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Mitigation Technical Guidance for Chesapeake Bay Wetlands

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—for—

Chesapeake Bay Wetlands

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PREFACE

The wetlands of the Chesapeake Bay watershed are at risk. From the mid-1950's to the late-1970's, 11,500 acres of coastal wetlands and 54,600 acres of inland vegetated wetlands were lost within the watershed. Annual losses during this time in the Bay region averaged over 2,800 acres and national wetland losses continue at a rate of over 300,000 acres per annum (Tiner 1984, 1987). Direct and indirect threats to wetlands and other Bay ecosystems include the quick pace of development and the rapid consumption of the Bay's natural resources. (U.S. Army Corps of Engineers 1984).

Given the projected level of development within the Bay watershed, continued loss of some wetlands is unavoidable. The mandate of government at all levels should be the minimization of such unavoidable losses while accommodating the public's needs. Wetland mitigation, in the broadest sense, is a mechanism that helps achieve this delicate balance between conflicting interests.

The science of wetland compensatory mitigation has advanced considerably in the recent past. While "mitigation" has been accepted as a concept in the environmental impact assessment field for some time, the application of the concept in regulatory programs such as Section 404 of the Clean Water Act has been problematic. There is a move towards consensus on the sequencing of mitigation steps (Kruczynski 1989; Salvesen 1990, U.S. Army Corps of Engineers, and U.S. Environmental Protection Agency 1989). Research continues into the technical aspects of wetland mitigation but the results to date reflect the difficulty in offsetting ecological damage due to development (Reimold and Cobler 1986; Larson and Neill 1987; Kusler and Kentula 1989a and 1989b).

The purpose of this guidance document is to clarify the concept of wetland mitigation. At the same time, the document provides a common approach to mitigation that will allow governmental decisions to rely on a sound scientific basis. Natural resource interests, developmental groups, and the general public deserve a wetland regulatory program that is based on scientific principles and is reasonably predictable.

Executive Summary

Like most wetlands in the United States, those in the Chesapeake Bay watershed are at risk. Recognizing this risk, the signatories of the 1987 Chesapeake Bay Agreement signed the Chesapeake Bay Wetlands Policy which focuses on attaining an immediate goal of no net loss of wetlands and ultimately on achieving a net gain in wetlands. To reach the policy's goals, regulatory agencies are encouraged to apply the sequential process of mitigation (avoiding, minimizing, and compensating for wetland impacts) to all activities adversely affecting wetlands.

This guidance document focuses on the use of mitigation (which includes compensatory mitigation) to restore and protect wetlands. The first part provides background information on the sequential process of mitigation. The rest of the document concentrates on appropriate site selection criteria fundamental to the development of a compensatory mitigation effort. Since the guidance in this document relies heavily on the landscape management approach, use of this information is strongly encouraged outside of the Chesapeake Bay watershed as well as within its borders.

Although the concept of wetland mitigation was first defined in 1978, confusion still exists as to what constitutes acceptable and proper mitigation practices. The primary defining factor in mitigation is that the process is sequential. That is, every effort should be made to fulfill the first criterion before moving on to subsequent steps. In addition, the process of mitigation should be applied in an ecological context by including the landscape as a significant scale of evaluation. Because cumulative impacts are landscape-level phenomena resulting from numerous regulatory and non-regulatory decisions (Gosselink and Lee 1989), applying mitigation only at the site-specific level will continue to compromise the ecological integrity of wetland ecosystems.

The first step in the sequential process of mitigation is avoiding an impact to a wetland parcel, community, and system by not conducting a specific activity. In cases where the impact is unavoidable, the second step should minimize adverse impacts to these areas by limiting the degree or magnitude of the activity. The third step involves compensating for the impact by replacing or providing substitute resources or environments.

Historically, applicants viewed the process of compensatory mitigation as a means to obtain a permit or satisfy a permit condition. In recent years, the process has evolved to a mechanism to replace both lost wetland acreage and function. Although exact replication of a wetland community is unlikely, development and subsequent implementation of compensatory mitigation plans should utilize the functions, values, and structures of the project wetland community as a model. To develop a viable compensatory mitigation plan, this document proposes the use of eight variables to serve as both site selection criteria and ecological goals:

Variable 1:
Identification of wetland hydrologic core and structural factors

Variable 2:
Identification of wetland ecosystem processes, functions, and values

Variable 3:
Identification of compensatory mitigation types

Variable 4:
Identification of in-kind or out-of-kind replacement

Variable 5:
Identification of on-site or off-site location

Variable 6:
Identification of compensatory mitigation timing

Variable 7:
Identification lands compatible with compensatory mitigation efforts

Variable 8:
Identification of lands not compatible with compensatory mitigation effort

The use of variables 1, 2, and 3 serve as baseline data for the project wetland. These data are fundamental sources of information critical for the replacement of wetland ecosystem properties. Federal and state regulatory and review agencies should determine the applicability of variables 4 through 8 for each particular case.

Traditionally, mitigation has occurred primarily at the site-specific scale for the sole purpose of meeting a regulatory obligation. This document greatly expands the scope of the mitigation process, incorporating the landscape as a primary consideration in the management of an affected wetland parcel. The approach espoused in the document suggests evaluating the optimal means of mimicking the values and functions of the project wetland for use in the replacement site. Generally, the closer the replacement wetland is to the project site in terms of geographic location, geomorphic similarity, physical structure, hydrology, and ecological integrity (as well as other factors), the more closely it will replicate the project site and meet the ultimate goals of the sequential process of mitigation.

INTRODUCTION

In December 1988, the signatories of the 1987 Chesapeake Bay Agreement signed the Chesapeake Bay Wetlands Policy. The goal of the policy is:

"....to achieve a net resource gain in wetland acreage and function over present conditions by:

(1) protecting existing wetlands; and

(2) rehabilitating degraded wetlands, restoring former wetlands, and creating artificial wetlands."

The objectives of the policy include an immediate target of "no-net-loss" and a long-term target of "net-resource-gain."

"Mitigation" in this document is defined as the sequential process of avoiding, minimizing, and compensating for impacts to wetlands. This sequential process is critical to achieve the no-net-loss goal. The principles of mitigation should apply in any proposed project which may result in adverse impacts to wetlands. To merge the no-net-loss goals of the Bay policy with the federal and state regulatory programs in the Chesapeake Bay watershed, the regulatory agencies are encouraged to apply the sequential process of mitigation to all activities affecting wetlands.

Regulatory programs at the federal and state levels have limited ability to deal with wetland issues comprehensively. Wetland ecosystems, the landscapes surrounding them, and the activities which affect wetland ecosystem processes, are interactive. The functioning of wetlands and the benefits provided to society by wetlands are critically dependent on the interactions among the wetland ecosystem, land use activities, and the landscape.

The sequential mitigation concept should become an integral part of all governmental decisions, both regulatory and non-regulatory, that affect the functional integrity of any wetland ecosystem. It is only through such efforts that the differentiation of "cumulative effects" from "cumulative impacts" can occur (Preston and Bedford 1988). The identification of both the cumulative impact sources and the management efforts necessary to control or eliminate such sources are a function of such a landscape level perspective. Until a landscape management approach is applied to the living resources of the Chesapeake Bay (including wetland ecosystems), the no-net-loss and net-resource-gain goals remain lofty policy expressions rather than realistic policy goals.

Field application of mitigation has not yet achieved the no-net-loss goal due to many factors including:

1. a lack of definitive scientific data concerning natural wetlands and the interaction of these wetlands with terrestrial and aquatic communities;
2. the scientific uncertainty of predicting compensatory mitigation results;
3. the lack of unified mitigation guidance, directives, standards, and criteria among federal, state, and local agencies;
4. a lack of technical and scientific training of agency staff; and
5. a lack of quality control concerning compensatory mitigation projects (i.e., oversight, tracking, and monitoring).

To achieve a net resource gain, additional mechanisms are necessary to complement federal and state regulatory programs. Mitigation, particularly compensatory mitigation, can not result in a net-resource-gain independently. The development and application of initiatives, such as comprehensive incentive programs aimed at wetland conservation, restoration, and creation, are critical to achieve the net resource gain goal.

Wetlands are complex systems and do not generally function in a linear fashion. By the same token, management directives affecting compensatory mitigation efforts must take this complexity into consideration. The fundamental guiding principle for compensatory mitigation should be repairing the damage resulting from project impacts on wetland communities. Better methods are needed to document and account for cumulative impacts which adversely affect wetlands.

Since federal and state laws, policies, and regulations may exempt some activities or minimum wetland acreage from specific regulatory requirements, wetland ecosystem structure and function within the Chesapeake Bay drainage basin may become diminished or fragmented by such measures. Because wetland ecosystems are integral to the functioning of the Chesapeake Bay landscape, land use impacts to other ecosystems in the Bay directly or indirectly affect wetland ecosystems.

Compensatory mitigation cannot fully restore or protect wetlands independent of other factors. The guidance in this document therefore, focuses both on the use of replacement when wetland impact is unavoidable along with the ecological considerations of replacement activities. Only the replacement of wetland ecosystems with comparable wetlands is considered. Replacing wetland features with non-wetland properties will not provide the magnitude and diversity of wetland functions and values in the Bay landscape.

The application of the mitigation sequence is an important first step in the implementation of the immediate no-net-loss goal mandated by the Chesapeake Bay Wetlands Policy. **Part I - The Mitigation Concept** provides the necessary background information on the sequential process of mitigation. **Part II - Compensatory Mitigation Site Selection Criteria: Ecological Considerations** emphasizes the ecological complexity associated with compensatory mitigation and reinforces the sequential process in mitigation. In the future, as more data become available and compensatory mitigation efforts are more thoroughly analyzed, the studies may show that avoiding the impact initially may be the most ecologically and economically sound decision in the long term. The sequential mitigation concept, as applied to currently proposed activities, serves as a management tool to minimize potential negative impacts to the Bay landscape.

Application of any or all of the guidance contained within this document to federal and state actions outside of the Chesapeake Bay drainage may be appropriate and is strongly encouraged for application throughout the mid-Atlantic region. Implementing this for the Chesapeake Bay region may enhance management decisions concerning living resources across geopolitical boundaries.

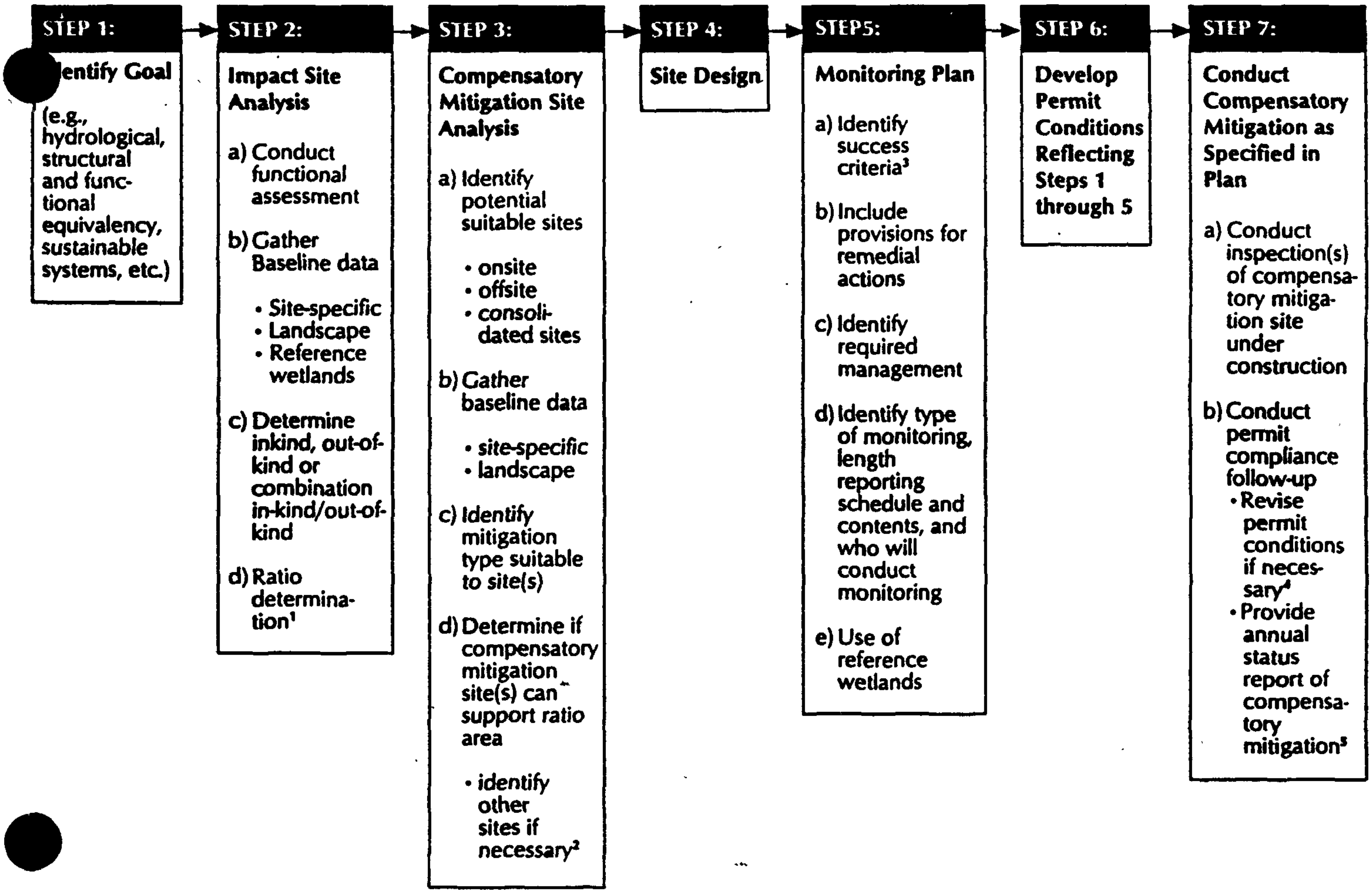
Several policy and regulatory documents were used as background informational sources for the development of the mitigation discussion:

