/A Breeding	Not evaluated
Wildlife D/A Migration	Not evaluated
Wildlife D/A Wintering	Not evaluated
Aquatic Diversity/Abundance	Low
Uniqueness/Heritage	High
Recreation	Low

WET automatically elevates the probability rating of any wetland within this system. However, in consideration of the large number of wetlands that occupy the region, the on-site wetland is not particularly important as an individual wetland. Groundwater discharge was given a HIGH rating due to the potential for important wetland dependent species in the area. Since the endangered Pine Barrens tree frog (*Hyla andersonii*) and the threatened barred owl (*Strix varia*) have been observed in the area, the probability rating is elevated. The HIGH probability rating given to uniqueness/heritage is due to the on-site wetland's position within the New Jersey Pinelands. The Pinelands Commission manages the region for purposes of ecological preservation as well as cultural preservation.

WET considers this significant, hence the HIGH rating. Similar to groundwater, however, there are numerous wetlands in the region, many undisturbed, which are of higher value than the on-site wetlands. The on-site wetland is not particularly significant when taken alone.

The remaining function/values categories all received a LOW. The floodflow alteration category received a LOW probability rating because of the buried wastes, which exist within the on-site wetland. Flooding could potentially release contaminants and move them surficially downstream. Thus, it is not beneficial to have the on-site wetland perform the floodflow alteration function. Sediment stabilization received a LOW rating due to characteristics of the surrounding area. The watershed is not prone to erosion, there are many other wetlands in addition to those within the on-site wetland, and it is not an urbanized area. Therefore, sediment stabilization is not a significant issue. Wildlife diversity/abundance and aquatic diversity/abundance both received LOW ratings for the simple reasons that there are not limited occurrences of unique wildlife or aquatic species within the on-site wetland, no special designations have been issued regarding recognized wildlife value, and there are numerous wetlands throughout the area that are equally or more suitable as habitat. Recreation value received a LOW rating because the on-site wetland is not used recreationally and is not an access point for other areas used for recreational purposes.

In summary, all HIGH probability ratings were given to functions or values that do not consider the numerous other wetlands in the region, and thus the on-site wetland is not uniquely important. The MODERATE ratings were issued only when considering impacts that would result if the entire on-site wetland were destroyed, which is not a potential circumstance. It may therefore be concluded that the social significance of the on-site wetland is relatively minimal.

3.1.2 Effectiveness and Opportunity Evaluation

The effectiveness and opportunity category of the evaluation measures the ability of a wetland to perform a function as well as the potential for the wetland to perform that function. Naturally, a wetland may exhibit qualities that would favor the performance of some function, while the physical requirements to actually perform the function may be lower or absent. Conversely, conditions may exist where the opportunity is high but the wetland is ineffective at performing that function. The result would be a higher rating in effectiveness, with a lower rating in opportunity. In any case, this category evaluates functions and values regardless of their effect on society. The social significance evaluation accounts for those effects.

Effectiveness Results

The categories receiving HIGH probability ratings in terms of effectiveness were floodflow alteration, sediment/toxicant retention, wildlife diversity/abundance breeding, and wildlife diversity/abundance wintering (Table 3-2). A HIGH effectiveness rating was given to floodflow alteration mainly due to the size of the assessment area (356.3 acres) and the dominance of woody vegetation. These two characteristics suggest that the on-site wetland can store large quantities of floodwater and produce a desynchronized effect. Sediment/toxicant retention received a HIGH rating due to its slow flow of channelized water; erect, persistent vegetation; and lack of evidence of erosion. Wildlife diversity/abundance breeding received a HIGH rating because of the large size of the on-site wetland and its irregular shape. These properties are very effective at predicting the desirability of a wetland for breeding. The wildlife diversity/abundance wintering also received a HIGH. Reasons for this rating include those described for breeding but also include the fact that annual precipitation exceeds annual evapotranspiration.

MODERATE effectiveness ratings were given to groundwater discharge, sediment stabilization, and production export. Groundwater discharge received a MODERATE essentially because of the nature of its hydrology. Since there are no signs of excessive groundwater discharge, flooding, or high groundwater recharge, WET considers groundwater discharge to be intermediate. Sediment stabilization received a MODERATE rating due to the absence of strong erosive forces while still providing plenty of rooted woody vegetation. A MODERATE rating was given to production export because it fulfills none of the requirements for either a HIGH or LOW.

Table 3-2. Effectiveness and Opportunity Results, Wetland Functional Analysis, Old Buddy Farm Site

Function/Value	Effectiveness Probability Rating	Opportunity Probability Rating
Groundwater Recharge	Low	Not estimated
Groundwater Discharge	Moderate	Not estimated
Floodflow Alteration	High	Moderate
Sediment Stabilization	Moderate	Not estimated
Sediment/Toxicant Retention	High	High
Nutrient Removal/Transformation	Low	High
Production Export	Moderate	Not estimated
Wildlife Diversity/Abundance (D/A)	Not estimated	Not estimated
Wildlife D/A Breeding	High	Not estimated
Wildlife D/A Migration	Low	Not estimated
Wildlife D/A Wintering	High	Not estimated
Aquatic Diversity/Abundance	Low	Not estimated
Uniqueness/Heritage	Not estimated	Not estimated
Recreation	Not estimated	Not estimated

LOW effectiveness ratings were given to groundwater recharge, nutrient removal/ transformation, wildlife diversity/abundance migration, and aquatic diversity/abundance. Groundwater recharge was given a LOW rating because its inlet has an intermittent flow while its outlet has a permanent flow. The combination of these characteristics suggests recharge is potentially nonexistent on a regular basis. Nutrient removal/transformation was given a LOW rating because neither the requirements for HIGH nor MODERATE were met.

Wildlife diversity/abundance received a LOW due to lack of vegetation interspersion and lack of significant open water. Aquatic diversity/abundance was LOW due to lack significant open water.

Opportunity Results

Potential opportunity is evaluated for only three functions: floodflow alteration; sediment/ toxicant retention; and nutrient removal/transformation. Both sediment toxicant/retention and nutrient removal/transformation received HIGH probability ratings of opportunity due to the existence of a storm water outfall from the residential development to the northeast, as well as the existence of contaminants in the groundwater that could potentially be released to the surface. Similarly, a HIGH rating was given to nutrient removal/transformation because of the storm water outfall and the existence of fertilized agricultural lands adjacent to the on-site wetland, which could be a potential nutrient source.

Floodflow alteration received a MODERATE rating because there were insufficient criteria to reach either a HIGH or LOW probability rating.

In conclusion, it appears that the probability ratings given to the various functions and values with respect to effectiveness and opportunity are plausible and intuitively reasonable. The only areas of doubt lie in the HIGH ratings given to the effectiveness of wildlife diversity/abundance breeding and wintering. The criteria used to generate the results, such as wetland size and shape, seem rather weak. Based upon the results of the WET analysis, it is unlikely that remedial activities within portions of the on-site wetlands will result in any severe impacts to the functions or values of the wetland as a whole.

4. CONCEPTUAL MITIGATION APPROACH

Approximately 85,260 square feet of wetlands will be created from existing upland areas. Because this area is surrounded on the north, south, and west by existing wetlands (the east side is separated from another wetland unit by the Site access roadway), the design of the creation area will be dependent on the characteristics of these contiguous areas. Most of the wetlands to the north and west are not heavily inundated but are more transitional in character. The wetlands to the south and east are more classical in character, due to the high degree inundation.

The general approach to the creation of wetlands in this area will be to clear and grub all vegetation, strip and stockpile topsoil, and remove the subsoil over the entire area down to a series of final grades consistent with the surrounding wetlands. Following removal of the soil, preparation of the remaining substrate and topsoil placement, appropriate wetlands vegetation will be planted consistent with the vegetative characteristics of the surrounding wetlands.

4.1 Proposed Vegetation

The majority of the wetlands to the north and west of the creation area have vegetative communities dominated by pitch pine (*Pinus rigida*), eastern red cedar (*Juniperus virginiana*), and red maple (*Acer rubrum*) for the canopy layer and coast pepperbush (*Clethra alnifolia*), red maple saplings, black gum (*Nyssa sylvatica*), swamp azalea (*Rhododendron viscosum*), and black highbush blueberry (*Vaccinium atrococcum*) in the understory. The plants utilized in the Wetlands Creation Area will be selected to closely match those identified in the surrounding area, depending on nursery availability. Only those plant species confirmed to be indigenous to the New Jersey Pinelands will be considered for possible use in the creation project. Confirmation of the indigenous nature of a species will be made through the use of *The Vegetation of the New Jersey Pine-barrens* (J. W. Harshberger, Dover Publications, New York, 1970).

At the extreme southeast corner of the Creation Area, emergent wetlands are present. These emergent wetlands are contiguous with the on-site pond. The pond receives surface water drainage from the surrounding area, including the uplands area to be modified in the wetlands creation. It is bordered on the west by the access road and on the south and west by an earthen dike approximately 3 feet above the elevation of the pond. The northern end of the pond borders a narrow strip of emergent wetlands characterized by various sedges and rushes. Immediately beyond that is a small grassed area approximately 30 feet wide and 60 feet long. This area is characterized by hydric soils and is consistently vegetated with various short grasses and herbaceous plants, including blue-eyed grass (*Sisyrinchium* sp.) and bush clover (*Lespedeza capitata*). North of the grassy area (adjacent to the southwest corner of the existing parking area, see Drawing C002), the vegetative community is characterized by upland plants seen throughout the Creation Area. That includes European white birch (*Betula alba*), red-osier dogwood (*Cornus stolonifera*), mountain laurel (*Kalmia latifolia*), and pitch pine (*Pinus rigida*).

The emergent area on the north side of the pond will be expanded to allow for a greater emergent area. The created emergent area will be planted with soft rush (*Juncus effusus*) and rice cutgrass (*Leersia oryzoides*).

4.2 Proposed Hydrology

The predominant requirement necessary to maintain wetland functions is hydrology. Without the necessary periods of soil saturation characteristic of wetlands, hydrophytic vegetation cannot be supported. Additionally, the various chemical processes that result in hydric soils will not occur without sufficient soil saturation. Therefore, for the wetlands creation to be successful at the site, it is imperative that an adequate hydrology be ensured.

The existing hydrology for the area is relatively simple. The site is surrounded by extensive areas of wetlands that are mostly supported by a high groundwater table. While surface runoff and precipitation do contribute to the overall hydrologic budget, the incidence of high groundwater is probably the determining factor in the distribution of on-site wetlands.

Data taken from monitoring wells located just south of the Wetlands Creation Area indicate that groundwater is found at the 76-foot elevation. The wetlands delineation lines around the periphery of the Wetlands Creation Area generally are found at elevation ranging from just over 79 feet to the north, to less than 78 feet to the south. These elevations would equate to the more saturated wetlands in the south and to the more transitional wetlands in the north. The upland area that is included in the Wetland Creation Area ranges in elevation up to 80.46 feet.

Because of the groundwater influence, it is logical to assume that a reduction in the elevation of the Wetlands Creation Area to within closer proximity of the high water table will allow for sufficient saturation to support hydrophytic vegetation. It is believed that artificial support of the created wetlands by supplemental watering, once the planted vegetation is established, will not be necessary.