1. Chesapeake Bay Wetlands Policy
2. 404(b)(1) Guidelines
3. Section 404 Mitigation Memorandum of Agreement (February 6, 1990)
4. U.S. Fish and Wildlife Service Mitigation Policy
5. Council on Environmental Quality Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act (NEPA).

A comprehensive literature search of information concerning mitigation (particularly compensatory mitigation efforts) was not undertaken. Literature addressing the ecological principles and issues pertinent to compensatory mitigation, however, was selected from several sources, including a comprehensive annotated bibliography on wetland restoration and creation (Schneller-McDonald et al. 1990), a review of the scientific status of compensatory mitigation efforts (Kusler and Kentula 1989a and 1989b), and relatively recent symposia, conference, and peer-reviewed journal articles. Literature references cited in this document as well as additional references that may provide more in-depth information are also provided.

In addition to the federal legislation and guidance cited above, the following federal laws and programs are relevant with respect to the mitigation process: the Emergency Wetlands Resources Act of 1986, the North American Waterfowl Management Plan and the Atlantic Coast Joint Venture, the North American Wetlands Conservation Act, the wetland conservation provisions of the 1985 Food Security Act, and the 1990 Food, Agriculture, Conservation, and Trade Act (i.e., the 1985 Farm Bill and 1990 Farm Bill, respectively). Appendix A contains a description of these laws or programs and Appendix B describes the applicability of these programs and legislation to this guidance document.

Currently, this guidance document addresses only a small portion of the many components associated with mitigation (Figure 1). This document represents the first in a series of technical guidance materials that will eventually be compiled into a mitigation technical guidance handbook.



[1] *Ratio determinations may be based on quantification of functions/values, potential success/risk associated with type of mitigation selected, hydrologic dynamics or vegetation structure to be replaced; temporal losses of functions, both site-specific and in a landscape context.*
[2] *Selection of additional sites due to hydrological factors, existing or future land use, etc., should also be based on the identified goal, and whether in-kind, out-of-kind, or a combination has been selected to achieve the goal.*
[3] *Success criteria should be based on the identified goal; replacement in-kind, out-of-kind, or a combination; and the sustainability of the replacement site.*
[4] *This should occur only as a result of unforseen environmental catastrophies; compensatory mitigation plan specifics which, due to variability of environmental factors, will not achieve the goal; site design or construction mistakes.*
[5] *Regulatory agencies should compile an annual report that provides a yearly update of all compensatory mitigation efforts which are "active" (i.e., construction or monitoring underway). In addition, the availability of the report should be well advertised.*

Figure 1. Conceptualization of the compensatory mitigation process.

PART I
The Mitigation Concept

The Council of Environmental Quality (CEQ) first defined the concept of mitigation in 1978. The council's definition includes the following comments:

(a) Avoiding the impact altogether by not taking a certain action or parts of an action.

(b) Minimizing impacts by limiting the degree or magnitude of the action to its implementation.

(c) Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.

(d) Reducing or eliminating the impacts over time by preservation and maintenance operations during the life of the action.

(e) Compensating for the impact by replacing or providing substitute resources or environments.[1]

The Chesapeake Bay Wetlands Policy subscribes to the CEQ definition of mitigation and defines it as a sequential process. The "Section 404 Mitigation Memorandum of Agreement" (U.S. Army Corps of Engineers and Environmental Protection Agency 1989) also supports the sequential mitigation process. Furthermore, the Wetlands Policy sets forth the following principles which provide guidance in the development and implementation of mitigation activities to achieve the stated goals:

- **Mitigation will be included for any project conducted by or subject to review or approval by the signatories (i.e., the Chesapeake Bay Executive Council [see glossary]).**
- **Compensatory mitigation shall proceed from the presumption that "in-kind" and "on-site" is the preferred solution. Other solutions, including "off-site" and "out-of-kind" mitigation, will only be allowed when acceptable to public/government agencies or performed in the context of watershed management planning or other specific objectives.**
- **The signatories shall require that compensatory mitigation projects incorporate public or private arrangements for long-term management.**
- **Compensation projects will generally be designed and evaluated cooperatively among project sponsors, the signatories, and appropriate public and private entities.**
- **Monitoring and evaluation of the success of compensatory mitigation replacement projects shall be incorporated by the signatories as a fundamental part of the mitigation process.**

To address the above mitigation policies, the Wetlands Workgroup Implementation Plan included the following actions:

Landscape Ecology

Until recently, the ecology of a wetland was studied largely by examining the wetland itself, exclusive of the characteristics of the landscape surrounding the study area. With the realization that wetlands are integrally connected to this landscape, however, scientists have strived to incorporate distinctive features of both the terrestrial and aquatic landscape into their studies.

Landscape ecology uses a holistic approach that promotes a more comprehensive examination of wetlands and other ecosystems by focusing on the primary ecological interactions of the surrounding landscape (or watershed). The key to landscape ecology is the recognition that processes operate at a variety of scales within a landscape. Rather than concentrating only on the smallest-scale processes within a given wetland parcel, it is more important to examine the full suite of processes and their functions. Several factors contribute to the function of wetlands within the landscape context: scale, thresholds, and the size, slope, and position of the wetlands within the landscape (Preston and Bedford, 1988)

On a more practical level, landscapes or watersheds often cross jurisdictional boundaries, making management at these scales challenging. Within the landscape, wetlands and other ecosystems are often ephemeral and dynamic—that is, boundaries of a wetland may naturally shift seasonally and over longer time periods, complicating management efforts. However, landscape level information can be used to minimize duplication and enhance management efforts because it addresses the linkages between wetland and other systems. Therefore, land management decisions incorporate the connectivity between units of the landscape. In addition, because landscape-level information is comprehensive in nature and useful to a variety of land managers, its application promotes dialogue and cooperation between different government units so that integrated land management decisions result.

[1] Quoted material is indented and in bold type throughout the document.

The Federal Signatory, in consultation with appropriate governmental agencies, will develop updated standards and criteria in compliance with the overall wetland protection goals and specific mitigation policies incorporating state-of-the-art technological, ecological, and biological applications.

Traditionally, mitigation has occurred primarily at the site-specific scale such as the filling of a wetland parcel for a parking lot. The filling is the direct impact and is typically addressed within federal and state regulatory programs. Indirect impacts, such as declining water quality due to pollutant discharges from the parking lot, may also be addressed. The application of the process of mitigation in an ecological context, however, requires an additional scale of evaluation: the "landscape." A landscape is a spatial mosaic of ecosystems which interact functionally (Forman and Godson 1986; Gosselink et al. 1990). Examples include watersheds, physiographic provinces, and ecoregions.

In the parking lot example, the effects from the parking lot runoff may not be limited to the surrounding wetland community but may extend to adjacent wetlands and waterways. Within a sub-basin, other parking lots may be contributing similar runoff pollutants. Individually small or insignificant activities may cumulatively affect wetland ecosystem properties within the sub-basin landscape negatively.

Because existing regulatory programs generally focus on individual projects and analyses of potential environmental impacts are usually limited to the immediate project wetland parcel or community, these other effects may not be evaluated. Furthermore, different analyses may not be coordinated among agencies or between regulatory and non-regulatory programs.

Regulatory programs are often incapable of effectively managing impacts which originate beyond the wetland system. The adverse effects of numerous individual projects accumulate in time and/or space and are called "cumulative impacts" (Bedford and Preston 1988). Because cumulative impacts are landscape-level phenomena resulting from numerous regulatory and non-regulatory decisions (Gosselink and Lee 1989), applying mitigation only at the site-specific level will continue to compromise the ecological integrity of wetland ecosystems.

Cumulative Effects vs Cumulative Impacts

Although "cumulative effects" and "cumulative impacts" may appear to be interchangeable terms at first glance, an important distinction differentiates the two. The term, "cumulative effects," is broader scope and identifies those changes that result from a specific alteration(s) within the wetland system. These effects indicate only a change from the norm; no value is placed on these changes. When society determines that certain effects are negative, the effects then become known as impacts. In other words, "cumulative impacts" incorporate a value judgment on the ultimate effect of the changes.

Several mechanisms (Beanlands et al. 1986) may trigger cumulative impacts to wetland ecosystems:

(1) Disturbances clustered so closely in time that an ecosystem does not have sufficient recovery time between the actions and resulting effects. Disturbances of this nature are "time-crowded perturbations."

(2) Disturbances occurring close together or overlapping so that the effects are concentrated in a specific area. Such disturbances are "space-crowded perturbations."

(3) Individual disturbances which collectively produce effects that are quantitatively and qualitatively unlike the individual perturbations. These disturbances are called "synergistic" effects.

(4) Disturbances which cause successive actions producing effects that are temporally or spatially distinct from the original disturbance. Disturbances of this form are defined as "indirect" effects.

(5) Disturbances which result in small changes (i.e., incremental effects) or produce a gradual diminution in quality or quantity (i.e., detrimental effects).

Wetland ecosystems are closely coupled with terrestrial and aquatic systems (Nixon and Oviatt 1973; Likens and Bormann 1974; Mulholland and Kuenzler 1979; Brinson et al. 1981; Odum et al. 1984). Transport mechanisms, such as water, animals, wind, and people control the flow of materials and energy across the ecosystem boundaries within a landscape (Forman and Godson 1986). While much remains unknown about these linkages, integrating information derived from landscape-level analyses into regulatory programs is critical if the mitigation sequence is to have ecological meaning.

This document addresses the ecological context of mitigation, particularly as it applies to compensatory mitigation site-selection criteria. Understanding each component of the sequential process is a prerequisite to the ecological application of the mitigation concept.

Avoidance

Avoiding an impact to a wetland parcel, community, and system is the first step in the sequential process of mitigation. Analyzing the potential impacts from a proposed project requires site-specific and landscape level evaluation. The nature of cumulative impacts in relation to the loss of wetland ecosystem function suggests that even small wetland communities or parcels may be important within a landscape context (Odum 1978) and the application of the sequential process to proposed projects in such areas is ecologically sound.

With respect to current federal regulatory practices, the application of avoidance pursuant to Section 404 must adhere to the 404(b)(1) guidelines which largely parallel the NEPA guidelines. The principles upon which the guidelines are based, however, can be applied in a broader context. These guidelines are the environmental standard against which projects are measured to secure a Section 404 permit. To satisfy the avoidance directive in the guidelines, an applicant's proposal must meet all of the following standards:

1. No practicable alternatives to the proposed discharge exist (Section 230.10(a));
2. The proposed activity complies with other environmental standards (i.e., state water quality standards; toxic effluent standards or prohibitions pursuant to Section 307; Endangered Species Act; and the Marine Protection, Research, and Sanctuaries Act of 1972) (Section 230.10(b)); and
3. The project will not cause significant degradation and adverse effects (Section 230.10(c)).