To evaluate the proposed hydrology for the Creation Area, a water budget for the Site was calculated. The methodology and formula for the calculation of the water budget was based on information detailed in *Planning Hydrology for Constructed Wetlands*, by Gary J. Pierce (Wetlands Training Institute; Poolesville, Maryland; 1993). Essentially, the hydrology of the wetlands was considered to be equal to the water input per unit time, minus the water output per unit time. To support viable wetlands, the storage change of the wetlands generally needs to be positive (more input then output) over the unit of time. It is particularly important that the storage be a plus value over the period of the growing season. The actual formula used for the budget calculation was

$$P + SWI + GWI = ET + SWO + GWO + S \ ,$$

where

P	=	precipitation,
SWI	=	surface water inflow,
GWI	=	groundwater inflow,
ET	=	evapotranspiration,
SWO	=	surface water outflow,
GWO	=	ground water outflow (infiltration),
S	=	change in storage.

Several assumptions were utilized in the development of this water budget. The created wetland, as supported by the drawing cross sections (Drawing C004), was assumed to be an enclosed system, with no surface water outflows. Based on the cross sections, the surface elevations of the created wetlands will all be lower than the surrounding existing wetlands.

Inflow was assumed to be from precipitation. Though groundwater is of sufficient elevation to remain close to the surface of the created wetlands, for purposes of the hydrologic budget calculations, groundwater was assumed to not flow into the wetland. Also, surface inflow through runoff or surface water was considered to be negligible because of the lack of streams running through the Creation Area and the presence of a slight berm around the majority of the wetlands. Outflow was assumed to include evapotranspiration and infiltration. Overflow is assumed to pass over a weir to be installed between the Creation Area wetlands and the existing pond.

All climatological data used in the calculations were obtained from the National Climatic Data Center for Indian Mills, New Jersey. Indian Mills is located approximately 4 miles southwest of the Site. Precipitation and temperature data was obtained for the years 1961 to 1990. Data from the year 1986 was utilized for the budget calculations because this is the year closest to the normal value for the entire period.

The formula for the development of the potential evapotranspiration value is

$$E_t = 1.6(10T_a/I)^a \ ,$$

where

E_t	=	potential evapotranspiration in cm/mo,
T_a	=	mean monthly air temperature (C),

and the monthly heat index (I) is

$$I = \Sigma(T_a/5)^{1.5} ,$$

where $a = 0.49 + 0.0179I - 0.0000771I^2 + 0.000000675I^3$ (a latitude adjustment for sunlight duration was included).

Other assumptions included the use of 1×10^{-6} cm/2 for permeability and the use of a pan evaporation rate of 80% of Class A pan evaporation rates for the area. Groundwater data was collected from two wells (P3 and P4) adjacent to the Creation Area for the determination of potential groundwater elevations and inflow.

The results of the hydrologic budget calculations are presented in Table 4-1. The results indicate that the hydrologic budget has a cumulative positive value of 24.84 inches for storage change over the course of the year, based on the climatological data similar to 1986 (normal year). This would indicate that the Creation Area has sufficient hydrology (based on normal year precipitation) to support wetlands. While the late summer and fall months operated at a budget deficit, the overall budget was positive. Of particular importance was the fact that the water budget was positive during the growing season.

Table 4-1. Water Budget Calculations

Month	Precipitation (inches)	Temperature (mean)	Heat Index (I-monthly)	Heat Index (I-total)	a	E (inches/month)	Correlation Factor	E (corrected)	Infiltration (inches)	Storage (inches)	Storage Change (inches)
March	2.14	44.3	1.60	55.91	1.37	0.83	0.99	0.82	1.05	0.27	6.31
April	6.58	51.9	3.29	55.91	1.37	1.60	1.1	1.76	1.02	3.80	10.11
May	0.56	65.3	7.12	55.91	1.37	3.24	1.2	3.88	1.05	–4.38	5.73
June	2.68	71.4	9.16	55.91	1.37	4.07	1.25	5.09	1.02	–3.43	2.30
July	5.71	76	10.81	55.91	1.37	4.74	1.23	5.83	1.05	–1.17	1.13
August	2.39	72.2	9.44	55.91	1.37	4.19	1.15	4.82	1.05	–3.48	–2.35
September	2.45	67.1	7.70	55.91	1.37	3.48	1.04	3.62	1.02	–2.19	–4.54
October	2.3	57	4.63	55.91	1.37	2.19	0.93	2.03	1.05	–0.79	–5.33
November	5.49	44.6	1.66	55.91	1.37	0.86	0.83	0.71	1.02	3.76	–1.57
December	6.41	37.3	0.45	55.91	1.37	0.26	0.78	0.20	1.05	5.15	3.58

An analysis of the water budget calculation using different climatological parameters allowed for a more complete evaluation of the hydrology for the Creation Area. Using the average climatological data for the period of 1961 through 1990, a cumulative storage change of a positive 44.88 inches was calculated. Under that scenario, the only month with a negative budget would be September, at –0.11 inches. Using the driest conditions, which occurred in 1969, a cumulative storage change of –25.23 inches was calculated. Negative budgets would be seen for June through December. Using the wettest conditions, which occurred in 1979, a cumulative storage change of 190.80 inches was calculated. Under those conditions, no monthly negative budgets would be observed. This comparison is presented in Table 4-2.

Table 4-2. Comparison of Storage Changes under Various Precipitation Scenarios, in inches

Month	Normal (1986)	Low (1965)	High (1979)	Average
January	3.43	2.55	7.85	2.56
February	6.04	3.80	13.21	4.76
March	6.31	6.21	15.26	6.90
April	10.11	5.80	16.23	8.06
May	5.73	2.39	19.60	7.48
June	2.30	–0.81	17.98	5.08
July	1.13	–1.92	15.46	2.43
August	–2.35	–6.38	15.82	0.99
September	–4.54	–8.45	16.08	–0.11
October	–5.33	–9.96	16.72	0.10
November	–1.57	–10.72	18.02	1.94
December	3.58	–10.29	18.57	4.69
(Cumulative)	24.84	–25.23	190.80	44.88

The stockpiled topsoil, if needed, will be utilized as the topsoil for the area once initial grading has been completed. The goal is to have the top 12 inches of the Creation Area substrate contain some clay and silt and contain approximately 5%–10% organic carbon. As further described in Section 5, soil measurements prior to soil removal and following final grading will determine the need for supplemental nutrient addition and addition of topsoil to ensure proper soil particle size distribution. Following completion of the final grade of the Wetlands Creation Area, the soil will be prepared for planting through discing or other means of field cultivation.

To increase the functional effectiveness of the mitigation area for providing vegetative abundance and diversity, the grading design will include topographic variations that provide high and low points in the landscape. The low points will be designed to allow an increase in the extent and duration of spring flooding, and the high points will provide refuge to inundation into tolerant species. This grading design will also interconnect the topographical low points with each other as well as to the emergent wetlands adjacent to the on-site pond. This will ensure that water is not impounded within the created wetland to an excessive degree.

4.3 Proposed Soils

The organic layer of soil from the Wetlands Creation Area will be removed and stockpiled for future use. The underlying soils will also be removed to consistent grades as presented in Section 5 and stockpiled in upland areas on site.

5. DETAILED SPECIFICATIONS

The Wetlands Creation Area is an upland pocket extending into surrounding Palustrine Forested wetlands. The upland area is bordered to the north, west, and south by the existing wetlands. The upland area covers approximately 85,260 square feet. This area will be excavated to meet elevations consistent with the surrounding wetlands. Topsoil will be segregated from the underlying material, with both stockpiled in separate upland areas on site. Approximately 3–6 inches of topsoil obtained from the stockpiled material will be placed on the rough graded subsoil. The topsoil will be sculpted to produce hummocking prior to planting. This is to allow for the development of a more heterogeneous habitat following planting. One depressional area will be excavated in the northeastern section of the Creation Area.

Once the soil has been removed, the final grades have been established, and the ground surface prepared for planting, vegetation consistent with the surrounding wetlands area will be planted.

5.1 Construction Specifications

5.1.1 Cultural Resources Survey

Prior to any soil disturbance in the Creation Area, a Stage IB Cultural Resources Survey will be conducted to verify that wetlands mitigation activities will not impact cultural resources or significant archeological receptors potentially present in the Creation Area.

The Stage IB survey will be conducted by dividing the area within the Creation Area that will be impacted by soil disturbance activities into a grid with 75-foot centers. At each grid nexus, a shovel test will be made. The test will be made by digging a hole approximately 16 inches in diameter and extending into the natural subsoil or to the limit of practical excavation, whichever is shallower. The location of each shovel test will be recorded on a map of the Creation Area, and the soil profile of each location will be recorded on standardized recording forms. Soil from the test unit will be passed through ¼-inch hardware cloth to ensure uniform recovery of cultural remains. Such remains will be retained in bags marked with standard information. Narrative field notes and photographs will also be produced to document the results of the field investigation.

Articles recovered in the course of the field investigation will be washed and inventoried. To the extent appropriate, the recovered artifacts will be identified as to material, temporal or cultural/ chronological association, style, and function. Preliminary analysis will seek patterns in the relative composition of the recovered artifact assemblages, particularly to the extent that such patterns may indicate the functional nature of the assemblages and/or the Site formation processes associated with their deposition. These attributes are particularly relevant to the evaluation of potential archeological significance.

A fully detailed report presenting the goals, methods and results of the Stage IB investigation will be prepared in accordance with state and federal guidelines. Background and field data will be reviewed, synthesized, and presented in the report, along with the conclusions regarding the presence or absence of potentially significant archeological resources within the Creation Area. The potential significance of any resource identified will be assessed. Appropriate recommendations will be presented, including the need for further investigations to evaluate significance and possible National Register of Historic Places eligibility of any archeological resource encountered. The report will be provided to the USEPA prior to the commencement of disturbance activities in the Creation Area.

5.1.2 Surveying

Prior to Site disturbance, the Wetlands Creation Area will be surveyed and staked to correspond to Drawing Number C002. This step will ensure conformance of the excavation to the borders of the upland area and reduce the possibility of intrusion into the existing wetland areas. In addition, grade elevations will be surveyed and staked following Site clearing but prior to rough grading.

5.1.3 Soil Erosion and Sediment Control

Prior to the commencement of any construction activities which will result in the disturbance of the existing soils in the Creation Area or adjacent thereto, soil erosion and sediment control measures shall be constructed in accordance with the attached soil erosion and sediment control plans (see Drawing Numbers C006, C007 and C008). The primary objectives will be to prevent sediment from being washed from the Creation Area into the existing wetlands north, west, and south of the Creation Area, preventing sediment from being washed from the stockpiles to surrounding areas and preventing erosion of bare soil once construction is complete. All soil erosion and sediment control measures shall be maintained in good condition and left in place until permanent vegetation cover is established.

5.1.4 Clearing

A miscellaneous stone mix will be placed in roadside swales to create access routes to the creation area and topsoil stockpile area. Prior to excavation, the Creation Area will be cleared and grubbed of all standing vegetation. All mossycup oaks (*Quercus macrocarpa*), black gum (*Nyssa sylvatica*), pitch pine (*Pinus rigida*), and red maples (*Acer rubrum*) of manageable size (larger than 1 inch DBH) will be removed during the clearing operations for replanting. These trees will be removed with a sufficient root ball to support the plant prior to replanting. The ball will be, to the extent possible, wrapped in burlap. Following any other required preparations, the plants will be stockpiled adjacent to the Proposed Soil Stockpile area (Drawing C007). All cleared vegetation will be chipped and temporarily staged with other debris in an upland area noted on Drawing Number C007. Chipped material will serve as mulch for planting operations. Nonrecyclable material will be disposed at a landfill.

5.1.5 Rough Excavation

Following clearing, the Creation Area will be excavated to the contours shown in the Drawings included with these detailed specifications. Drawing Number C004 shows the cross-section details of the Creation Area and consists of contour elevations showing the current and finished grades to be obtained. The cross sections have been established through the Creation Area at a minimum of 50-yard intervals and show the current grade from the existing wetlands on the south of the Creation Area to the existing wetlands on the north. A similar set of cross sections has been provided for an east to west direction. Each cross section extends 50 feet beyond the limits of the Creation Area on both ends of the transect to ensure consistency with the grades of the neighboring wetland areas.

Excavation will commence with the stripping of the topsoil layer (top 3–6 inches) from the creation area. The topsoil that is removed will be stockpiled at a location indicated on Drawing Number C007.

Prior to excavation, four soil samples will be collected from locations spread across the Creation Area. The samples will be analyzed for total organic carbon and grain size distribution. The objective of this sampling is to determine the adequacy of the topsoil to support the planting of hydrophytic vegetation. If the results of the analyses indicate that an insufficient percentage of silt or clay is present, supplemental topsoil may be brought in to mix with the native topsoil. This step would be conducted during stockpiling, prior to the final grading activities.

Following removal of the topsoil, the subsoil material will be removed to a rough grade, approximately 3–6 inches below the final grade consistent with the elevations shown on the Wetlands Creation Plan, Drawing Number C002. This soil material will be stockpiled at the existing soil stockpile. Soil excavation will commence from existing grade at the existing and proposed wetlands lines and graded at an approximate slope of 5:1 (20%) to final wetland grade at the eastern and northern boundaries. Soil disturbance within the existing wetlands will be avoided. The one exception is the southern portion, which will be excavated to extend the existing pond towards the wetlands creation area as part of the mitigation activities to extend the emergent wetland area immediately adjacent to the pond northward towards the created forested wetlands area. The Creation Area will be graded to allow for runoff over a weir installed between the Creation Area and the emergent area. This structure will serve as a hydrologic connection between the pond and its adjacent emergent wetland area and the remaining created wetlands area.

Inspections will be made on a periodic basis of the conditions of the earthwork. The frequency will be at a minimum of 24 hours. At the completion of the soil excavation to the rough grade, a final inspection of the grades will be made. Documentation of the results of all inspections will be maintained in a field notebook.

5.1.6 Final Grade

Following completion of the rough grade excavation, approximately 3–6 inches of topsoil will be returned to the Creation Area to bring the wetlands grade up to its final contour. Final grades will be consistent with the grade elevations shown on the cross sections (Drawing Number C004). Final grades are shown in plan view on the Wetlands Creation Post Grading Plan, Drawing Number C003. The final grade will not be smoothed flat. Surface sculpting will be developed based on site observations and under the supervision of an engineer. Surface sculpting will be conducted to allow for hummocking to develop and allow for a more heterogeneous habitat. The sculpting will not be such that it interferes with preparation of the soil for planting.

During the final grading, imported topsoil may be used to supplement on[site topsoil if the soil analyses described in Section 5.1.5 indicate that the native topsoil contains an insufficient percentage of silt and clay.

Inspections will be made on a periodic basis of the conditions of the earthwork. The frequency will be at a minimum of 24 hours. At the completion of the work to bring the Creation Area to final grade, a final inspection of the grades will be made. Documentation of the results of all inspections will be maintained in a field notebook.

5.1.7 Stockpiling of Excavated Material

Excavated material will be stockpiled as indicated on Drawing Number C007. Debris will be temporarily staged at a designated temporary debris staging area prior to being removed off site. Topsoil will be stored at the proposed topsoil stockpile area while subsoil will be placed at the proposed/existing soil stockpile area. The existing soil stockpile will be expanded to accommodate the extra material from the wetlands creation. Stockpiled soil will be encircled with sediment barrier and graded and vegetated with switchgrass to stabilize and prevent erosion of the material.

5.2 Planting Specifications

Following excavation and grading of the Creation Area, the soil will be prepared and then planted consistent with the vegetative characteristics of the surrounding wetlands. Spacing of plants will be approximately 9 feet between canopy species and 4.5 feet between understory species. Based on a total area of approximately 85,260 square feet of created wetlands, this spacing will amount to approximately 1,052 trees and 4,208 shrubs to be planted within the Wetlands Creation Area.

5.2.1 Planting Preparation

Prior to actual planting, the graded soil will be prepared. The ground will be disced or harrowed to a depth of approximately 6 inches to facilitate soil aeration and planting. If the soil data collected as described in Section 5.1.6 indicates that the pH for the Creation Area soil is below 4.5, sufficient lime will be added to the soil prior to discing to raise the soil pH to 4.5. Detailed calculations as to the quantity of lime to be added will be conducted prior to any addition. Additionally, if the soils data collected as described in Section 5.1.6 indicates that additional nutrients are required to support the growth of groundcover, supplemental nutrients in the form of fertilizer may be added on a broadcast basis prior to discing. Detailed calculations as to the quantity and type of soil nutrients will be performed prior to the addition of any fertilizer. Great care will be taken to ensure that excessive quantities of fertilizers are not added to the Creation Area. The goal is to ensure that the Creation Area soils are consistent with the soils of the surrounding existing wetlands.

5.2.2 Planting Material

Plants will be consistent with the surrounding wetlands areas. Table 5-1 presents the trees, shrubs, herbs, and grasses and their vegetative characteristics (stock size and type) to be planted. All stock to be planted will be nursery grown. Because of the lack of a significant herbaceous groundcover strata in the surrounding wetlands, herbaceous plants (other than grass) will not be included in the planting activities.

Table 5-1. Plant Material List

Key	Botanical Name	Common Name	Quantity	Size/ Comments	Wetlands Indicator
Trees					
AR	*Acer rubrum*	Red Maple	631	3′–4′ pot	FAC
NS	*Nyssa sylvatica*	Black Gum	105	3′–4′ pot	FAC
PR	*Pinus rigida*	Pitch Pine	105	3′–4′ pot	FAC
MV	*Magnolia virginiana*	Sweetbay Magnolia	52	1′–1.5′ pot	FACW
AS	*Alnus serrulata*	Smooth Alder	52	1′–1.5′ pot	OBL
QB	*Quercus bicolor*	Swamp White Oak	105	2′–3′ pot	FACW
Shrubs					
CA	*Clethra alnifolia*	Coast Pepperbush	1473	1.5–2′ pot	FAC+
VC	*Vaccinium corymbosum*	Common Highbush Blueberry	1497(1)	1.5′–2′ pot	FACW
RV	*Rhododendron viscosum*	Swamp Azalea	1286(2)	1′–1.5′ pot	OBL
Herbs					
JE	*Juncus effusus*	Soft Rush	1304	2″ peat pot	FACW
Grasses					
LO	*Leersia oryzoides*	Rice Cutgrass	40 lbs./acre	Seed	OBL
PV	*Panicum virgatum*	Switchgrass	40 lbs./acre	Seed	FAC

(1) 24 Common Highbush Blueberry will be planted in Emergent Wetlands Area.
(2) 24 Swamp Azalea will be planted in Emergent Wetlands Area.

The trees to be planted include red maple (*Acer rubrum*), black gum (*Nyssa sylvatica*), pitch pine (*Pinus rigida*), sweetbay magnolia (*Magnolia virginiana*), smooth alder (*Alnus serrulata*) and swamp white oak (*Quercus bicolor*). Swamp white oak will be used instead of the mossycup oak (*Quercus macrocarpa*) that was identified on site because of nursery availability.

Shrubs to be planted include the coast pepperbush (*Clethra alnifolia*), common highbush blueberry (*Vaccinium corymbosum*), and swamp azalea (*Rhododendron viscosum*). The common highbush blueberry will be used in place of the black highbush blueberry (*Vaccinium atrococcum*) that was identified on site because of nursery availability.

Using the total area of approximately 85,260 square feet and a density of 9 feet between trees and 4.5 feet between shrubs, it is calculated that approximately 1,052 trees and 4,208 shrubs will be planted within the Wetlands Creation Area. Based on frequency calculations for the canopy species, that will amount to 631 red maples (60%), 105 black gum (10%), 105 pitch pine (10%), 105 swamp white oaks (10%), 52 smooth alder (5%) and 52 sweetbay magnolia (5%). Based on frequency calculation for the understory species, that will amount to 1,473 coast pepperbushes (35%), 1,473 common highbush blueberries (35%), and 1,262 swamp azaleas (30%).

The emergent wetlands (pond expansion) will be planted with soft rush (*Juncus effusus*) in a grid pattern on two-foot centers. Based on an area of 5,218 square feet, approximately 1,304 plants will be planted. The emergent wetlands area will then be broadcast seeded with rice cutgrass (*Leersia oryzoides*) on a rate of 40 pounds per acre. The border of the emergent area will be planted with a mixture of highbush blueberry and swamp azalea (50% of each). The shrubs will be planted along the 77-foot contour that marks the extent of the extended emergent area. Based on a length of 217 feet, that amounts to 24 highbush blueberry shrubs and 24 swamp azalea shrubs. Total quantities of shrubs in Table 5-1 include these Emergent Wetland Area shrubs. Shrubs will be planted 4.5 feet apart.

Following planting of all woody species, all bare areas in the Wetlands Creation Area will be broadcast seeded with switchgrass (*Panicum virgatum*) at a rate of approximately 40 pounds per acre.

5.2.3 Planting Execution

Planting will be based on the use of 9-foot by 9-foot planting squares over the entire Creation Area. Trees and shrubs will be planted randomly within the square based on Drawing Number C005. The mix of particular species of trees and shrubs within each planting square will be on a random basis, though FACW and OBL species will be biased towards those portions of the Creation Area expected to have higher levels of saturation.

Plants will be delivered and staged on site prior to planting. Planting pits that are dug will be 1 foot larger than the plant container. Pit depth shall be to the depth of the plant container. When the trees and shrubs have been properly set, the pit shall be thoroughly watered during and after backfilling. Enough topsoil shall be used to bring the surface, when settled, to the required grade.

Plants will not be removed from containers until immediately before planting. Roots will be examined to determine if they are pot-bound. Roots that are pot-bound will be separated prior to planting. Plants shall be placed in the dug pit in such a manner so as to allow further growth without further constriction of the root ball. After planting and watering, each plant will be mulched with wood chips from on-site cleared vegetation, loose straw, or hay.