Due to their rarity or unique faunal or floral assemblages, some types of wetland communities are ecologically difficult to replicate and may be unmitigable, regardless of the type of compensatory mitigation proposed. Examples include wetlands characterized by the U.S. Fish and Wildlife Service (1981) as "Resource Category 1" or wetlands identified by state Natural Heritage Programs such as Atlantic white cedar communities or the Delmarva Bays.[2] Many of these rare or unique communities are hydrologically linked to other wetlands. Impacts to the linked wetlands may result in ecological damage to the rare or unique communities. It is, therefore, important to evaluate not only alternatives to direct impacts but also those to indirect impacts.

Within the federal and state regulatory programs, the most effective way to avoid impacts to wetland systems is to address the issues at the local level. Enhanced communication concerning federal and state program processes and requirements is critically needed between local planning entities and federal and state agencies. The programs designed to avoid wetland impacts must incorporate improved gathering and dissemination of natural resource information. Additionally, improved lines of communication among government agencies, the regulated community, and the general public must exist along with better integration of resource information into local planning activities at a scale that is sensitive to wetland ecosystem properties. These improvements will enhance effective decision making; subsequently, wetland resources will be more effectively regulated.

Section 230.80 of the 404(b)(1) Guidelines is one mechanism for addressing avoidance within a landscape context. This section of the guidelines discusses the application of "Advanced Identification" (ADID) of disposal sites in general terms. In the ADID process, the COE and EPA identify wetlands or other waters of the U.S. as:

(1) Possible future disposal sites, including existing disposal sites and non-sensitive areas; or

(2) Areas generally unsuitable for disposal site specifications.

The identification of sites as "possible" or "generally unsuitable" does not constitute a permit decision nor does it prohibit anyone from applying for a permit in any of the identified sites. Ecological information concerning wetlands and other systems is provided

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[2] The U.S. Fish and Wildlife Service lists four "Resource Categories" in its Mitigation Policy. Resource Category 1 is "habitat to be impacted is of high value for evaluation species and is unique and irreplaceable on a national basis or in the ecoregion section." The "Mitigation goal" for Resource Category 1 habitat is "no loss of existing habitat value."

through the ADID process in a manner which is not often available to the regulatory agencies during routine permit evaluations and which facilitates permit processing. While the process is focused on the federal regulatory program, ADID may provide helpful information to assist local planning and permitting agencies, land trusts, conservation organizations, and other entities whose decisions may affect wetland systems within the ADID landscape. Moreover, landscape analyses can be conducted either apart from or as a precursor to a formal ADID.

Minimization

Once all efforts to avoid impacts have been exhausted, minimizing adverse impacts to a wetland parcel, community, or system is the second step in the mitigation process. For projects requiring a Section 404 permit, a thorough analysis of efforts to minimize project impacts to a wetland parcel or community is mandatory (see Section 230.10(d) of the guidelines). Subsection H of the guidelines provides a listing of actions which should be investigated to minimize detrimental effects to wetland systems (see Section 230.70 through Section 230.77 of the guidelines). This list can also provide guidance for minimization efforts relative to activities that do not require a Section 404 permit.

The following example illustrates efforts to minimize impacts to a wetland parcel.

A marina is proposed in "waters of the United States" and all efforts to avoid wetland impacts have been undertaken. Placement of piers across a freshwater marsh is "unavoidable," however, several options are available: (1) reducing the size and/or number of piers proposed; and/or (2) relocating all or some of the piers to cross the narrowest portion of the wetland. Either option, or both, will minimize adverse potential impacts to the marsh. Like avoidance, investigating all efforts to minimize adverse impacts to wetland systems is a necessary step of the mitigation process. The same principles apply in cases of bulkhead construction, direct filling, or other regulated activities which may result in adverse effects to the wetland parcel.

Compensatory Mitigation

The final step in the sequential mitigation process is compensating for alterations to wetland systems known as compensatory mitigation.[3] To initiate the application of wetland functional replacement in compensatory mitigation projects (i.e., replacing the functions of the altered wetland community at the compensatory mitigation site), site-selection criteria must involve variables such as "in-kind," "out-of-kind," "on-site," "off-site," and "hydrologic, structural, and functional equivalency" to evaluate compensatory plans.

In the Chesapeake Bay Wetlands Policy, "... compensatory mitigation ... must not substitute for efforts to avoid or minimize losses or prejudice an agency determination affecting wetlands" (Chesapeake Bay Executive Council 1988). Compensatory mitigation generally involves restoration, creation, and enhancement which Part II covers in detail.

Recently, the U.S. Environmental Protection Agency published the two-volume report entitled *Wetland Creation and Restoration: The Status of the Science* (Kusler and Kentula 1989a and 1989b). This report identified three general conclusions on the scientific aspect of wetland restoration and creation:

1. **Practical experience and available scientific data bases on restoration and creation are limited for most wetland types and vary regionally.**
2. **Most wetland restoration and creation projects do not have specified goals, complicating efforts to evaluate "success."**
3. **Monitoring of wetland restoration and creation projects has been uncommon.**

The third conclusion is of concern to those reviewing, permitting, designing, and implementing compensatory mitigation projects since it indicates that there is minimal information on the "functional" replacement of wetlands. Attempts to replace natural wetland functions are currently based on incomplete data since effective methods to quantify or assess wetland functions are still evolving. Similar to other wetlands in the United States, the scientific data base is incomplete for Chesapeake Bay wetlands, particularly its nontidal wetland ecosystems. Yet, despite this deficit, alterations to these systems continue.

[3] The term "compensatory mitigation" is used throughout this document in lieu of the shorthand term "mitigation." Mitigation, as defined in this document and following existing federal laws, regulations, policies and agreements, is the sequential process of avoidance, minimization, and compensatory mitigation. Compensatory mitigation, therefore, is only one component of the whole mitigation process. The two terms are not interchangeable nor equivalent in meaning.

PART II
Compensatory Mitigation Site Selection Criteria: Ecological Considerations

Introduction

Historically, compensatory mitigation has been viewed from two perspectives;

1) As a means to an end (i.e., receiving a permit to conduct work in wetland systems).
2) Creating (usually) or restoring a site to satisfy the permit condition with little, if any, evaluation of the ecosystem processes and functions of the project wetland.

More recently, the emphasis has been on not only replacing lost wetland acreage but also wetland function. (Quammen 1986; Kusler and Kentula 1989a). Partly due to wetland ecosystem variability, exact replication of a wetland community (e.g., structure, processes, functions), is unlikely. This document suggests that development and subsequent implementation of compensatory mitigation plans may use the functions; values, and structure of the project wetland community as a model. Some argue that human impacts to landscapes are so pervasive that replacement of wetland characteristics modeled on these communities is not ecologically sound since they are "degraded." Although this is true in some situations, making a decision that a wetland parcel or community is completely "degraded" based solely on the appearance of the site may be more questionable.

Pulsed Stability in Wetlands

Wetlands, more than many other systems, are subject to constantly changing physical and chemical conditions. Often these changes are acute and rapid so that a wetland exists more in a state of dynamic equilibrium rather than following a linear path towards some marked successional endpoint. These changes, known as pulses, can cause wetlands to remain in an ever-changing state of development.

A variety of physical forces impose pulses upon the wetlands. Some of the more frequent include tides which cause both nutrient fluxes and the periodic aeration and flooding of the substrate, patterns of drought and fire which cause changes in decomposition rates and modifications in the hydrologic condition of the soil, and drought and flooding which can significantly affect seed germination and vegetation survival particularly in freshwater wetland systems.

At one time, pulses of most sorts were regarded as destructive. Wetland ecosystems, however, are adapted to these sorts of fluctuations and the pulses are critical to their survival. In maintaining existing wetlands, projects impacting these systems must account for the inherent variability and minimize disruption of natural pulses. In creating new wetlands, a balance must be found that mimics the natural variability of a particular type of wetland without creating pulses that swing so wildly or are so frequent that the system does not have adequate response time.

The approach presented in this document is founded on the following principles and concepts:

- A key principle of wetland ecosystems is that they are **dynamic** (Willard and Hiller 1989). These ecosystems vary both temporally and spatially and are "pulsed" (Niering 1987). The variability so characteristic of wetland systems largely results from the hydrology and its effects on the internal properties of a wetland community (e.g., vegetation community structure or composition, microtopographic relief, primary productivity, organic matter decomposition, and faunal assemblages). Whether a wetland community is dominated by surface water or groundwater regimes (or a combination of the two), hydrologic processes exhibit temporal fluctuations. These fluctuations occur daily, seasonally, and annually. This temporal hydrologic variability is a "natural disturbance" (White 1979). Other relevant natural disturbances include fire, wind or ice storms, shoreline ice buildup and movement, temperature fluctuations, coastal and alluvial soil deposition and erosion, coastal dune movement, salinity fluctuations, and intrusion of salt water into freshwater wetlands (modified from White 1979). An evaluation at a site is a snapshot of the dynamics which structure the wetland community at that particular moment. Components of compensatory mitigation plans—site selection, monitoring, and design criteria—need to reflect this inherent variability.
- Wetland systems can be characterized along a continuum of anthropogenic disturbance, with "pristine" wetlands at one end and very disturbed (degraded) wetlands at the other (Figure 2). There are many wetland ecosystems, however, that are often considered degraded when in fact they have not completely deteriorated. These wetland systems continue to provide values to society even though they have been altered physically in

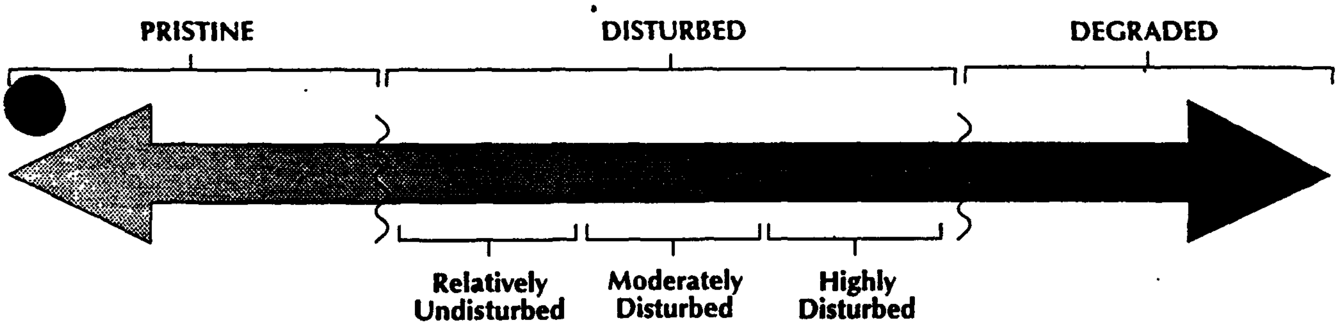

Figure 2. The wetland disturbance continuum

some manner and are "disturbed" systems. Disturbed wetlands have adjusted to the fluctuations caused by human activities that have altered the surrounding landscape. Unless a site is fundamentally degraded (based on valid scientific evidence), it is generally more appropriate to use the existing wetland communities as templates for compensatory mitigation.

Within the continuum, smaller scale continuums characterize each disturbance type. For example, wetland systems classified as disturbed may be highly disturbed, moderately disturbed, or relatively undisturbed. The purpose of recognizing a disturbance continuum is to identify the effort required for compensatory mitigation efforts.

- Management actions for specific landscapes may not use the existing wetland community model for compensatory mitigation due to existing landscape conditions. Two common examples include: (1) highly urbanized areas in which the wetlands may not yet be degraded but are reduced in number or acreage or lack the appearance of functional integrity; or (2) degraded wetlands. Both situations offer several options:

  Highly urbanized settings: Detailed hydrogeochemical and biotic analyses are often necessary to determine the functional status of the wetland systems in the landscape. Consideration of aesthetics should be distinct from ecological function. The analyses should then be used to develop a landscape management plan for compensatory mitigation. Effective functional replacement in urbanized settings, however, may require additional wetland ecosystem acreage beyond that typically mandated in compensatory mitigation plans.