If it is determined that supplemental nutrients are necessary to support the planted vegetation, fertilizer may be utilized. Fertilizer could be added through local application to the soils surrounding the introduced plants. Fertilizing will not occur in the spring or summer, but will be conducted, if necessary, in the fall. Detailed calculations as to the quantity and type of soil nutrients will be performed prior to the addition of any fertilizer. The type and quantity of fertilizer utilized will calculated to ensure consistency of soils between the Creation Area and the surrounding wetlands.

5.2.4 Stockpiled Soil

Following completion of the grading activities, the soil stockpiles will be vegetated with grass to stabilize the material and prevent erosion. The soil piles will be broadcast-seeded with switchgrass at an application rate of approximately 40 pounds per acre. Stockpiled soil will be utilized for future site activities.

5.2.5 Post-Construction Activities

Following completion of the Creation Area wetlands, an as-built report detailing the activities and results of the mitigation will be prepared and submitted to USEPA. Included in the report will be the notes and observations of the on-site supervising engineer collected during grading and planting activities. The report will include delineation maps, data sheets, photographs, and water budget data. Other post-construction activities include those activities specified in the Operations and Monitoring Plan detailed in Section 7.

6. SOIL EROSION AND SEDIMENT CONTROL PLAN

Prior to any land disturbance for this project, required soil erosion and sediment control measures must be implemented. These measures will primarily consist of sediment barrier installation. The sediment barrier will be either silt fence or hay bales and installed in accordance with the details shown on Drawing Number C008. The sediment barrier will be installed down-gradient of land disturbance activities along with encircling the proposed/existing soil stockpile and proposed topsoil stockpile. Sediment barrier presently exists around the existing soil stockpile, but the barrier will be extended in order to accommodate the extra soil material from the subsoil excavation. Sediment barrier is required at down-gradient land disturbance areas to prevent sediment from eroding onto adjacent areas.

A stabilized construction entrance is not needed for these activities since construction vehicles will travel approximately 3,300 feet on the dense graded aggregate access roadway. The roadway will remove sediment from vehicle tires better than a standard 100-foot-long stabilized construction entrance. Contractors will be required to remove excess soil from equipment prior to entering the access roadway.

Soil erosion and sediment control measures will continue throughout the project. Drawing Number C008 contains Burlington County Soil Conservation District notes as well as seeding and mulching notes. Seeding and mulching notes detail preparation of the seedbed, seeding and mulching specifications, and seeding and mulching procedures.

Seeding will occur on all bare areas within the wetlands creation area and emergent wetlands area in order to control soil erosion. Disturbed areas left exposed for more than 30 days and not subject to construction traffic will be seeded. If the time of year does not permit seeding, a temporary mulch will be applied.

Stockpiles will be seeded to further prevent soil erosion. Sediment barrier will not be removed until a good vegetation cover is present at the previously disturbed areas.

7. MONITORING AND MAINTENANCE

Planting success will be monitored to ensure the success of the created wetlands. Plantings will be monitored on a periodic basis to ensure survivability of the plants. A detailed Operation and Maintenance Plan will be developed and submitted to USEPA prior to the completion of the wetlands creation activities. The monitoring plan will describe the monitoring procedures to be utilized during all monitoring events. The goal of the plan is to ensure that the goal of the wetlands creation is met. That goal is to replace the wildlife habitat and aesthetic quality functions of the wetlands lost during the remediation of the Site. The Operation and Maintenance Plan will state this goal.

Preliminary monitoring will occur four to six weeks after the completion of the planting to measure the vegetative response to planting. Survival will be determined based on a stem count of trees and shrubs. The measure of survivability of the plants will be determined both by mortality and by apparent vigor. Any dead trees or shrubs in excess of 15% of the original planting (85% survival) will be replaced before the first of October.

Following the initial monitoring, the Creation Area will be monitored on a semiannual basis. Monitoring inspections will be conducted at the beginning of the growing season (March) and at the conclusion of the growing season (September). Inspection will be conducted for a 10-year period. The results of the semiannual monitoring inspection will be noted on a Wetland Mitigation Area Assessment Checklist that will be developed and presented in the Operation and Maintenance Plan. The monitoring inspection will include the following:

1. Groundwater level measurements from on-site wells located adjacent to Wetlands Creation Area and other water budget measurements as necessary will be made to determine whether Site remediation activities are creating a drop in groundwater elevation that might be detrimental to the hydrologic function of the wetland.

2. Soil fertility will be checked annually the first year after the completion of creation activities. This check will be conducted to determine whether a regular program (i.e., spring and fall for the duration of the monitoring period) of fertilization is necessary and/or whether the existing fertilization program is adequate. If conditions warrant it, additional fertilizer may be applied at the end of the growing season (October). Fertilizer will be applied via local application to the individual plants. A 10-10-10 fast-release fertilizer is expected to be used.

3. Planting success rates will be determined by stem counts (for understory and canopy species) and percent cover. The success of the mitigation will be based on a minimum of 85% survival.

4. During the first three years, undesirable invasive species that are identified during the monitoring inspections will be physically removed following the semiannual inspection at the end of the growing season (October) to prevent their becoming established.

5. Trespass and predation will be closely monitored. Installation of fencing will be a contingency if browsing and grazing by deer, rabbit, etc. stunts vegetation growth or causes the survival rate to drop below 85% for more than two years in a row.

6. Replanting will be conducted if mortality occurs to a significant degree (i.e., a 15% or greater rate of mortality) or if there is severe browsing/grazing of a single species. Replanting will be consistent with those species lost and will occur as soon as possible after the completion of the monitoring inspection.

7. Any damage to the Creation Area resulting from erosion prior to the establishment of vegetative cover will be identified during the monitoring inspections and corrected.

An annual report, including photographic documentation of the conditions of the Creation Area, will be prepared and submitted to USEPA by December 1 of each year. The report will include copies of the Assessment Checklist completed during each semiannual inspection.

8. SCHEDULE

Upon acceptance of this Detailed Wetlands Mitigation Plan, planning for execution of the Wetlands Creation will begin. Construction and earthwork activities will begin either just prior to the beginning of the growing season or in sufficient time to allow for planting in the fall. All earthwork activities and soil preparation will be completed in time to allow for planting of the trees and shrubs to be completed by the end of April. If construction activities cannot begin by the beginning of the growing season, then they will be timed to allow for planting of the trees and shrubs to be completed between September and October. A detailed timeline is included as Figure 8.1.

8.1 Mitigation Support Activities and Deliverables

The following is a listing of activities necessary to support the construction of the wetlands as outlined in this report. Additionally, those deliverables required as specified in this Detailed Wetlands Mitigation Plan are listed.

- Stage IB Cultural Resources survey and report,
- Soil sampling of Creation Area topsoil prior to excavation,
- Operations and Maintenance Plan,
- As-Built Report, and
- Annual Inspection Report, including semiannual assessment checklists.

Appendix F

National Mitigation Action Plan

National Wetlands Mitigation Action Plan

December 24, 2002

The Bush Administration affirms its commitment to the goal of no net loss of the Nation's wetlands. The Administration is hopeful of achieving that goal and in the near future to begin increasing the overall functions and values of our wetlands through the combined efforts of the numerous governmental programs and initiatives, including the Clean Water Act, and non-regulatory wetland conservation initiatives and partnerships among federal agencies, state, tribal and local governments, and the private and not-for-profit sectors. The primary purpose of this Action Plan is to further achievement of the goal of no net loss by undertaking a series of actions to improve the ecological performance and results of wetlands compensatory mitigation under the Clean Water Act and related programs. The actions, listed below and outlined in more detail in the attached Action Plan, will help ensure effective restoration and protection of the functions and values of our Nation's wetlands, consistent with the goals of our clean water laws. The themes guiding these actions include:

- working in consultation with the Tribes, States, and interested parties to provide a consistent voice on compensatory mitigation matters;
- focusing our guidance, research, and resources to advance ecologically meaningful compensatory mitigation, informed by science;
- emphasizing accountability, monitoring, and follow-through in evaluating compensatory mitigation;
- applying the same compensatory mitigation provisions to Federal projects and on Federal lands as we do to private parties, consistent with existing laws and policies;
- providing information and options to those who need to mitigate for losses of wetlands functions; and
- providing technical and research assistance to those who undertake the work of mitigation.

An interagency team will guide the development and implementation of the following action items. Recognizing that advances in science and technology will continue to improve our ability to protect and restore the Nation's aquatic resources, some of the following action items may be modified by the team consistent with our evolving understanding of effective wetlands management.

Clarifying Recent Mitigation Guidance

- The Army Corps of Engineers (Corps), in consultation with the Environmental Protection Agency (EPA), the Department of Agriculture (USDA), the Department of the Interior (DOI), the Federal Highway Administration (FHWA), and the National Oceanic Atmospheric Administration (NOAA), has re-evaluated its mitigation Regulatory Guidance Letter and is reissuing it to improve mitigation implementation provisions.

Integrating Compensatory Mitigation into a Watershed Context

- The Corps and EPA, in conjunction with USDA, DOI, and NOAA, working with States and Tribes, will co-lead the development of guidance on the use of on-site vs. off-site and in-kind vs. out-of-kind compensatory mitigation by the end of 2003.

- EPA and the Corps, in conjunction with USDA, DOI, and NOAA, working with States and Tribes, will co-lead the development of guidance on the use of vegetated buffers as a potential component of compensatory mitigation by 2004.

- The Corps and EPA, in conjunction with USDA, DOI, and NOAA, working with States and Tribes, will develop guidance on the appropriate use of preservation for compensatory mitigation by 2004.

- Building on the guidance above, EPA and the Corps, working with USDA, DOI, and NOAA, will co-lead an analysis with Tribes and States on the use of compensatory mitigation within a watershed context and identify criteria for making compensatory mitigation decisions in this context by 2005.

Improving Compensatory Mitigation Accountability

- EPA, the Corps, and the FHWA will develop guidance that clarifies implementation of the TEA-21 preference for mitigation banking in 2003.

- EPA will continue to provide financial assistance through its wetlands State grants program to encourage Tribes, States, and others to increase the success of mitigation in their jurisdictions.

- EPA and the Corps, in conjunction with USDA, DOI, and NOAA, will develop guidance by 2004 for protecting those wetlands for which mitigation, restoration, or creation is not feasible or scientifically viable.

♦ EPA and the Corps, in conjunction with USDA, DOI, and NOAA, will clarify considerations for mitigating impacts to streams in the Section 404 program in 2003.

Clarifying Performance Standards

♦ The Corps, EPA, USDA, DOI, and NOAA, working with States and Tribes, will develop a model mitigation plan checklist for permit applicants in 2003.

♦ EPA and the Corps, in conjunction with USDA, DOI, and NOAA, will review and develop guidance adapting the National Academies of Sciences' National Research Council-recommended guidelines for creating or restoring self-sustaining wetlands to the Section 404 program in 2003.

♦ EPA will analyze existing research to determine the effectiveness of using biological indicators and functional assessments for evaluating mitigation performance in 2003.

♦ Building upon the biological indicators and functional assessments research, EPA, in conjunction with the Corps, USDA, DOI, and NOAA, and working with States and Tribes, will lead the development of performance standards guidance on monitoring and adaptive management of mitigation sites by 2005.

♦ EPA and the Corps, in conjunction with USDA, DOI, and NOAA, will clarify key concepts related to performance standards.

Improving Data Collection and Availability

♦ The Corps, EPA, USDA, DOI, and NOAA, in conjunction with States and Tribes, will compile and disseminate information regarding existing mitigation-tracking database systems in 2003.

♦ Building upon the analysis of existing mitigation data base systems, the Corps, EPA, USDA, DOI, and NOAA will establish a shared mitigation database by 2005.

♦ Utilizing the shared database, the Corps, in conjunction with EPA, USDA, DOI, and NOAA, will provide an annual public report card on compensatory mitigation to complement reporting of other wetlands programs by 2005.

The signatories or their designated representatives shall meet annually to review the progress being made regarding the implementation of the Action Plan. EPA and the Corps may invite other relevant federal agencies to participate in one or more of the action items.

This plan may be modified as necessary, by mutual written agreement of all the parties.

The participating agencies intend to fully carry out the terms of this agreement. All provisions in this agreement, however, are subject to available resources and authorities of the respective agencies under Section 404 of the Clean Water Act.

/Signed/ 12/24/02
Les Brownlee
Acting Assistant Secretary for Civil Works
Department of the Army (Civil Works)

/Signed/ 12/24/02
G. Tracy Mehan, III
Assistant Administrator for Water
U.S. Environmental Protection Agency

/Signed—Scott B.Gudes/ 12/24/02
/for/ Vice Admiral Conrad C. Lautenbacher, Jr.
U.S. Navy (ret.)
Undersecretary of Commerce for Oceans and Atmosphere
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Assistant Secretary for Transportation Policy
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ACTION PLAN

Introduction

Several recent independent analyses and public commentaries have provided a critical evaluation of the effectiveness of compensatory mitigation for authorized losses of wetlands and other waters of the United States under Section 404 of the Clean Water Act. These analyses and commentaries highlighted a number of shortfalls and identified a variety of technical, programmatic, and policy recommendations for the Federal agencies, States, and other involved parties.

In particular, the agencies are mindful of the comprehensive evaluation of wetlands compensatory mitigation completed by the National Academies of Sciences' National Research Council (NAS) last year. This report, in addition to the General Accounting Office (GAO) report on in-lieu-fee mitigation and others recently completed, provided the basis for a broad, independently facilitated stakeholder gathering in October 2001, during which the agencies gathered feedback from those with an interest in the future of compensatory mitigation, including representatives from academia, States, mitigation bankers, in-lieu-fee mitigation providers, environmental organizations, home builders, and industry. We recognize that success in our ultimate goal is dependent on effective interactions with these stakeholders as we proceed.

Background

The Bush Administration affirms its commitment to the goal of no net loss of the Nation's wetlands. The Administration is hopeful of achieving that goal and in the near future to begin increasing the overall functions and values of our wetlands through the combined efforts of the numerous governmental programs and initiatives, including the Clean Water Act, and non-regulatory wetland conservation initiatives and partnerships among Federal agencies, state, tribal and local governments, and the private and not-for-profit sectors. A fundamental objective of the Clean Water Act Section 404 program is that authorized losses of wetlands and other waters are offset by restored, enhanced, or created wetlands and other waters that replace those lost acres and functions and values. Importantly, the regulatory program provides first that all appropriate and practicable steps be taken to avoid impacts to wetlands and other waters, and then that remaining impacts be minimized, before determining necessary compensatory mitigation to offset remaining impacts. This mitigation sequence parallels that which is embodied in the National Environmental Policy Act governing the review of other Federal actions as well. Compliance with these mitigation sequencing requirements is an essential environmental safeguard to ensure that Clean Water Act objectives for the protection of the Nation's remaining wetlands are achieved.

Federal guidance on compensatory mitigation has been provided in several interagency documents, including the 1990 Memorandum of Agreement between the Environmental Protection Agency and the Department of the Army Concerning the Determination of Mitigation under the Clean Water Act Section 404(b)(1) Guidelines (MOA). In 1995, EPA and the Department of the Army were joined by the Departments of the Interior, Commerce, and Agriculture in developing the Federal Guidance on the Establishment, Use and Operation of Mitigation Banks (Banking Guidance). In 2000, the multi-agency Federal Guidance on the Use of In-Lieu-Fee Arrangements for Compensatory Mitigation under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act (In-Lieu-Fee Guidance) was issued. These interagency efforts have helped clarify compensatory mitigation objectives, endorse entrepreneurial mechanisms to achieve mitigation goals, and guide permit applicants in developing environmentally sound and enforceable mitigation projects. It is in light of this background that the agencies outline the following specific actions to improve wetlands compensatory mitigation under the Clean Water Act and related programs.

Clarifying Recent Mitigation Guidance

The Corps, in consultation with EPA, USDA, DOI, FHWA, and NOAA, has re-evaluated its mitigation Regulatory Guidance Letter and is reissuing it to clarify mitigation implementation provisions. The GAO noted that in some circumstances where mitigation involved third-party providers that were not mitigation bankers or in-lieu-fee providers, permits did not clearly state who was responsible for the success of the compensatory mitigation. Consistent with previous joint guidance and independent recommendations, the Corps will reissue the mitigation Regulatory Guidance Letter to clearly identify the party responsible for the ecological performance and results of the compensatory mitigation, the level of documentation necessary by applicants and mitigation providers, and other relevant implementation issues to ensure that mitigation is properly completed.

Integrating Compensatory Mitigation into a Watershed Context

The Corps and EPA, in conjunction with USDA, DOI, and NOAA, working with States and Tribes, will co-lead the development of guidance on the use of on-site vs. off-site and in-kind vs. out-of-kind compensatory mitigation by the end of 2003. Existing guidance provides that "compensatory actions…should be undertaken, when practicable, in areas adjacent or contiguous to the discharge site (on-site compensatory mitigation)" and that "generally, in-kind compensatory mitigation is preferable to out-of-kind." Existing guidance provides flexibility, however, by allowing the use of off-site mitigation where it is determined to be practicable and environmentally preferable to on-site mitigation and allows use of out-of-kind mitigation in circumstances where it is environmentally desirable, in the context of consolidated mitigation. To ensure effective and consistent use of off-site and out-of-kind compensatory mitigation, the agencies will clarify, and if necessary, expand upon, existing guidance. This effort will build on existing language developed for the 1990 MOA, Federal Banking Guidance, In-Lieu-Fee Guidance, and Mitigation RGL and provide examples illustrating when it may be appropriate to use off-site and/or out-of-kind mitigation in lieu of on-site and/or in-kind mitigation.

EPA and the Corps, in conjunction with USDA, DOI, and NOAA, working with States and Tribes, will co-lead the development of guidance on the use of vegetated buffers as a potential component of compensatory mitigation by 2004. Lands bordering open waters (e.g., rivers, lakes, estuaries) play important roles including but not limited to maintaining water quality, providing habitat for fish and wildlife, and providing flood storage benefits. To date, limited guidance has been provided to agency field staff on the appropriate use of vegetated buffers as a component of an overall compensatory mitigation plan. To ensure appropriate and consistent use of vegetated buffers, the agencies will provide guidance to clarify the use of vegetated buffers as mitigation in the Section 404 program. This effort will utilize performance goals/standards in recommending vegetated buffers and include examples of methodologies for determining mitigation credit for vegetated buffers. This effort will draw upon buffer information complied for the non-point/agricultural water programs and existing wetlands/forestry best management practices.

The Corps and EPA, in conjunction with USDA, DOI, and NOAA, working with States and Tribes, will develop guidance on the appropriate use of preservation for compensatory mitigation by 2004. Typically, the preservation of existing aquatic resources has been accepted as compensatory mitigation only in exceptional circumstances. To ensure the appropriate and consistent use of preservation as compensatory mitigation, the agencies will develop specific guidance that will clarify the exceptional circumstances described in current guidance in which preservation may serve as an effective and environmentally appropriate approach to satisfy compensatory mitigation requirements. This effort will build on existing language developed for the 1990 MOA and Federal Banking Guidance and provide examples of acceptable preservation projects.

Building on the guidance above, EPA and the Corps, working with USDA, DOI, and NOAA, will co-lead an analysis with Tribes and States on the use of compensatory mitigation within a watershed context and identify criteria for making compensatory mitigation decisions in this context by 2005. As a general matter, compensatory mitigation decisions are made on a case-by-case basis and often do not consider the proper placement of mitigation projects within the landscape context, the ecological needs of the watershed, and the cumulative effects of past impacts. The Federal agencies will analyze the issues associated with better use of compensatory mitigation within a watershed context, with assistance from the States and agencies. Following this analysis, the agencies will develop guidance to encourage placement of mitigation where it would have the greatest benefit and probability for long-term sustainability. The guidance will help decision-makers utilize the watershed-based planning tools/resources already developed by the agencies as well as state (Basinwide Management Approach), regional (Synoptic Assessment, Southeastern Ecological Framework), and local (watershed plans, land suitability models) watershed planning efforts. This guidance will complement other non-regulatory watershed management initiatives and partnerships.

Improving Compensatory Mitigation Accountability

EPA, the Corps, and the FHWA will develop guidance that clarifies implementation of the TEA-21 preference for mitigation banking in 2003. The statutory preference for mitigation banking in offsetting impacts to aquatic resources and natural habitats from federally-funded highway projects has caused some confusion in circumstances where onsite mitigation opportunities are available. The agencies will clarify how the mitigation banking preference may be used to most effectively mitigate for such projects with linear and scattered impacts to wetlands.

EPA will continue to provide financial assistance through its wetlands State grants program to encourage Tribes, States, and others to increase the success of mitigation in their jurisdictions. EPA has identified improving wetlands ecological performance and results of compensatory mitigation as a priority, along with wetlands monitoring and assessment and the protection of vulnerable wetlands and aquatic resources. The Wetland Program Development Grants, administered by EPA, provide recipients an opportunity to conduct projects that promote coordination and accelerate research, investigations, experiments, training, demonstrations, surveys, and studies relating to the causes, effects, extent, prevention, reduction, and elimination of water pollution. Priority is given to proposals that address EPA's priority areas, including improving the effectiveness of compensatory mitigation. EPA will announce a set of Wetland Program Development Grants for projects that support the improvement of mitigation success in achieving wetlands performance and results, in the context of building or enhancing wetlands protection, restoration, or management programs, and will publicize the annual availability of grants for this purpose.

EPA and the Corps, in conjunction with USDA, DOI, and NOAA, will develop guidance by 2004 for protecting those wetlands for which mitigation, restoration, or creation is not feasible or scientifically viable. As concluded by the NAS, there are a number of aquatic resource systems for which successful re-creation or restoration has not been effectively demonstrated and therefore avoidance of impacts to these resources was strongly recommended. Certain aquatic resource types require a specific combination of plant types, soil characteristics, and water supply that are currently difficult to create. To ensure that we meet our Clean Water Act goals, the agencies will provide guidance emphasizing the protection of the Nation's wetlands resources that are difficult to restore.