  Degraded wetland communities or systems: **Degraded wetland systems** are those altered by toxic substances or other pollutants that result in impaired ecosystem processes and functions, and lack any societal benefits (e.g., water quality deterioration from heavy metal loadings resulting in the closure of shellfish bed harvesting or the restriction of recreational fishing). Degradation usually results from watershed land practices. Using degraded systems as models for the replacement of wetland losses is not generally desirable. The identification of such areas is important, however, to implement remedial actions within the landscape and reverse degradation of the wetland system. The use of compensatory mitigation as a sole remedy will probably not result in ecologically meaningful long-term replacement if the sources of the degradation remain untreated or if other communities in the vicinity of the wetland system are not rehabilitated.

- Landscape-level analysis may indicate changes in wetland ecosystem functions due to recent land use practices. These practices are accompanied by a decrease in the wetland's ability to perform certain functions and benefits. These changes may dictate several responses regarding compensatory mitigation:

  A determination is made that compensatory mitigation efforts will not use existing wetland communities as models. This decision may require the use of intensively managed systems such as stormwater ponds.

  A verification of wetland functional change and the associated decrease in ecosystem values may prompt changes in the land practices causing the adverse effects. The response of the wetland to changes in land practices should be monitored to determine whether compensatory mitigation efforts should continue to use models of existing wetland communities. A decision to either alter the mitigation model or abandon it altogether (and develop a new model based on the monitoring results) will then be based upon the best available information.

- The federal permit program generally requires compensatory mitigation for moderate or large-scale projects in which significant impacts to wetland systems are easily identifiable. A comparable requirement is not generally applied to projects in which the impacts are small either in terms of acreage or measurable functional loss. The guidance in this document does not distinguish between the requirements for compensatory mitigation based on size or the degree of project impact. In circumstances where wetland losses result from unregulated activities, guidance in this document can be used to direct efforts in which restoration, creation, or enhancement is deemed appropriate or necessary.
- Regardless of the type of compensatory mitigation or whether the existing wetland community serves as the mitigation template, compensatory mitigation will not maximize ecological function unless it is integrated into a landscape perspective. Many of the information sources and methods for landscape analysis are presently beyond the scope of regulatory programs at any level. Current efforts in the Chesapeake Bay basin, however, are developing landscape-level information which will enhance compensatory mitigation efforts. It is also incumbent upon federal, state, and local agencies involved in regulating wetland systems to develop a mechanism for gathering, sharing, and implementing landscape-level information.

The previous discussion outlines many of the issues addressed in this section of the document and lays the foundation for the more detailed discussions which follow.

The compensatory mitigation process involves several steps (Figure 1). The following information, however, is limited to steps 1 through 3. Information relevant to steps 4, 5, 6 and 7 will be developed in the future for inclusion as additional chapters.

Wetland Compensatory Mitigation Site Selection Criteria

Site selection criteria are those variables fundamental to the development of a viable compensatory mitigation effort. They are particularly important in plan development and serve as the ecological goals of each compensatory mitigation effort. A complete evaluation of the variables is critical for both the affected wetland community and the replacement site(s). Information on the variables should be collected at both the community and landscape levels. The variables presented below constitute the site selection criteria needed for the effective review of wetland compensatory mitigation plans:

Variable 1: *Identification of wetland hydrologic core and structural factors*

Variable 2: *Identification of wetland ecosystem processes, functions, and values*

Variable 3: *Identification of compensatory mitigation types*

Variable 4: *Identification of in-kind or out-of-kind replacement*

Variable 5: *Identification of on-site or off-site location*

Variable 6: *Identification of compensatory mitigation timing*

Variable 7: *Identification of lands compatible with compensatory mitigation efforts*

Variable 8: *Identification of lands not compatible with compensatory mitigation efforts*

Variables 1 through 3 for the project wetland are the baseline data. Baseline data serve as fundamental sources of information critical for the replacement of wetland ecosystem properties. These data may be collected by the project sponsor or a consultant for the project sponsor, federal, or state agency employees. Application of variables 4 through 8 should be determined by federal and state regulatory and review agencies.

Variable 1: *Identification of wetland ecosystem hydrologic core and structural factors*

1A. HYDROLOGIC CORE FACTORS

Hydrology is the driving force shaping wetlands (Gosselink and Turner 1978) and describes the water movement into, through, and out of a wetland ecosystem. The balance between the inflows and outflows is the water budget (Mitsch and Gosselink 1986). The inflow components of the water budget are precipitation, surface runoff, groundwater discharge, and, where appropriate, tidal inflow. Evapotranspiration, surface outflow, groundwater recharge, and tidal outflow constitute the outflows of water from wetland ecosystems (Mitsch and Gosselink 1986; Zimmerman 1988). Determining a water budget as part of compensatory mitigation is expensive since several of the parameters are difficult to measure precisely (e.g., evapotranspiration rates). In lieu of developing a water budget for each project, it may be more practical to focus on elements of the water budget components.

The physical replacement of a wetland and its attendant ecosystem processes and functions (and the goods and services provided by them) are dependent upon several hydrological properties termed "core factors" (Brinson and Lee 1989). Core factors largely determine the wetland community which will result from compensatory mitigation efforts since they define the "energy signature" of a particular wetland community or ecosystem (Odum 1983). The core factors consist of the hydroperiod, hydrologic energy, and nutrient regime. If a compensatory mitigation plan does not include information on these factors, one cannot determine what type of wetland community will result from the compensatory mitigation effort. Predictions concerning the wetland functions and values likely to result as well as the physical and ecological resemblance to the affected wetland will be uncertain.

1A1. Hydroperiod

Hydroperiod is defined as the depth, duration, frequency, and timing of both inundation or of the seasonal highs of water table (in part, after Brinson et al. 1981; Hollands et al. 1986), or the "seasonal pattern" of water level for a particular wetland community (Mitsch and Gosselink 1986). Depth is defined as the water level during flooding, ponding, or soil saturation (as measured in an unlined borehole). Duration describes the length of time of a specific hydrological event (typically measured in days or months). Frequency describes the return interval of a particular hydrologic event. Timing describes when a particular hydrologic event occurs (e.g., during the winter/spring, January through June).

1A2. Hydrologic Energy

The hydrologic energy of wetland ecosystems describes the direction and source of water (Brinson and Lee 1989; Brinson 1988; Gosselink and Turner 1978). Hydrologic energy direction is **vertical, bidirectional, or unidirectional** (Brinson 1988). Wetland communities in topographic depressions (e.g., Delmarva Bays) typically exhibit vertical hydrologic energy due to fluctuations in groundwater levels. Bidirectional flow is characteristic of tidal and lakeside wetlands, resulting from lunar or wind influences on surface waters. Wetlands along drainage pathways may be influenced by unidirectional hydrologic energy as a result of overbank flow (Brinson and Lee 1989).

The force of a particular type of hydrologic energy on a wetland system can be described along a continuum (Brinson and Lee 1989), with depressional wetland systems exhibiting low hydrologic energy, tidal/lakeside wetland systems having intermediate energy, and streamside wetland system communities showing high hydrologic energy. Each energy signature has specific variables which control the effect of the hydrologic energy direction. For example, overbank flows have unidirectional hydrologic energy which may vary both in velocity and the aerial extent of flooding through a wetland system for a particular storm. Seasonal and daily fluctuations in vertical hydrologic energy may exist laterally within some wetland systems which exhibit both groundwater discharge and recharge capabilities (Doss 1991). Tidal amplitude varies daily, seasonally, and annually when bidirectional hydrologic energy dominates. Understanding the mechanics and dynamics of the hydrologic energy direction in a wetland system aid in defining its ecosystem processes, functions, and values.

Many wetland systems throughout the Chesapeake Bay basin exhibit more than one pattern of hydrologic energy. For example, wetlands on floodplains of the Coastal Plain physiographic province of Maryland and Virginia experience some degree of overbank flooding. Although, the duration of flooding is relatively short, water table levels remain high following the flood event. If such an event occurs during the peak of vegetation growth (July-September), then evapotranspiration will readily lower the high water table. During this same period, however, precipitation levels tend to be high and a cycle of overbank discharge coupled with a seasonally high water table may be common. Groundwater fluctuations appear to dominate most of these floodplain wetland systems, but surface flooding also affects nutrient cycling, vegetation community dynamics, microtopographic relief, organic matter production, decomposition, organic and dissolved carbon export, and biotic interactions.

Identification of water sources to the project wetland and the compensatory mitigation site(s) is critical since the water chemistry of these sources may vary considerably and affect the wetland ecosystem processes and functions. Possible sources include overland runoff, direct precipitation, groundwater, overbank flooding, tidal exchange, or a combination of these sources. It is advisable to use long-term hydrologic data when available (e.g., U.S. Geological Survey river gaging stations, U.S. Soil Conservation Service water table wells, U.S. Army Corps of Engineers navigation or flood control projects), since a single observation (e.g., day, season, or year) of hydrology does not characterize the long-term hydrologic dynamics affecting wetlands. Indeed, as Loucks (1989) notes, "... the size and return period of extreme events must be considered ... the significance of return-time consideration lies in the fact that restoration on a large number of wetlands must be designed for events that are unusual locally, but fairly frequent over a large population of wetlands."

Where waterways (e.g., small tributaries and tidal guts) are part of the project wetland and/or replacement effort, it is necessary to investigate the morphology of either the existing waterway or one which serves as a model for the replacement site.

1A3. Nutrient Supply

The **nutrient supply** is a function of the hydroperiod, particularly duration, as well as **"residence time"** which is the average time that water remains in a wetland community or system (Mitsch and Gosselink 1986). It is important to identify nutrient sources, constituents, and fluctuations along with hydrologic energy characteristics of the project wetland and compensatory mitigation site. Sources of nutrients include adjacent, upstream, and downstream land uses and vegetation cover types; soils; precipitation; wind; and biotic contributions (e.g., presence of a seasonal waterfowl or wading bird population, wastewater treatment plant effluent). Plans for temporal changes in nutrient supply at the compensatory mitigation site and integrating some requirements for remedial actions in the monitoring component of the plan are important if these fluctuations are necessary to achieve the goals of the replacement effort.

Craft et al. (1988) found that three regularly flooded marshes with organic substrates had higher concentrations of nitrogen (N), carbon (C), and phosphorus (P) than three comparable marshes that were created. Two natural marshes with mineral soils, however, had similar N, C, and P concentrations compared to two created marshes. Researchers attribute this similarity to the relatively young age of the natural marshes and the hydrologic regime of the compared sites. In addition, total C and N pools of the natural marshes were significantly larger than those for the created marshes. As a result of tidal exchange, salt and brackish water marshes may have adequate supplies of Mg, Ca, K, and S, and fertilizer or other soil amendments may not be required for these elements. However, N and P may be limiting, particularly in sandy substrates or where the topsoil at the replacement has been stripped (Broome 1989). Nutrient conditions and dynamics, therefore, need to be identified prior to wetland replacement (Broome 1989).

1B. STRUCTURAL FACTORS

Closely linked to the hydrologic core factors are the other physical features which influence wetland ecosystem processes, functions, and values. The **structural factors** consist of geomorphic features and geologic substrates, vegetation, and landscape setting.

1B1. Geomorphic Features and Geologic Substrates

Wetland communities and systems exhibit a variety of geomorphic features that are underlaid by differing geologic substrates which should be documented at both the project wetland and substrate sites. Many of these elements are closely linked with the hydrologic dynamics.

1B1(a). Physiographic provinces. The characteristics of each physiographic region affect the distribution, biotic assemblages, and values of wetland communities and systems (Heeley and Motts 1973).

1B1(b). Geomorphic setting. This factor refers to the landforms on which wetland communities are situated. For example, to determine the cumulative effects of wetland alteration on water quality, Brinson (1988) proposed classifying wetlands into three categories: **basin** (depressional wetlands); **riverine** (riparian wetlands); and **fringe** (tidal wetlands). This classification is tied closely to the hydrologic energy directions discussed above. Together, the two factors characterize the **hydrogeomorphic setting** of the project wetland communities, clarifying desired replacement site characteristics. Each of the geomorphic locations also provides a general description of hydroperiod and nutrient supply (Brinson 1988). This hydrogeomaphic classification has since been revised, and in addition to the previous three wetland categories includes extensive peatlands (i.e., blanket bogs) (Brinson 1993). The hydrogeomorphic classification serves as the foundation for the functional assessment models under development by the Corps of Engineers, Waterways Experiment Station (Dan Smith, personal communication). It will also provide a useful tool to implement compensatory mitigation within a landscape context (e.g., throughout a watershed).