EPA and the Corps, in conjunction with USDA, DOI, and NOAA, will clarify considerations for mitigating impacts to streams in the Section 404 program in 2003. Historically, impacts to stream systems such as filling, impoundment, and channelization, have been compensated with wetland mitigation. To date, limited guidance has been provided to agency field staff in the appropriate considerations for mitigating impacts to streams. To ensure appropriate and consistent mitigation for impacts to streams, the agencies, working with States, will clarify considerations for mitigating impacts to streams in the Section 404 program. Many agency field offices are independently developing a variety of stream assessment approaches and stream standard operating procedures(e.g., NC, SC, GA, TN, KY, MS, and AL). Also, a number of stream and stream/wetland mitigation banks have been established or are currently under review by agency field offices. These and other ongoing stream restoration training efforts will help inform development of the guidance.

<u>Clarifying Performance Standards</u>

The Corps, EPA, USDA, DOI, and NOAA, working with States and Tribes, will develop a model mitigation plan checklist for permit applicants in 2003. The type of information needed for mitigating impacts to wetlands and other waters is often unclear to permit applicants. Taking advantage of State and Corps District examples, this effort would result in a model compensatory mitigation checklist to facilitate permit applicants providing necessary information early in the permitting process. The checklist would also allow more effective participation during public notice and help minimize delays in the permit decision-making process. The checklist could be regionally adapted to respond to specific needs of different areas of the country. A number of mitigation checklists are currently in use by various Districts, States, and Mitigation Bank Review Teams and could be readily consulted.

EPA and the Corps, in conjunction with USDA, DOI, and NOAA, will review and develop guidance adapting the NAS-recommended

guidelines for creating or restoring self-sustaining wetlands to the Section 404 program in 2003. The NAS proposed ten operational guidelines that would aid agency personnel and mitigation practitioners in designing projects to become ecologically self-sustaining. As stated by the NAS, to become self-sustaining, aquatic resource mitigation sites must have the proper hydrological processes present and be able to persist over time. The agencies will adapt the NAS guidelines for use in the Section 404 program. The NAS-recommended guidelines could be adapted into a series of questions (e.g., checklist) that could be made available to permit applicants and answered by regulatory staff in consultation with other resource agencies during project review.

EPA will analyze existing research to determine the effectiveness of using biological indicators and functional assessments for evaluating mitigation performance in 2003. Independent evaluations of mitigation raised concerns that there was an over-reliance on the use of vegetation to measure wetlands mitigation success. Biological assessments (bio-assessments) are based on the premise that the community of plants and animals living in a wetland will reflect the health of a wetland. Typically, bio-assessments evaluate wetland health and could be used in conjunction with functional assessments, which are primarily designed to inform management decisions regarding proposed impacts to wetlands and restoration of wetlands to compensate for wetland losses. EPA will lead an effort to review potential biological indicators, functional assessments, and other reference site parameters for assessing compensatory mitigation. Literature reviewed by NAS in the completion of its report and work done by the Corps and EPA to develop several assessment methodologies will serve as a starting point.

Building upon the biological indicators and functional assessments research, EPA, in conjunction with the Corps, USDA, DOI, and NOAA, and working with States and Tribes, will lead the development of performance standards guidance on monitoring and adaptive management of mitigation sites by 2005. Current guidance does not provide sufficient consistency regarding how to evaluate achievement of wetlands ecological performance and results, nor does current guidance establish appropriate monitoring and adaptive management activities. The GAO recommended that the agencies establish criteria for evaluating performance of mitigation projects and develop and implement procedures for assessing achievement of wetlands ecological performance and results. The NAS concluded that more effective monitoring, as part of adaptive management, as well as compliance evaluations, would increase the performance of compensatory mitigation sites and allow for adaptive management. EPA will lead the effort to build upon the guidelines for maintaining self-sustaining wetlands, draw upon published approaches to performance standards, and use the results of the biological/functional assessments analysis.

EPA and the Corps, in conjunction with USDA, DOI, and NOAA, will clarify key concepts related to performance standards.

Improving Data Collection and Availability

The Corps, EPA, USDA, DOI, and NOAA, in conjunction with States and Tribes, will compile and disseminate information regarding existing mitigation-tracking data base systems in 2003. The independent evaluations of mitigation highlighted a need for improved data to track mitigation. While a system currently exists to track acreages of permitted impacts and compensatory mitigation required, the lack of wetlands function information and other parameters hampers efforts to accurately measure achievement of wetlands performance goals and results. The Corps and the other Federal agencies will compile and evaluate the merits of the various mitigation-tracking data base systems in use, including the Corps' RAMS/RAMS2 data base as well as regional data bases established by agency field offices.

Building upon the analysis of existing mitigation data base systems, the Corps, EPA, USDA, DOI, and NOAA will establish a shared mitigation database by 2005. Based on the results of the analysis, the agencies will establish a database that can be shared with federal and state regulatory and resource agencies and the public. An interagency team is currently working on a pilot internet-based tool to assist in tracking large—scale mitigation projects such as mitigation banks. This tool is being designed to manage and monitor information regarding mitigation bank credit/debit transactions, attainment of performance standards, credit release, and bank documents. The system is being designed to reside on a District's server and allow different levels of access/input for the public, bank sponsors, Corps staff, and other Mitigation Bank Review Team members.

Utilizing the shared database, the Corps, in conjunction with EPA, USDA, DOI, and NOAA, will provide an annual public report card on compensatory mitigation to complement reporting of other wetlands programs by 2005. The NAS reported that "the goal of no net loss of wetlands is not being met for wetland functions by the mitigation program." To ensure that the public is informed about the status of the Administration's commitment to the no net loss of wetlands goal, the Corps would lead the development of an annual public report card on the contributions of the Section 404 program to the no net loss of wetlands goal, to complement reporting of other wetlands programs. Shared databases would allow relatively easy queries regarding credit/debit transactions and the status of restoration/enhancement for mitigation projects and sites.

Appendix H

Response to Comments

RESPONSE TO COMMENTS

Comment	Response
Pat Trochlell, PWS, PH, PSS, Wetland Ecologist Lakes and Wetlands Section, Wisconsin Bureau of Fisheries Management and Habitat Protection	
Wetland policy is not well defined in this document. References to federal and state policy are mixed and not clearly identified. In some cases, state policies are summarized with no references. There are no citations for mitigation success numbers. The document does claim to provide a framework for regulatory decisions yet this framework is not consistent with all states policies and regulations.	The intent is not to define policy. We reviewed the document and have modified what might be suspected as policy. Even though we give some examples, the team agreed in the initial scoping meetings that the regulatory variations were too complex to be incorporated in this document.
Some of the recommendations are not scientifically possible in "real world" situations. For instance, the establishment of goals and objectives for a mitigation site based upon an assessment of impacted wetlands implies that we can create "twin" wetlands—wetlands that mimic the functional values of the lost wetlands. This does not take into consideration site variability and limitations. In order for projects to be successful, wetland mitigation site goals and objectives should be based upon site-specific conditions.	The approaches in this document are based on real-world experience and mirror the NRC recommendation on mitigation. There is nothing wrong with setting a goal as high as possible; however, a realistic view is a product of our team's field experience. Considering the practicality of the application and designing the mitigation accordingly will create the potential for a full recovery to occur at some point in time.
Some of the statements are inaccurate. For instance, the statement that wetlands are aggressively protected by federal and state government does not recognize the loss of protection for isolated wetlands resulting from the SWANCC decision. The definition of wetland hydrology is not correct—it refers to inundation of saturation for seven consecutive days and not 5% of the growing season. Wet meadows including fresh wet meadows, wet prairies and sedge meadows cover extensive areas (most common types in Wisconsin) and yet are not even mentioned in the section on wetland types. The information on marsh soils and the soils section are not accurate or complete. The reference to preservation does not correctly state federal requirements for only allowing this method under exceptional circumstances. The section on wetland functional values does not mention wildlife/bird watching, one of the most significant values, especially from an economic perspective.	The SWANCC decision is a policy or legislative issue not within the scope of this document. However, some states still regulate these wetlands. This section on wetland hydrology has been rewritten to address this concern. This document is not intended to be a comprehensive dissertation of every wetland that exists but rather to provide technical guidance for compensatory mitigation projects regardless of size, type, or location. Bird watching and wildlife have been added as functional values.
Examples from other states were not particularly helpful, especially since they refer to species or wetland community types that are not present elsewhere. There is a lot of discussion on treatment "wetlands," which did not appear to pertain to the document's topic of wetland compensatory mitigation.	Thank you. The document has been rewritten to address these concerns.

Comment	Response
I had serious concerns about the document tree for wetlands mitigation. The most important steps in the decision process are site potential and site restrictions. These considerations should be at the very beginning of the process but are not shown until the end of the decision tree. Also, determining the volume of water needed to support a wetland is an unnecessary exercise if you have gone through the process of choosing a site with reversible hydrological impacts and limited restrictions. Again, this decision tree implies that we are able to create “twin” wetlands, constructed to the specifications of the lost wetland. Practice has shown us that this is not possible.	The team spent a considerable amount of time discussing the decision tree and believes that it addresses the significant steps for a successful compensatory mitigation project and incorporates the recommendation from the NRC 10.
The mitigation site assessment form is biased toward marshes and ponds, largely avoided now that wetland restoration science has advanced further. Considering that the state of Wisconsin has over 50% of wetlands with saturated soil and no inundation, it is not reasonable to bias our sites toward the traditional “duck pond,” particularly when we have had 20 years of experience beyond those initial mitigation projects. Table 1.1 is not useful at all, without comparable wetland types between classifications and repetition of types under the Cir. 39 column.	The table is not intended to be a cross reference of classification but simply a compendium of classifications. A footnote has been added to explain the purpose of the table.
In summary, I could not take the time to review every page of this document but was very concerned that what I did review has inaccuracies and has not involved the experts in the field of wetland compensatory mitigation. Also, recent developments in wetland mitigation, such as the National Wetlands Mitigation Action Plan, are not referenced. This document addresses many of the issues addressed in your guidance and reaches different conclusions.	The National Mitigation Action Plan was cited on pp. 1, 4, 15. Alan Miller, USCOE HQ gave the team a presentation on the plan and the progress to date on the 17 action items cited by the National Resource Council, National Academy of Science. The team composition is included in the acknowledgements and does consist of state regulator and consultants of the field. We do have people on the team who conduct field work and feel the team qualifications are appropriate.
Your report is either too general when it refers to federal or “some states” policies and regulations for it to be useful by the regulated community and government officials, and it is too specific with references to specific projects or examples from other states. I do not feel that it will be a tool that we can use in Wisconsin.	The team has considered the variability in its audience and attempted to find a balance between wetland experts and the general public. The purpose of this document is to provide a single comprehensive technical guidance for a diverse audience, including regulators, environmental professionals, permittees, and the general public. This document is not specific to a particular states’ regulatory approach.