Another means of describing the geomorphic setting of wetland systems is through a **hydrogeologic characterization** of the landscape (O'Brien and Motts 1980). This classification is landscape-based and uses a variety of data sources to establish the hydrogeomorphic units, including surface and groundwater characteristics, land use and vegetation cover type, surfical geology, topography, physiography, and soil properties (O'Brien and Motts 1980). This type of classification enhances the understanding of the relationships among hydrology, geomorphic setting, and wetland ecosystem properties. Recently, the U.S. Geological Survey identified and classified the two regional geomorphic settings of the Delmarva Peninsula into "hydrogeomorphic units" (Phillips 1992; Phillips et al. 1993). Results of the hydrologic and nutrient analyses conducted on the Delmarva Peninsula indicate that wetlands located in different hydrogeologic units (i.e., different hydrogeologic settings) alter groundwater quality differently (Phillips et al. 1993).

1B1(c). Macrotopography. Topography may be viewed at either broad or detailed scales; both are relevant to wetland compensatory mitigation efforts. Macrotopography refers to the slope and elevation of the project wetland—important variables to establish for use in the replacement site. Both are closely linked to hydroperiod and hydrologic energy direction and source.

Slope and elevation, as well as tidal amplitude, are important in the replacement of salt and brackish water marshes (Broome 1989). These three elements determine the boundary between the "low" and "high" marshes (Broome 1989). Broome recommends observing or measuring the lower and upper elevation limits of a neighboring marsh. McKee and Patrick (1988) reviewed the existing literature to determine the relationship between *Spartina alterniflora* and tidal elevations along the Atlantic and Gulf coasts. This analysis revealed a positive correlation between mean tide range and the growth of *Spartina alterniflora* relative to elevation. In addition, they cite other biotic and abiotic factors which may, in addition to tidal amplitude, limit the distribution of *Spartina alterniflora* along the elevational gradient. These factors including edaphic features (e.g., salinity, available nutrients, and redox potential), interspecific competition, and natural and human disturbance (e.g., mosquito ditching). In addition, elevation may be a significant factor controlling particle size as well as the amount and dispersion of nutrients within marsh communities (Lindau and Hossner 1981).

The slope of a project wetland should serve as a guide for the replacement site gradient. Slopes of tidal wetland communities are another important element in determining the aerial extent of marsh vegetation. The steepness of a slope will affect the dissipation of wave energy which in turn influences plant colonization and survival (Woodhouse 1979; Broome 1989). Gentle slopes dissipate wave energy over a broad area, whereas steep slopes concentrate the force of the wave over a small distance. Slopes which are too flat, however, may impede drainage, limit soil aeration, and concentrate salts which may inhibit the growth of desired plant species.

Elevation and slope are also important in the replacement of nontidal wetland communities. Slopes which are too steep will not exhibit the desired hydrologic conditions and be subject to significant erosion. Because of the linkages with hydroperiod and elevation, incorrect elevations may result in significantly longer or shorter hydroperiods than those of the project wetland.

1B1(d). Micro-relief. Micro-relief (microsite) refers to the fine-scale topographic heterogeneity exhibited by most wetland communities as a function of substrate, hydrologic dynamics and other physical disturbances, and biotic forces. Excluding some tidal shoreline wetland communities, the "hummocky-hollow" nature of wetland communities is fairly common, particularly in those areas with organic substrates and long periods of soil saturation. Micro-relief is also present in many forested floodplain wetland communities where floods have moved sediment and other debris so that a variety of microtopographies exist across the site. Downed and decaying woody materials, such as tree stumps, trunks, limbs, exposed roots, or mounds from tree uprootings also cause small-scale differences in relief. Micro-relief is important in the regeneration of wetland vegetation communities (Huenneke and Sharitz 1986). The distribution and diversity of microsites may differ significantly between wetland communities and even within a community due to disturbance (Huenneke and Sharitz 1986).

Where possible, compensatory mitigation plans should incorporate micro-relief features of the project wetland at the replacement site based on an evaluation of the factors responsible for the micro-relief at the project wetland. This evaluation will determine if similar factors exist at the replacement site, the temporal nature of these factors, the abundance and types of microsites of the project wetland, design specifications needed to achieve the desired micro-relief features, and monitoring requirements.

1B1(e). Soil properties. The important soil properties of wetland communities include: texture, organic matter content and structure (applicable for peatlands), types of horizons present and their corresponding depths, pH, redox potential, soil salinity, nutrient pool, cation exchange capacity, conductivity, and Munsell color (matrix and mottles). Soil characteristics which indicate hydrologic dynamics such as the presence of iron and manganese concretions and oxidized rhizospheres, porosity, hydraulic conductivity, bulk density, presence of toxic substances (heavy metals, pesticides, herbicides), and measurements for wetland gases (methane, ethylene, hydrogen sulfide) (Veneman 1986; Pacific Estuarine Research Laboratory 1990) are also important.

Evaluating several of the soil properties listed involves some data collection and laboratory analysis. Due to differences in soil properties between wetland communities, it is not practical to determine what soil properties must be measured for all sites. It is, therefore, advisable to have a suite of soil properties evaluated for different types of wetlands based on the establishment of "reference wetland communities" (see pages 26 - 27 for a discussion of reference wetlands).

1B1(f). Surficial geologic characteristics. Wetland ecosystem distribution and the diversity of wetland communities are related to surficial geologic characteristics which affect the hydrologic dynamics (Heely and Motts 1973). Phillips (1992) found groundwater movement beneath forested wetlands along drainage divides in the upper sandy zone of the surficial aquifer. Groundwater pathways beneath forested riparian wetlands occurred in the lower sandy zones of the same surficial aquifer. The results from this study help to elucidate the relationship between the geomorphic position of wetlands and their hydrogeologic dynamics, and the way in which this relationship affects wetland ecosystem structure, processes, functions, and values.

1B1(g). Underlying bedrock. This feature may be important in evaluating the hydrologic properties, functions, and values of wetland communities in some physiographic provinces (e.g., the Appalachian Plateau).

1B2. Vegetation

Wetland vegetation dynamics refers to the temporal and spatial changes exhibited by the structure and composition of wetland ecosystems as a result of changes in the environment (Neiring 1987). One of the most important environmental factors responsible for wetland vegetation changes is hydrology. **The relevance of vegetation dynamics to wetland compensatory mitigation efforts is the recognition that the vegetation composition at any one time is the result of both past and present changes in environmental conditions.** While we may use such data as part of the replacement model, continual structural and floristic changes are inevitable. Understanding the elements involved in wetland vegetation dynamics is key in evaluating the vegetation at the project wetland and transferring that information to the replacement site, as well as determining monitoring requirements.

1B2(a). Succession. For many years, succession was viewed as the predictable and directional change in vegetation community structure and composition over time in both wetlands and other systems. Succession was accepted as the result of autogenic factors within the community, always moving towards a single "climax" community ultimately determined by the regional climate (Clements 1916, 1936). As an alternative to this model, Henry Gleason (1939) proposed that local environmental conditions determine the composition of a plant unit and time and space variability cause changes in the environmental conditions—the **"individualistic concept"** of plant succession.

Studies by Whittaker (1953 and 1967) and others resulted in greater support of the individualistic concept as opposed to the Clementsian "climax" view. Their analyses demonstrated that plants are individually distributed along "environmental gradients" and that changes in plant species composition are related to changes in these environmental gradients (van der Valk (1982). For wetland ecosystems, the spatial differences within and between wetland communities are affected directly or indirectly by changes along the "moisture gradient." As such, the Clementsian model of "succession" is generally not relevant to wetland ecosystems (Van der Valk 1981; Neiring 1987). Because hydrology exerts such a considerable effect on wetland vegetation dynamics and hydrologic conditions are inherently variable, existing wetland ecosystems are likely to remain until human or natural disturbances alter the hydrologic connection (van der Valk 1982). Wetland communities are greatly influenced by allogenic factors although autogenic processes (e.g., competition) are also important (Neiring 1987).

In lieu of the Clementsian model, van der Valk (1981) proposed a "Gleasonian" model for succession in wetland ecosystems. The model focuses on wetland vegetation "succession" (i.e., annual changes in the floristic composition of vegetation within a wetland site) in response to three life history traits: the potential life span of a species, propagule longevity, and propagule establishment requirements as affected by fluctuating water regimes (van der Valk 1982).

1B2(b). Seed Banks. Because of the limited information available on life history characteristics of wetland vegetation, the Gleasonian model of succession is qualitative and depicts allogenic succession only. One important contribution of this model, however, is that it highlights the relevance of wetland vegetation seed banks for compensatory mitigation efforts. A seed bank is "... the number, store, or density of viable seeds in the soil at a given time" (van der Valk et al. 1992). In addition to seeds, other vegetative propagules are included in the seed bank.

Van der Valk and Davis (1978) examined the relationship of seed banks to vegetation dynamics in glacial prairie marshes of Iowa. They identified three categories of seed banks present in this type of wetland system and determined that changes in water level and the muskrat population were primarily responsible for the cyclic vegetation changes occurring at intervals between five and 30 years. Leck and Graveline (1979) investigated the seed bank of freshwater tidal marshes in New Jersey and found a diverse seed bank which reflected the standing vegetation. Van der Valk and Davis 1978 reported similar results for the prairie glacial marshes although Milton (1939) did not find similar findings for a salt marsh.

Allogenic vs Autogenic Factors

Studies on succession have long been dominated by the relative importance of allogenic vs autogenic factors in driving changes in vegetation. Autogenic factors are those changes in the ecosystem caused by the plants themselves. Plants alter the environment by shading the ground, adding and removing nutrients from the soil, minimizing temperature fluctuations, changing the micro-climate, and altering the soil structure. Thus, changes through time to the ecosystem as a whole result from self-contained factors within the environment.

Allogenic factors also drive successional change. Unlike the biological autogenic factors, however, allogenic factors are geological, physical, or chemical changes which propel succession. The local organisms have no control over this sort of wholesale ecosystem change because the alterations are caused by external forces.

Wetlands are driven predominantly by allogenic factors although autogenic factors do alter the environment to some degree. Of the allogenic factors, hydrology is most important in determining allogenic succession. The ecosystem hydrology can be described by the hydroperiod—the seasonal fluctuations of a wetland's water level—along with the type of local landforms, other local water bodies, water sources, precipitation, and the chemical constituency of the wetland's water. Tides also influence the hydrology of coastal and some estuarine wetlands.

The Seed Bank

In wetlands, the seed bank is the substrate that contains the seed reserves for the immediate wetland plant community. Seeds transported to the seed bank either by wind or water dispersal often remain dormant until conditions suitable for their germination occur. The seed bank also contains vegetative propagules in addition to the seeds.

Seed banks are critical sources of new vegetation both in pristine and impacted wetlands. Although characteristics of the sediments play a role in the species type, composition, and viability of seed bank species, the hydrologic patterns in the wetland may be equally or more important (Schneider and Sharitz, 1986). The significant role of hydrology in controlling seed bank dynamics has important implications for the status and restoration of some wetlands. Anthropogenic changes to the wetland hydrology can alter a major mechanism for sustaining the diversity and abundance of wetland vegetation.

Leck and Graveline (1979) found that annuals were more prevalent than perennials overall, although some perennials (e.g., *Typha latifolia*) may dominate perennial numbers. They found the species numbers decreased with soil depth although the surface layers had few seeds, possibly reflecting environmental conditions (e.g., tidal exchange, export of surface seeds with debris); there was a more gradual decrease of seeds with depth compared to upland communities (which may reflect prolonged dormancy and increased longevity of a tidal freshwater marsh seed bank); and there appeared to be different germination requirements and viability of the marsh vegetation as reflected in the seed bank. Wienhold and van der Valk (1989) found that the number and density of vegetation species found in drained wetland seed banks declined over time. *Typha angustifolia* was the only emergent species represented in the seed banks of wetlands which had been drained for 70 years.

Schneider and Sharitz (1986) examined seed bank dynamics of a cypress-tupelo swamp and bottomland hardwood communities. They found dissimilar seed bank compositions between the two communities both prior to and following the first winter flood. After the flood, however, the appearance of *Acer rebrum* and *Itea virginica* seeds in the cypress-tupelo seed bank caused an increase in similarity. *Acer rubrum* produces samaras which are dispersed initially by wind and are relatively short-lived. The investigators concluded that the presence of *Acer rubrum* in the cypress-typelo swamp samples after the flood was due to dispersal by flood waters and wind. Unlike the results from the freshwater tidal and nontidal marsh studies, the woody seed banks of the two communities did not reflect the standing floristic composition. The herbaceous seed banks of both communities were similar, however, with the seed banks more diverse in species composition than the standing vegetation.

Utilizing a seed bank from a project wetland may offer a more successful means of establishing the wetland vegetation community(ies) at the replacement site. The previous studies show that seed banks are variable, however, and a thorough examination of both the seed bank from the project wetland and the environmental conditions affecting germination from the seed bank (particularly the hydrologic core factors) is required prior to implementing compensatory mitigation efforts (van der Valk 1992).

1B2(c) Vegetation Evaluation. Merely noting the presence of a few plant species from the project wetland does little to indicate the eventual vegetation community(ies) that will develop at the replacement site. In addition to either describing or conducting a statistical sampling of community dominants from each vegetation strata present, an evaluation of the plant community should also include the number and distribution of federal or state-listed endangered and threatened plant species. Such an assessment will trigger coordination between the project proponent and the U.S. Fish and Wildlife Service pursuant to the Endangered Species Act. Other state natural heritage listed species which do not fall into one of the preceding status categories should also be noted. Other factors to consider include: an estimate of the age or developmental stage of the vegetation community; microsite types and abundance (refer to the micro-relief discussion above); and seed bank composition, relation with soil depth, and utility at the replacement site (e.g., can the seed bank be used, should it be augmented with other species and why, what conditions at the replacement site preclude the use of the project wetland community seed bank, etc.). In addition, geomorphic features and hydrologic core factors need to be incorporated in the evaluation of project wetland vegetation dynamics to serve as the template for the replacement site. In circumstances where the project wetland does not serve as the model for the replacement effort, an evaluation of the vegetation, geomorphic, and hydrologic characteristics of an adjacent wetland community (or from a population of reference wetlands) is suggested.

1C. LANDSCAPE SETTING

This factor refers to the spatial relation of the project wetland community and the replacement site within the landscape and how this relationship affects the hydrologic core and structural factors of the project wetland for implementation at the replacement site. The surrounding landscape and project wetland community interact in the exchange of materials, energy, and biotic forces. Wetland ecosystem processes, functions, and values provided by the project wetland are a reflection of the structure and function of the surrounding landscape.

The boundaries of the landscape setting evaluation should incorporate some hydrologically defined area, such as a subwatershed or watershed (Gosselink and Lee 1989). Components of the evaluation include the spatial relationship of terrestrial, aquatic, and other wetland communities with land use features. For example, the evaluation of a project wetland might include the following assessment:

The project wetland occupies approximately one-tenth of a contiguous forested wetland ecosystem that extends three miles longitudinally and 1,000 feet laterally along a third-order stream. The forested wetland system occupies approximately 27% of the drainage area of the third-order stream and represents the largest intact forest within the watershed. The project wetland community is contiguous with a beaver-impounded scrub-shrub wetland downstream and is part of a mature forested wetland community extending upstream. Wetland communities altered by beaver are common throughout the system. A drinking water supply reservoir exists one-half mile downstream. The entire forested wetland ecosystem borders farmed upland pasture and upland forests. There is some low density residential development in the forested uplands throughout the watershed. All lots have septic systems. A steep forested upland slope lies between the project wetland and farmed upland. The farmed upland is typically planted in corn and soybean with a three-year fallow period between. The fields are regularly fertilized with inorganic fertilizers and periodically with manure and sprayed with a commonly used herbicide. Soil type within the project wetland community is generally a sandy loam overlying a two to five-foot thick clay loam subsoil. The soil in the adjacent beaver wetland is a silt-loam with large amounts of organic material at the soil surface. The adjacent forested slope has draughty sandy soils. The farmed upland soils adjacent to the forested slope are also sandy but have a higher percentage of silt. Approximately one-third of the stream/wetland association above the project wetland community has been fenced to prevent livestock entry into the stream and wetlands although there is no fencing downstream. Close to 30% of lands housing livestock upstream of the project wetland have on-site animal waste management. Only 2% of downstream farms have on-site animal waste treatment. The forested wetland system is hydrologically driven by shallow groundwater, overbank flooding, and by overland flow in the headwaters. The project wetland is predominantly groundwater driven and receives water input from a seepage along the forested upland slope. It is also infrequently flooded by overbank flow.

The previous example represents a minimum evaluation of landscape setting. More indepth analyses of spatial relationships throughout a landscape will require use of a Geographic Information System (GIS). While more costly and time consuming in the short term, use of a GIS to identify compensatory sites, as well as determine impacts to wetlands within a landscape context, will provide a more comprehensive and ecological sound approach in the long term.

Inclusion of the landscape setting for the project wetland and the replacement site will broaden the spatial component of the compensatory mitigation efforts. Analyzing the hydrologic core and structural factors at the landscape scale will enhance the understanding of wetland ecosystem properties and result in more ecologically sound management decisions affecting compensatory mitigation.

Variable 2: Identification of wetland ecosystem processes and functions, and wetland values

2A. ECOSYSTEM PROCESSES

The hydrologic core and structural factors identified above are responsible for processes which are identifiable at the ecosystem level. Hydrology is the predominant factor defining the ecosystem processes within wetlands, including organic matter production and decomposition, energy flow, and biogeochemical cycling and transformation (Table 1). Appendix C provides a summary of technical information regarding these wetland ecosystem processes.

Table 1. Selected Wetland Ecosystem Processes.

Process	Description
Organic Matter Production	Ability of vascular plants, primarily macrophytes, and algae to fix carbon via photosynthesis, producing a usable organic energy source for heterotrophs. Typically measured as g dry wt/m^2/yr as primary productivity. Basis of most aquatic, wetland, and terrestrial food webs.
Organic Matter Decomposition	Processing and reprocessing of plant material by chemical and biological processes for assimilation by invertebrates and vertebrates in aquatic, wetland, and terrestrial systems. Production of detritus (decomposing plant matter) provides substrate for further conversion of organic carbon to assimilative forms. Basis of detrital food webs.
Energy Flow	Detrital or grazing trophic pathways may dominate, but many wetlands exhibit a complex interaction of both. Trophic structure dynamics (i.e., "whom" eats "whom," when, where, and how often) frequently involve aquatic, wetland, and terrestrial organisms, including humans.
Nutrient Cycling and Transformation	Cycling and transformation of nutrients is biologically, geologically, hydrologically, seasonally, and climatically mediated. Whether any particular wetland is primarily a source, sink or transformer of nutrients depends on the previous variables, as well as landuses which affect those variables. Generally, wetlands appear to function as sinks for various inorganic nutrient forms, sources of organic materials to downstream and adjacent systems, or transformers of inorganic inputs to organic forms for export.

2B. ECOSYSTEM FUNCTIONS

Wetland ecosystem processes can be categorized into wetland ecosystem functions. Table 2 presents examples of wetland ecosystem functions, specific ecosystem processes associated with the function, and resultant societal values. Several wetland functional assessments in use today do address ecosystem processes indirectly (e.g., "trophic chain support" or "organic matter export"). The assessments, however, do not reflect the degree to which the ecosystem processes operate within any given wetland. Rather they are surrogates that gauge the relative importance of that particular process or function. The measurements produced by quantitative assessments determine whether a compensatory mitigation project closely approximates the lost functions and values of an altered wetland. As Kusler and Kentula (1989a) state:

> **.... {the} authors and informed contributors continually affirmed that the creation and restoration of wetlands is a complex and often difficult task. This in turn, pointed to the need for setting clear, ecologically sound goals for projects and developing quantitative methods for determining if they have been met. To validate the goal setting process, wetland science must progress and the role of wetlands in the landscape must be understood. Only then can one truly evaluate which ecological functions of naturally occurring wetlands are provided by created and restored wetlands.**

Existing wetland ecosystem assessments are primarily qualitative regarding function. While they are intended to provide a means to assess attributes which may reflect wetland ecosystem functions, sufficient quantitative data generally do not exist for every wetland type to assess those attributes confidentially. In addition, there is no single synthesis of existing data for Chesapeake Bay wetland systems which would aid in modifying existing assessments.

2C. WETLAND VALUES

Wetland values are defined as the goods, services, and benefits provided by a particular wetland community or ecosystem, reflecting the unique hydrologic core and structural factors, ecosystem processes, and functions of wetland systems. The following are examples of wetland ecosystem values (adapted from Adamus and Stockwell 1983):

- Passive and active recreation areas
- Archeological, historic, or unique geologic features

- Aesthetics
- Education
- Scientific research
- Fish, wildlife, and endangered, threatened, and rare species habitat
- Harvesting of wetland foods, fibers, and, plant or animal products (e.g., pelts, skins, chemical/medicinal products)
- Flood storage and desynchronization
- Shoreline/sediment stabilization
- Water quality maintenance or enhancement
- Base flow augmentation (groundwater discharge)
- Drinking water source (groundwater recharge)

Compensatory mitigation plans should include measures to replace the values of the project wetland at the community and landscape scales. Unfortunately, the scientific data base documenting wetland ecosystem properties in the Chesapeake Bay is limited, particularly for nontidal wetland systems. Existing wetland "functional assessments" ultimately rely on a literature base that may not represent Chesapeake Bay wetland systems. To assess systems, geographically relevant information is critical. For example, extrapolation of information on hydroperiod dynamics from Mississippi alluvial bottomlands to periodically inundated, seasonally saturated forested wetlands on the lower Coastal Plain of Virginia may inaccurately assess hydrologic functions for the Virginia wetlands.

It is, therefore, difficult to assess values for Chesapeake Bay wetland systems and to develop compensatory mitigation plans that attempt to replicate the values identified for the project wetland. The identification and quantification (where feasible) of the hydrologic core and structural factors of the project wetland will increase the likelihood that the compensatory mitigation site will approximate the values of the project wetland. The collection of baseline data should be integral to the development of any compensatory mitigation plan.

2D. WETLAND ASSESSMENTS

It is important to document accurately the specific hydrologic core and structural factors, functions, and values of the project wetland rather than evaluate the wetland superficially. For example, forested wetlands provide habitat for species requiring trees for survival (e.g.,

Table 2. Examples of wetland ecosystem functions, processes, and values.[1]

Ecosystem Process	Identified Function	Resultant Value
• Biogeochemical Interactions • Organic Matter Production • Decomposition Dynamics • Hydroperiod/Hydrologic Energy Source and Direction • Alluvial Deposition/Erosion Patterns	• Biotic Diversity	• Recreation • Scientific Study • Education • Aesthitics • Sustenance • Commercial Harvesting • Landscape Heterogeneity
• Biogeochemical Interactions • Hydroperiod/Hydrologic Energy Source and Direction • Alluvial Deposition/Erosion Patterns	• Nutrient Cycling/Transformation Mechanisms	• Drinking Water Supply • Recreation ("Fishable" and "Swimmable" Waters) • Wetland Ecosystem Maintenance
• Biogeochemical Interactions • Hydroperiod/Hydrologic Energy Direction and Science • Organic Matter Production • Decomposition Dynamics • Energy Flow Pathways	• Trophic Structure Support	• Commercial Harvesting • Consumptive and Nonsumptive Recreation • Landscape Integrity

[1](Adapted from information provided by Jean O'Neil, USCOE-WES, Vicksburg, MS.)

barred owl, red-shouldered hawk, and prothonotary warbler). A herbaceous wetland community does not meet the needs of such forest-dwelling species. While both wetland communities provide habitat, the hydrologic core and structural factors for each wetland community are very different and support different faunal communities (vegetation structure is obviously different, but so too are the hydrologic core and other structural factors). While replacement of the project wetland community with a herbaceous wetland may be more easily accomplished, establishing "success" remains problematic.