Comment	Response
Conrad A. Kuharic, P.G., Team II Project Manager, Texas Commission on Environmental Quality	
I have reviewed the document from the perspective of a Resource Conservation and Recovery Act (RCRA) hazardous waste permit writer with some exposure to the subject of wetlands, through working with one facility now in the process of constructing a wetland as part of a permitted closure plan. I expect that someone in Water Quality Assessment, with a stronger understanding of wetlands would comment on different aspects of the process.	Agreed
General Comment: The document does succeed in providing a single source of information for all interested parties, ensuring that they all see the same basic issues and requirements for successful implementation. However, it also demonstrates there is a basic level of understanding required to effectively implement the guidance. As a RCRA permit writer, I find most of what is presented useful and interesting, but far beyond my realm of expertise. While the document does provide decision points and checklists, someone with my knowledge level has no real way to evaluate the quality of the assessments or actions taken or judge the validity of information provided to me. Merely being able to say that some particular activity has been completed says nothing about how effective the activity was. In this regard, the document reinforces the need to involve others who are much more knowledgeable in other fields, such as the biological sciences and regulatory arena.	Agreed
Section 2.3, Types of Mitigation—The USACE mitigation ratio definition calls for at least a 1:1 functional replacement, but further on in the same paragraph is the statement that the ratio may be less than 1:1 for areas that meet certain conditions. However, no explanation is given for how a <1:1 ratio for mitigation wetlands would/could be determined, other than a brief comment in the last paragraph of Section 4.2.5.1. Table 2-1 does not allow for it, but that is a California specific table. Who does allow for it? Section 8.7 briefly reviews replacement ratios and no-net-loss, but seems to imply at least a 1:1 ratio. There should be additional discussion of how a <1:1 ratio can be achieved.	A ratio of <1:1 could be allowed if the functional value of an existing but impacted wetlands is low. This is not a common practice and is determined on a case-by-case basis. Since this is the exception rather than the rule, we have removed the reference from the document.
Section 2.3, Types of Mitigation—How is a ratio calculated for a no-net-loss of function when out-of-kind wetland replacement is the best option? What sort of factors would go into such a determination?	The team decided not to address replacement ratios since this is a policy issue not a technical issue. We have included the following links as a reference to give examples of methods of calculating ratios. http://www.epa.gov/owow/wetlands/pdf/RGL_02-2.pdf and http://www.epa.gov/owow/wetlands/pdf/map1226withsign.pdf
Section 8, Issues—Considering the high rate of projects that are not deemed successful, it might be worth considering a section on addressing why any given project failed, and how the knowledge gained can be used in future projects. If the time and expense dedicated to assessing, planning, and executing a less than successful plan are to be made worthwhile, it is necessary to know why something in the plan was faulty and what can be done to avoid that problem in the future. In general, nature is more complex that we realize, and even the best plans will fall short to some degree. Being able to understand what went wrong or could be improved upon will just make the next project that much more likely to succeed.	Section 1.2.10 addresses the likely failures See Section 3.0 Predesign assessment • Goals and Objective • Site hydrology Section 9.0 • Lack of follow-up inspections

Comment	Response
Section 8.2, Regulatory—This may be a special case comment based on my limited experience with a Gulf Coast facility currently constructing a wetland as part of its closure plan for an adjacent RCRA permitted hazardous waste unit. It is important to structure a RCRA permit provision to allow for changes without requiring a formal permit modification each time an unforeseen natural condition necessitates a change in the plan. Also, based on this experience, I disagree with the comment in your cover letter Key Issue #3 and Section 8.2, that the applicant should not need to coordinate between the appropriate regulatory agencies. I agree that all relevant parties need to work together, but without one party taking the lead the process will not progress as well. The logical choice of who should coordinate the process is the party that wants to construct the wetland. Often, they are more aware of any local/regional issues than a regulator several hundred miles away, as well as the appropriate personnel to seek out. All of the parties should meet as needed to ensure compliance with varied regulatory constraints, and an understanding of what issues each agency may have. This is preferable to the applicant talking to them individually in some sort of sequence. In addition, personnel from any one regulatory agency may not be aware of who else needs to be involved, or the degree of their involvement. Getting all of the parties together should facilitate an understanding of how everybody fits into the process.	This had been corrected previously and was nothing more than the word "Not" had not been struck while editing. Your statement is correct and the intent is corrected. Thank you for your comment. The team's experience is that having one central agency facilitates the permitting process.
Jim Lewis, Superfund Remedial Programs, Colorado HMWMDEXT 3390	
I have reviewed the above referenced document and associated case studies. I found the document to be very informative, very well presented, and overall, very well done. I have no comments to submit. This document will serve as an excellent guideline for industry and regulators interested in wetland design, construction, and the monitoring of the wetlands after construction. I have had several people inquire about the very same information that is presented in the general document, but I have not been able to direct them to summary document like this. Again, very impressive. I congratulate all those involved in the compilation!	Thank you.
Connie Bersok, Florida Department of Environmental Protection	
Top 3 paragraphs in page 9 as an example— The document is in dire need of reorganization and editing to reduce and hopefully eliminate many examples of redundancy. Sometimes this redundancy is merely two adjacent sentences that say essentially the same thing (see the top three paragraphs in page 9, discussing photosynthesis and plant growth), sometimes it is in the structure of the document whereby the same issue is repeated in two or more different sections, but with no further insights (such as the discussion of mitigation goals and objectives, or the Cowardin classification discussion or Tables 3-1 vs. 4-5). As a result of this problem, I found that that document as a whole was not easy to read and it was not easy to locate particular information.	The organization has been discussed at length and will remain essentially as you see it; however, we will work through the document to address any unnecessary redundancies.

Comment	Response
I was expecting this document to provide more technical information than it did and did not expect this document to include policy decisions. It does not seem appropriate for the team to provide policy-type recommendations, since federal and state regulations would supersede any such input. Given that some of the federal guidance documents proposed by the NMAP are either in the draft or review stage, it is difficult to provide much of any guidance on those (such as in-kind/out-of-kind; on-/off-site; difficult to replace wetlands; and the use of vegetated buffers). In addition, any state-level guidance would only be specific to each state. However, if you wish to summarize the various state and federal policies in a spreadsheet or such for comparison purposes, that might be meaningful, as would perhaps a list of state and federal rules with their respective web pages (no need to include the actual rules themselves).	The purpose of this document is to provide a technical guidance for compensatory mitigation projects and is not intended to be a policy document. Stating an issue and recommending a solution is an opportunity we continue to offer in ITRC documents. Section 1.2 Page 3 references the Association of State Wetland Managers (ASWM 2004) Web site, which contains the list of states and a live link to all of their state pages for the readers' reference.
As currently presented, the shifting between references to a federal issue, then to one state's take on things, then the team's approach does not provide much clear guidance. Sections 8 and 9 (entitled ISSUES and Stakeholder Issues) should be completely eliminated, as most of this has already been or should have been addressed somewhere else in the document. As an example, the team recommendation re: "incidental wetlands" (your term) does not appear to have a broad legal or regulatory basis and would only serve to confuse the situation where there are local/state requirements for some of these situations.	You are correct in your assessment that the issues are found in other areas in the document; however, it is our intent to elevate the issues by repeating them in their own sections. This section on incidental wetlands has been rewritten to reflect your comments.
As for the technical information, it appears that at least some of the document was lifted from the document on constructed treatment wetlands. I do not agree that "much…is immediately transferable." As a result of this approach, however, it appears that much of the design, construction, and monitoring sections are applicable only to created wetlands and very little, if any, information is given on enhancement or restoration mitigation projects. As a result, this seems to take a bit of the "old school" approach and does not provide the new, cutting-edge technology that is out there for many forms of mitigation (which is what I thought this document was intending to cover). For instance, planting wetlands, particularly with woody species, in straight rows is not mitigation—unless one is mitigating for the loss of tree plantations. There is no mention of the importance of fire in long-term management, which is very important for many types of wetlands. There was no mention of the best (or any) means to control any number of invasive exotic species, which have been a major issue nationwide. I was surprised that some of the very good information in the SER Primer on Ecological Restoration (http://ser.org/content/ecological_restoration_primer.asp) or Guidelines for Developing and Managing Ecological Restoration Projects (http://ser.org/content/guidelines_ecological_restoration.asp), was neither included nor referenced in this document. In addition, Bill Streever has continued to develop his work with performance standards, which should be an important component of this document, rather than a ½-page general discussion. The team's apparent bias against mitigation banks should be overcome by providing actual information on/reference to federal guidance and state programs on mitigation banking. See also http://www.sws.org/wetlandconcerns/banking.html.	The document has been rewritten to address some of these concerns. The references you have included have been added to our "Other Resources" section for the reader to access when necessary

Comment	Response
As for the glossary, I would recommend limiting it to those terms already legally defined in state or federal documents and to reference those documents. This has already been done with many of the terms; simply delete the rest. Also, the use of the term "injured" or damaged wetland when referring to areas impacted by human activity should be deleted from the body of the text and replaced with the more commonly accepted and used term "impacted."	The team feels that the glossary may be used by individuals less familiar with the process and therefore might benefit from it. "Damaged" and "injured" have been replaced where appropriate with "impacted."
It is not clear to me that Section 7 actually does address "innovative wetland mitigations" as much as it gives examples of interesting wetlands that we developed along the way—some of which do not resemble any natural wetland. Discussion of mitigation wetlands should be limited to those that actually serve to offset defined wetland impacts. And there probably are some good examples—just not these.	This section was rewritten to address these comments.
I have a question about the conceptual mitigation plan for Great Stinky Marsh—has this plan been accepted by the applicable state and federal agencies? If so, clearly state that so that it has more weight as an example to be followed.	Yes, it was approved.
David Scott, Savannah River Ecology Lab	
General comment—Make sure you are certain who your audience for this will be. I realize that a document of this breadth is very difficult to pull together, but my impression is that in places there is too much scientific jargon, assumed knowledge of the mitigation process, etc. However, if you are confident that your audience is one which will be familiar with "primary autotrophic organisms," redox potential, mitigation ratios, etc., etc., then it is fine.	It is admittedly difficult to pinpoint an audience and assumptions must be made; however, we expect that the science, at the level we have included it, can support the process we have described. The ability to reconstruct the functions of wetlands is continuously improving with our enhanced understanding of the mechanisms involved. There is a glossary and appendices serving as real-world examples, and there will be Internet-based training to answer additional questions.
General comment—This may not work, but at least consider it…it seems that your decision tree (Figure 1-1) is the unifying element of your document. To the extent possible, make sure that the flow of the document matches the flow of the figure. In the figure itself it would help if, for each point/box, you included the page # of the final document where a more detailed explanation/information is found.	Agreed.
General comment—As will be obvious from some comments below, I would like to see a great deal more emphasis in the document placed on a particular subset of wetlands—seasonal (AKA isolated/temporary/depressional) wetlands. From my very limited knowledge of wetland loss, this is a category of wetlands that is most often eliminated, and it is frequently not mitigated for (but perhaps I'm way off base on this). Certainly the seasonal wetland category is common throughout the US under different names (Carolina Bays, Prairie Potholes, Vernal Pools, etc.) and is therefore important nationally. It is also the category of wetlands that currently receives little or no protection (post-SWANCC, depending on who you ask). With this document you have a chance to summarize much of the information concerning these valuable (albeit small) wetlands, especially with regard to construction/restoration of the habitat (see Tom Biebighauser's guide at http://www.southernregion.fs.fed.us/boone/vernal.pdf).	This document is intended to provide a single comprehensive technical guidance for regulators, environmental professionals, or permittees to use to appropriately characterize, design, construct, and monitor any compensatory mitigation wetlands as part of any federal, state, or local permitting requirement regardless of type, size or location. We added the Web link.