Rationalizations of improved "community diversity" are often put forward with little substantiation. In the example just outlined, development of the compensatory mitigation plan should include measures to replace the destroyed forested wetland community over time. Such a plan may necessitate the natural reestablishment and development of the plant community from a herbaceous assemblage to a community dominated by woody species. The ultimate goal is the establishment of a forested system that is similar to the altered one. The guidance in this document suggests using the project wetland as the model for the replacement wetland.

Presently, various qualitative and quantitative function and value assessments are in use, such as Wetland Evaluation Technique - Part II (Adamus et al. 1991) and Habitat Evaluation Procedures (U.S. Fish and Wildlife Service 1980). Such assessments are usually applied to large wetland tracts or when the potential for significant wetland impact exists. Some computer models of water quality and flood events may also be useful in the assessment of wetland ecosystem values. The existing assessment techniques are not designed to evaluate cumulative impacts, including the ramifications from existing compensatory mitigation practices.

Development of more sensitive wetland ecosystem assessment tools is necessary, along with significantly more research on the values of Chesapeake Bay wetland systems. The science and technology of wetland ecosystem assessments will generally lag behind the information requirements necessary for effective wetland management. Therefore, federal and state agency field personnel should assess and document wetland ecosystem functions and values for all wetlands potentially affected by a proposed project. Such an interagency evaluation may use qualitative or quantitative assessments or professional judgement to provide such documentation. More in-depth quantitative analysis may be required, particularly if the project is controversial or significant impacts are likely. Furthermore, efforts should ensure the utility and compatibility of data gathered to expand the base data. Table 3 presents various wetland ecosystem values and identifying criteria which may be helpful in evaluating minor impacts or where an in-depth assessment of wetland values is not possible due to time constraints.

Significant uncertainties remain regarding the feasibility of replacing wetland ecosystem processes, functions, and values (Moy and Levin 1991; Kusler and Kentula 1989a). Scientists lack a basic understanding of many of the ecosystem processes operating in wetland systems, the interactions with adjacent systems within a landscape, and the effect of human activities on wetland ecosystem properties in the short or long term. Qualitative assessments give a small and incomplete measure of the complexity of wetland ecosystems. From this information, combined with hydrologic core and structural baseline data, the type of wetland community to replace and the required acreage are determined. Until better function and value assessment tools based on scientific measurements are available, the most appropriate course of action is to replace unavoidable wetland ecosystem losses on an acre-for-acre basis. This acre-for-acre replacement is a minimum value. Where it is determined that more than a 1:1 replacement is necessary (e.g., based on a lack of demonstrated "success," enforcement proceedings, or state permit regulations), there should be a sufficient water source and water supply given the existing water uses of the replacement site (Clewell and Lea 1989a).

2E. REFERENCE WETLANDS

A relatively recent concept in compensatory mitigation efforts is the application of "reference wetlands" (Pacific Estuarine Research Laboratory 1990). Reference wetlands are a population of wetlands, including wetland communities, which exhibit some degree of disturbance. Reference wetlands serve several purposes relative to compensatory mitigation efforts:

- They may provide baseline data when project wetlands have already been lost but development of compensatory mitigation plans has not occurred or been approved. The popula-

Table 3. Wetland Values and Identifying Criteria

(adapted from Maryland Soil Conservation Service unpublished guidelines, VIMS 1991, and Adamus et al. 1987).

Value	Criteria
Erosion Control	Wetland is located in a landscape position where it protects the soil from erosion caused by concentrated surface flow, overbank flooding, or wave action.
Sediment Control	Wetland is located in a landscape position which is adjacent to or downstream of sediment sources, including Highly Erodible Land where conservation practices are not in use; the wetland topographic gradient is gradual; and/or the wetland is forested or otherwise heavily vegetated.
Floodwater Storage and Flow Reduction*	Wetland is characterized by presence of very sinuous channels within the vicinity of the wetland, dense vegetation, watershed slope of at least 3%, presence of vegetation with rigid stems (e.g., trees, shrubs, cattails), and/or 1-foot or more of water is impounded during flood events.
Water Quality Maintenance and Enhancement	Wetland is adjacent to sources of nutrients and pollutants such as cropland, active pastureland, barnyards, manure storage areas, urban lawns, golf courses, sewageoutfalls, dumps/landfills, defective septic fields or those built on wet soils, lands denuded of vegetation, or urbanized areas such as commercial parking areas.
Migratory Bird Habitat	The wetland provides or would provide feeding, nesting, resting, or cover habitat for migratory birds, including songbirds, raptors, wading birds, ducks, geese, swans, or other birds protected by Federal Migratory Bird Treaty laws.
Endangered, Threatened, or Rare Species Habitat	The wetland contains or is likely to contain habitat for Federal or state listed plants and animals.
Upland Wildlife Habitat	The wetland provides breeding, nesting, feeding, or cover habitat for upland wildlife such as deer, pheasant, wild turkey, eastern cottontail, black bear, woodcock, bobwhite quail, etc.
Wetland Wildlife Habitat	The wetland provides breeding, nesting, feeding, and cover habitat for wetland wildlife species such as otter, beaver, muskrat, nutria, marsh rabbit, mink, green frog, spring peeper, painted turtle, brown snake, four-toed salamander, etc.
Finfish Habitat	The wetland is flooded at a sufficient depth and duration, and is connected to surface water (i.e., stream, river, lake/reservoir, or the Bay) which provides breeding, nursery, and/or feeding areas.
Areas of Special Concern	The wetland is located within an area designated by Federal, State, or local government agencies as requiring particular landuse provisions (e.g., Maryland's Critical Area law, Virginia's Chesapeake Bay Preservation Act, Executive Order 11988 - Floodplain Management and the Floodplain Management Guidelines (FR 43(29) 1978); the wetland is designated as an important natural resource area (e.g., NOAA designated Estuarine Reserve); or the wetland is immediately adjacent to other protected lands (e.g., National Wildlife Refuge System, State wildlife management area, land owned by a conservation organization).

tion of reference wetlands should provide baseline characteristics similar to the project wetlands unless the goal of replacement is not structural and functional equivalency. For example, using ten salt marsh communities to replace coastal forested flats in southeastern Virginia would not be an appropriate reference wetland population if the goal is to replace the structure and function of the forested coastal flats.

- Where baseline data are collected, such data provide snapshots through time particularly when hydrologic information is lacking. A population of reference wetlands can supplement the data base.
- A population of reference wetlands serves as a means of adjusting monitoring criteria for compensatory mitigation efforts underway.
- Reference wetlands serve as "living laboratories" providing quantitative measurements of wetland ecosystem structure, processes, and functions. They also help identify the benefits provided by a variety of wetland systems within a landscape, enhancing management decisions so that landscape integrity can be maintained relative to wetland ecosystem properties.
- Reference wetlands also serve as a useful tool in refining compensatory mitigation site selection, design, and success criteria.

To date, there has not been a systematic identification and incorporation of reference wetlands into mitigation efforts throughout the Chesapeake Bay watershed. As a result of the June 1993 wetlands compensatory mitigation workshop in Arnold, Maryland, however, a concerted effort is underway to identify reference wetlands, test the applicability of the reference wetland concept, and design an implementation strategy for forested wetlands on the Mid-Atlantic Coastal Plain. This effort should assist in identifying additional reference wetland populations throughout the Chesapeake Bay region.

Variable 3: Identification of types of compensatory mitigation

Once the baseline data for the project wetland have been gathered and analyzed, the specific type of compensatory mitigation should be determined by the federal and state regulatory and review agencies. A project sponsor or consultant acting on behalf of the project sponsor can still present information on a replacement site or sites and this is strongly encouraged. For the regulatory and review agencies to evaluate compensatory mitigation plans in an ecological context, however, it is important to consider variables four through eight. Application of these variables must rest with the public agencies which comment on and approve the activities in question and the attendant compensatory mitigation efforts. The entire site-selection process (i.e., variables one through eight) should be an iterative process.

Kruczynski (1989b) identified and discussed the application of four types of compensatory mitigation: **restoration, creation, enhancement, and preservation.** These concepts, with some modification, are presented below.

3A.RESTORATION

Restoration refers to the reestablishment of a wetland community with hydrological modifications in an area where wetlands previously existed in the same general topographic location. Hydric soils may continue to characterize the former wetland site, although the soils may exist in an altered form (e.g., buried, oxidized, drained). Restoration is an evolving science and requires experts who understand and can manipulate a site to reestablish wetland hydrology. The relative potential for success is high because only one or a few physical conditions need to be altered or manipulated.

3B. CREATION

Creation involves the establishment of a wetland community where one did not formerly exist. Creation usually occurs in terrestrial environments but it has also taken place in open water. Creation, like restoration, requires knowledge of wetland hydrology. Unlike restoration, creation generally involves the manipulation of terrestrial environments to establish wetland hydrology. The site soil conditions do not usually exhibit hydric soil characteristics as determined by texture, organic profiles, and other properties. Creation is a more difficult process than restoration and requires extensive pre-planning to select the appropriate location and ensure the proper elevations and water supply for establishment of the hydroperiod. Creation often requires more monitoring and follow-up than restoration.

3C. ENHANCEMENT

Enhancement is any activity conducted within an existing wetland community that manipulates one or more physical characteristics of the site to increase one or more wetland functions and/or values. Enhancement differs from restoration in that it occurs in existing wetland communities. While enhancement often benefits specific wetland ecosystem functions and values, it involves trade-offs between wetland ecosystem structure, processes, functions, and values. Enhancing one wetland function or value may negatively affect others. Evaluating when and where enhancement is ecologically appropriate requires consideration within a landscape context.

3D. EXCHANGE

Exchange is an extreme type of enhancement which typically involves trading one wetland vegetation community type for another (e.g.,replacing a forested wetland with a marsh). It can also include replacing wetland communities of different hydrologies (e.g., replacing a tidal marsh with a nontidal marsh or a riverine swamp with a vegetated pond). Exchange may result in an ecologically functioning replacement wetland. However, the new wetland community may not provide the site or landscape-specific functions that were provided by the project wetland community. Implementing exchange, particularly as a standard mitigation practice, will result in cumulative effects to adjacent systems and the functions and values they provide. As Kruczynski (1989b) cautions, **"Exchange should only be used when there is ample scientific evidence demonstrating that the functions of an ecosystem or region are limited by the lack of a particular community type."** In other words, there should exist an ecological void that must be filled for an ecosystem or region to demonstrate ecological integrity.

3E. PRESERVATION

Preservation of existing wetland communities via monetary or land donation is generally an unacceptable form of compensatory mitigation when associated with the federal regulatory program. Many significant activities in existing wetland communities are regulated through the federal permitting program and some form of protection is usually afforded. Additionally, to achieve the no-net-loss goal in the Chesapeake Bay drainage through federal and state programs, the replacement of all wetland ecosystem losses is necessary. The purchase or donation of existing wetland communities in lieu of wetland replacement results in a net deficit of wetland community acreage and ecosystem functions and values. Furthermore, the source of funds (e.g., new vs. preexisting) is not easily tracked and potentially subject to abuse. The key to protecting existing wetland systems rests with avoiding alterations, acquiring or purchasing long-term easements for both wetland systems and adjacent uplands in perpetuity, and eliminating land practices which result in wetland ecosystem degradation.

Compensatory mitigation plans should consider, in order of preference: restoration, creation, and enhancement. Because the site-selection process is intended to be dynamic, this ordering may not be appropriate in all circumstances. Agencies, however, are encouraged to document why the suggested order is not applicable in specific cases.

The decision to select restoration, creation, or enhancement is based on a variety of factors including the probability of success for each type of compensatory mitigation as well as the land available. Documenting baseline data for a project wetland prior to its alteration, designing compensatory mitigation plans using the baseline data from the project wetland, and implementing the guidance contained in this manual will enhance the probability of functional replacement success.

Variable 4: Identification of in-kind and out-of-kind replacement

4A. IN-KIND REPLACEMENT

Closely replicating the hydrologic core and structural factors, ecosystem processes, functions, and values of a project wetland is referred to as "in-kind" compensatory mitigation. In-kind replacement reflects **hydrological, structural, and functional equivalency** of the project wetland community. Achieving hydrological, structural, and functional equivalency involves replacing as many of the specific hydrologic core and structural factors, ecosystem processes, and functions of a project wetland as possible. A prime goal is to maintain the values provided by the project wetland as well as achieve no-net-loss of wetland resources throughout a landscape. Hydrologic core and structural factors as well as ecosystem processes and functions of any two wetland communities differ to some degree. Along the continuum of wetland structure and function, the closer the specific structural characteristics and functions of one wetland to another, the closer one approaches in-kind wetland replacement.