Comment	Response
General comment—Do you think that a table in the introduction that lists 3–5 easily obtainable, key references for each topic would be appropriate? Basically this would entail taking the main headings from the table of contents (and perhaps the subheadings from the construction section) and listing the best "for more information see" references for each topic.	The team agrees with the reorganization but feels the information is available in an easily accessible format already.
Introduction, third paragraph—Needs a stronger transition/topic sentence. Something like "The History of wetlands loss is well documented, and the need for wetlands protection and mitigation well understood. Wetland ecology is scientifically complex, however, and at times the need for wetlands legislation and regulation outpaces the underlying science."	Good suggestion. Agreed
Some parts of this paragraph should be moved to the preceding paragraph.	Good suggestions. Agreed
Again, assuming that this document is for a very general audience, you might want to begin this paragraph with more general statements about the history of legislative efforts to protect wetlands. Perhaps a topic sentence such as "Despite the fact that scientists still have numerous questions about the workings of wetland ecosystems, it has been recognized for decades that these habitats are in need of protection."	Thank you. We have addressed the key functions and values of wetlands, the importance of wetlands and reviewed briefly the history of wetlands.
This paragraph just seems to hang by itself and it ends abruptly.	Thank you. Changes have been made.
Section 1.1—Would be better to cite Dahl 1999 as the primary reference for this information.	The correct citation is Dahl 2000, which has been corrected
Need to transition that points out that, faced with substantial wetland losses, wetland restoration/remediation/mitigation/ creation became of critical concern. Then lead into the relative success of these efforts.	History is not the focus of this document, nor is federal policy. We are trying to create a usable and valued technical guide.
I don't know if this is intended as a regional document or not, but you might want to include some specific regional info on wetland losses.	It (the process) should apply universally. See http://www.epa.gov/iwi/1999sept/iv7_usmap.html
Perhaps one of these two sections would be a good place to define some terms. Many folks (including myself) are guilty of using terms interchangeably that aren't really interchangeable; e.g. restoration and creation. Since these terms are integral to the decision tree, a description of what is meant by characterization; mitigation, restoration, remediation, creation, etc. would be helpful.	See Section 2.0 for definitions of various types of mitigation.
Section 1.4.1.2—Consider using a figure to illustrate this.	Thank you for your comment. The team reviewed this and felt that a figure is unnecessary.
Section 1.4.1.3—Maybe stress this point more, that microscopic algae/phytoplankton is the base of a critical food web.	Thank you, but realistically in the field, this is too much detail.
Perhaps an outline of wetland plant categories somewhere? **Small/microscopic** • **Algae** • Phytoplankton II. Large/Macroscopic/macrophytic • Herbaceous o Attached o Emergent o Submerged o Floating-leaved o Free-floating • Woody o Trees o Shrubs	Thank you for the suggestion and review, but the team intends to leave the description as it is.

Comment	Response
Section 1.4.2—Given the current emphasis/concern, the SWANCC-related issues, etc., I think you should put a special mention of seasonal/isolated/temporary/depressional freshwater wetlands in here. It is touched on page 15, but since depressional wetlands (especially small ones) are typically the ones of so much concern (and very little protection) then more should be said.	This is a policy or legislative issue not within the scope of this document. However, we have pointed out the need for protection of small wetlands in Section 9.5
Section 2—I think that the section should begin with a very general discussion of the goals of mitigation, perhaps even including a bit of philosophy, biology, and history behind mitigation efforts. Depressional wetlands, buffers are an essential piece of wetland ecosystems.	This section has been rewritten to reflect some of these concerns. A section on buffers, which applies to any wetland type, has been added.
Section 2.3.5—I would suggest including a statement that many scientists emphasize that, without proper buffers, the "wetland" itself can be severely degrade[d] or non-functional. Particularly in the case of depressional wetlands, buffers are an essential piece of the wetlands ecosystem.	See above comment.
Section 2.6—This section seems to detail the potential benefits of mitigation banking, but from what little I know (which I admit is very little) there are possible downsides, i.e., lack of in-kind and on-site projects, little enforcement, little or no monitoring, an inclination to go right to banking rather than considering it as a last resort, etc. If there are acknowledged problems with the system, should there be a presentation of these as well?	This section has been rewritten to reflect your comment. There is additional discussion of mitigation banking in Sections 8.5 and 9.2.
Section 3.2—There is a very abundant literature that makes the point that it is often the small wetlands (even <1 acre) that are critical to maintaining regional biodiversity. Get rid of "Larger."	"Larger" has been removed.
Section 3.3.2—OK, by now you probably guessed that my research is in seasonal wetlands. Because these wetlands are the most likely ones to be hammered by development I am somewhat sensitive to their fate. You have the opportunity in your document to stress some points about seasonal wetlands that are often ignored. One point is that these wetlands are indeed often dry, especially during long parts of the growing season, but they are nonetheless extremely valuable as wetlands. So they often don't quite fi[t] the hydrologic model presented in this section.	The purpose of this document is to provide a single comprehensive technical guidance for regulators, environmental professionals, or permittees to use to appropriately characterize, design, construct, and monitor any compensatory mitigation wetlands as part of any federal, state, or local permitting requirement regardless of type, size or location.
Section 4.1—I guess I am surprised that California would characterize their isolated freshwater marshes as "low value" given that they have destroyed >90% of their vernal pools. Is this statement correct?	Yes, according to the citation.

Comment	Response
Section 4.2.5.1—Two points in this section that are discussed, but perhaps they could be strengthened. First you probably can't emphasize too much that hydrology is the driving force (as has been mentioned) and the failure of plantings is a virtual certainty of plant species are not matched to the hydrology. I know this point is made, but it needs to be a major focus (with the correlate that loss of plants can be very expensive). Second, there is a little bit mentioned later about using "natural" wetlands soils in the "new" wetland as a source of seeds. Of course it can also be a source of many wetland invertebrates from the "egg bank." My question is, Can this be a point that gets more discussion? Is it a common practice (and one that you want to encourage), or is it something that is frowned upon (out of concern for degrading existing wetlands if it is practiced at too large a scale)?	The team believes that the document places appropriate emphasis on hydrology. The team does not generally recommend the practice of using natural wetlands soil in compensatory mitigation projects. This practice might be acceptable when the removed soil is used on the same site or when a wetland is destroyed as part of a permitted action and used on a comparative site. The team is concerned about the potential for reused soil to introduce invasive or undesirable species.
Section 4.2.5.2—If you do decide to include more about seasonal wetlands in the document, then go into more detail here about the extreme importance of hydroperiod in terms of driving the biota of the wetland.	The team decided not to add any additional detail about seasonal wetlands since the purpose of the document is to apply to a broader scope of general wetland types.
One of my general comments was to include a list of pertinent references for all steps in the process that anyone "doing mitigation" would find useful. Even if you don't do that, I think that coming up with a list of several "how to" guides when it comes to construction issues would be extremely helpful. I've seen a few related to the sorts of wetlands I deal with seasonal/small wetlands—again, see Biebighauser's guide at http://www.southernregion.fs.fed.us/boone/vernal.pdf Stratman's guide at http://www.in.nrcs.usda.gov/intranet/techicalnotes/indiana_tech_note_1.pdf and there must be many others. Maybe that is something that the state folks hand out to people, but if not then knowing where to go to get a cookbook procedures for construction would be something everyone would want.	Thank you. The references have been added.
Check on these to be sure. The practice of "Mountain top removal" mining for coal seems as though it would be impossible to reclaim; I don't believe that the stream valleys that are filled with mine waste have to be restored/reclaimed. Also perhaps this is not the place for it, but I'm assuming that there must be major problems associated with a practice such as this (wetland creation over mine spoils). For example, pH would almost certainly be much lower (probably 2.5 to 4.5?) and many of the metals associated with mine waste (even I Ponds) have significant sublethal effects of organisms. Do you really want to promote this as a positive case study? If so, should you at least point out some of the drawbacks?	This section has been rewritten to address some of these concerns. Mountaintop removal is beyond the scope of the document.

Comment	Response
Although I agree that the economics always have undue influence, and as a result development interests will almost always win (meaning that wetlands will continue to be lost, along with associated functions and values), these sentences here probably need major reworking. I think it is perfectly appropriate to point out that many folks think that mitigation, as currently practiced, does not and can not achieve anything close to “no-net-loss.” In making that point, however, it is essential to base it on fact and leave emotion out of the document. Somewhat along these same lines (in the interest of “fair and balanced”), in an earlier section there was a fair amount of mention of mitigation costs (to the individual doing the mitigating). That is certainly fine, but perhaps here in the “issues” section or somewhere you could present some of the data on the economic societal costs of wetlands loss. I know those wetlands functions are “externalities” in most economic models, but there is probably some literature out there (beginning with Odum’s economics of the salt marsh) on the economic benefit of flood control, water filtration, air quality, recreation value, etc. that wetlands provide.	We appreciate your concerns; however, these issues are outside the scope of the document. Section 9.1 is “Ecological Considerations” not “Economic Considerations.”
This reference to the corps reminds me that I’ve seen no reference to the SWANCC Decision in this document, or the implication for the hundreds of thousands (or more) of acres of wetlands that are now routinely declared nonjurisdictional by the corps, and which they therefore do not regulate. This obviously needs to be addressed somewhere.	This is a policy or legislative issue not within the scope of this document. However, some states still regulate these wetlands.
I reviewed the mitigation document. Overall, I was surprised with the amount of material they tried to cover. Most of it was very good from a general reference perspective.	Thank you.
There are some mitigation requirements that the document refers to that are not consistent with our program. Here are two examples: 1. Types of Mitigation: The administrative rules for Part 303, Wetlands Protection, don’t allow wetland enhancement to be used as mitigation. Rehabilitation of a wetland is also not allowed by our rules. Upland buffers also cannot be given mitigation credit. 2. Wetland definition/delineation: We define and delineate wetlands differently under Part 303 compared to the document. Our methods should result in essentially the same boundary determinations (for our CWA 404 Program, the EPA has determined the methods to be equivalent), but the sections in the guidance still conflict with our program.	The purpose of this document is to provide technical guidance and is not intended to be a regulatory driver nor to supersede any existing federal, state, or local rules/regulations. The document is intended to apply to compensatory mitigation sites across the country.
There are also some differences with our program in the site assessment, design, construction, and monitoring sections.	See above comment.
What is the process that will be used to determine if Michigan “agrees” with the document? There are several recommendations and part of the decision tree that wouldn’t be consistent with Part 303, Wetlands Protection. Most of these, I think, relate to the fact that Michigan is one of two states with administration of the federal Section 404 Clean Water Act program. Although our program needs to be equivalent to the federal program, our program is different and/or more protective in some areas. It looks like the other state (New Jersey) was pretty actively involved so it may not be an issue for them.	ITRC has a formal concurrence process, where each state selects its own level of concurrence. More information on concurrence is available on the ITRC Web site (www.itrcweb.org).

Appendix I

ITRC Contacts, Fact Sheet, and Product List

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