There are circumstances, however, in which attempting hydrological, structural, and functional equivalency of the project wetland may not be ecologically sound. One example is replicating wetland communities impacted by toxic runoff (i.e., degraded wetlands). In other cases, human activities have so disturbed the hydrology that the wetland does not function as it did originally and associated values are disrupted or nonexistent (e.g., farmed wetlands).

As with any type of wetland ecosystem compensatory mitigation effort, it is important to assess ecosystem functions and values and document hydrologic core and structural factors of degraded and highly disturbed wetland communities, so a factual evaluation of replacement can proceed. In such cases, the ecologically correct approach may be to determine the "potential" wetland ecosystem properties (i.e., hydrologic core and structural factors, ecosystem processes, functions, and values) of the project wetland without the impact. The potential then serves as the targeted site-selection variables of the compensatory mitigation plan. In-kind replacement refers to the potential ecosystem properties of the project wetland community without the effects of the current impact(s).

For example, seepage from a pesticide manufacturer has impacted a 10-acre forested wetland for 10 years. An evaluation shows that a proposed roadway will affect 4.7 acres of the forested wetland community. Analysis of soil, water, vegetation, and wildlife (invertebrates and vertebrates) indicates that the site is contaminated from leaching of the pesticide. Both a recovery plan to restore the wetland system and a compensatory mitigation plan for the loss due to the roadway are developed. Compensatory mitigation for the 4.7-acre road impact area is based on the potential ecosystem properties of the project wetland had it been unaffected by pesticide runoff. The mitigation plan required siting the replacement site adjacent to the newly rehabilitated forested wetland ecosystem. In this example, the emphasis is on the roadway impact. Ideally, the development of compensatory mitigation efforts and remedial actions due to contaminant issues (e.g., Superfund sites) should be coordinated to avoid cross-purpose goals that may inhibit completion of either action.

Continuing with the example above, it is important to use baseline data from the project wetland, such as the geomorphic setting, hydroperiod, nutrient supply, and adjacent land uses/covers to determine wetland community potential. Reviewing aerial photography taken prior to and during operation of the pesticide plant may identify some of the potential hydrologic core and structural factors. Compiling an information base with current and historical data provides the framework for designing the compensatory mitigation plan for the 4.7-acre wetland community loss. There may be enough information to easily determine whether in-kind replacement is feasible; if not, one must use best professional judgement to evaluate all the available information to proceed. "Out-of-kind" replacement may be the only feasible approach in the long term, or an initial out-of-kind replacement with the goal of eventual in-kind replacement may also be an option.

It is very difficult to replace wetland losses in-kind. In situations where the wetland community is dominated by seemingly "simple" and easily replicated hydrologic core and structural factors (e.g., regularly-flooded *Spartina alterniflora* marsh), evidence of in-kind replacement may not initially be apparent. Even in instances of the complete establishment of vegetative cover for such "simple" communities, some structural components may not have been developed or were not considered. The nutrient supply may be different so that nutrient cycling and primary and secondary productivity pathways are significantly different from either the project or reference wetlands. To attempt ecological replacement of lost wetland ecosystems, document the baseline data for either the project wetland or the reference wetlands is critical. If in-kind replacement is not ecologically or physically practical, the reasons must be documented. Until a concerted effort is made to achieve ecological integrity and document the mitigation process, mitigation efforts will be ineffective. Adherence to the best scientific information and careful documentation of efforts to replace wetland ecosystems should be the guiding principles. Measures of "success" are only valid in this context.

4B. OUT-OF-KIND REPLACEMENT

Out-of-kind compensatory mitigation refers to the replacement of the project wetland with one which is not hydrologically, structurally, and functionally equivalent or which is not so initially (particularly in cases involving wetland creation). Out-of-kind mitigation may also utilize another habitat type (e.g., non-wetland) which may not provide comparable wetland

In-Kind vs Out-of-Kind Replacement

In-kind replacement refers to the use of a hydrologically, structurally, and functionally equivalent wetland community as a substitute for the impacted project wetland. To achieve this equivalency, the replacement community should duplicate as many of the specific hydrologic, core and structural factors, ecosystem processes, and functions of the project wetland as possible. Such an effort maximizes the chance of transferring the values and functions of the project wetland to the replacement site while also achieving the no-net-loss goal.

In most cases, in-kind replacement is preferred over the alternative—out-of-kind replacement—since it attempts to closely simulate the original site. Out-of-kind replacement is the creation, restoration, or enhancement of a project wetland with a wetland that is not structurally and functionally equivalent (or is not so initially) or with another habitat type which may not provide wetland structural and functional equivalency. Certain circumstances, however, dictate the use of out-of-kind replacement as an alternative, particularly when the project wetland is so degraded that the wetland is non-functional and provides little or no value to society.

ecosystem properties. Generally, out-of-kind compensatory mitigation includes: the establishment of different wetland vegetation communities; the establishment of a different hydrologic regime; use of a substrate deficient in organic matter; location of the compensatory mitigation site in a topographic location different from that of the altered wetland; or application of practices which affect other landscape features, such as the stabilization of eroding stream banks or the enhancement of an upland woodlot for deer management. Out-of-kind compensatory mitigation involving non-wetland ecosystems is considered inappropriate. The achievement of the no-net-loss goal of Chesapeake Bay wetland acreage, functions, and values is not possible using this type of compensatory mitigation.

Hydrologic and geomorphic site selection variables are key factors in evaluating in-kind or out-of-kind options. Early evaluation of these variables will, in large measure, control the replacement wetland community in terms of vegetation structure, processes, functions, and values.

If the hydrological core factors differ significantly from those at the project wetland, many other site selection variables, including vegetation community dynamics, biogeochemical dynamics, and the values and functions provided by the project wetland, will be affected. For example, wetland communities located within a riparian corridor are affected by stream hydraulics (e.g., overbank flow rates and duration, sediment deposition, and scouring), whereas other wetland communities are more affected by groundwater, direct precipitation, and surface runoff. The hydrologic core factors of the two communities are different. As result, these contaminants exhibit different ecosystem properties. Riparian wetland communities are generally more free-flowing systems in the exchange of materials, energy, and biota than nonriparian wetland communities. The two wetland systems result from different geomorphic settings. The replacement of a riparian wetland community with a wetland situated in a dissimilar hydrogeomorphic location results in out-of-kind compensatory mitigation.

In other scenarios, the vegetation structure may not adequately reflect ecosystem processes (e.g., when the hydroperiod has been altered but vegetation has not significantly changed). Ecosystem processes, such as biogeochemical cycles, may have also changed because of the relationship between the hydroperiod and these processes. For example, Whigham (1992) found only minor differences between upstream and downstream wetland vegetation communities in relation to growth patterns, composition, and biomass (i.e., litter production). Due to road construction across the wetland communities, however, the hydroperiod differed greatly between the two sites and caused significant differences in soil and leaf litter nitrogen levels and decomposition rates. Such differences in ecosystem processes may result in functional differences, such as nutrient cycling, which may affect downstream water quality or the trophic structure of the adjacent aquatic community.

4C. OUT-OF-KIND REPLACEMENT EXAMPLES

In many instances, an applicant or agency representative proposes the replacement of one vegetated wetland community type with another. If the goal of compensatory mitigation efforts is to strive for hydrological, structural, and functional equivalency, however, this cannot be achieved by trading vegetated wetland types. Where management considerations dictate other courses, such actions should be carefully considered from a landscape perspective to retain the overall goal of no-net-loss.

Circumstances which routinely involve replacing one vegetation community with another include:

1) Exotic or invasive species dominate one or more vegetation strata in the wetland community;
2) Hydrophytic vegetation is virtually absent due to disturbance (e.g., farmed wetlands, cleared or other disturbed sites where all or most of the wetland vegetation has been eliminated); or
3) Forested wetland community losses are to be replaced.

The following examples illustrate out-of-kind compensatory mitigation involving an invasive hydrophytic plant species, farmed wetlands, and replacement of forested wetlands.

4C1. *Phragmites australis* Wetland Replacement
Replacement of a regularly flooded intertidal wetland vegetated with common reed (*Phragmites australis*) is required. A native plant community is proposed rather than reestablishing *Phragmites* (a typically invasive species which often results in monotypic stands). If the *Phragmites* wetland is located in a salinity regime compatible with the establishment of saltmarsh cordgrass (*Spartina alterniflora*), this out-of-kind change is acceptable since the intertidal cordgrass replacement community is a herbaceous wetland, the hydrologic regime is the same, and the substrate may be similar. These factors reflect structure which in turn reflects wetland function and ultimately, wetland values.

4C2. Farmed Wetland Replacement
Replacing farmed wetlands[4] as a result of unavoidable losses will generally involve out-of-kind replacement, particularly if the wetland site is actively farmed (i.e., it only lies fallow during rotational cycles or during very wet years). Compensating for farmed wetland losses should not involve only the creation of predominantly open-water habitats (e.g., wildlife/waterfowl ponds, stormwater management ponds, etc.) or the enhancement of existing wetlands for such purposes. The most acceptable action is to reestablish, as closely as possible, the original hydrology of a hydric soil in a cropland field and then allow reestablishment of the natural hydrophytic vegetation. Agricultural wetlands which are not actively cropped and are vegetated by hydrophytes are, by definition, "natural" (i.e., vegetated) wetlands and must be replaced accordingly.

4C3. Forested Wetland Repalcement
A considerable time span is required to replace forested wetland communities. Appropriate choices of vegetation and hydrology and the use of existing soils from the project wetland site (where practical) are critical elements. Even with the establishment of the appropriate type and composition of vegetation, the newly planted vegetative community will rarely resemble the project wetland community in terms of age, community structure, vigor, and growth potential over the short term. Such wetland replacement is considered out-of-kind because the vegetative structure does not reflect the project wetland and wetland ecosystem processes, functions, and values will often differ between the two wetlands. Baseline data for the project wetland or a population of reference wetlands provide the information required for compensatory mitigation plan design and the implementation of appropriate management needed at the site. While out-of-kind compensatory mitigation cannot be avoided for forested wetland replacement, comprehensive site planning, diligent implementation of the plan, and long-term management and monitoring of the site can guide the initial out-of-kind scenario towards in-kind replacement.

4D. ACHIEVING IN-KIND REPLACEMENT

Many creation projects fall under the out-of-kind compensatory mitigation category. Wetlands are often created on upland sites where hydrologic core and structural factors are not initially present. To achieve in-kind replacement, these factors from the project wetland must be incorporated into the design of the compensatory mitigation plan. Where feasible, appropriate structural factors within the project wetland (e.g., the soil and seed bank of the project wetland) should be transplanted to the replacement site. The remaining structural factors and hydrologic core factors of the project wetland can then be mimicked to achieve in-kind replacement.

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[4] "Farmed wetlands" are defined by the U. S. Soil Conservation Service as wetlands that are seasonally flooded or ponded (i.e., surface water is present for at least 15 consecutive days or 10% of the growing season, whichever is less under average conditions) and have been manipulated for commodity crop production prior to December 23, 1985, but otherwise meet wetland criteria.

Unfortunately, no means exists to easily measure at what point in-kind replacement is achieved. Furthermore, because of the inherent variability of wetland systems, in-kind replacement is a process with different variables contributing at different stages. The use of reference wetlands significantly improves the understanding of the in-kind replacement process and provide temporal bench marks to evaluate the progress of the replacement site. To achieve the no-net-loss goal for Chesapeake Bay wetland systems, efforts to replace wetland hydrology, structure, and function must become the norm rather than the exception.

On-site vs Off-site Location

On-site location of a replacement wetland community uses an area adjacent to the project wetland which is more likely to duplicate the functions and values of the impacted wetland. In most situations, a site closer to the project wetland is more likely to have similar hydrologic core and structural factors than one that is further removed and enhance the possibility of achieving in-kind replacement. On-site locations also help fulfill the no-net-loss goal and minimize disruption of landscape-scale processes within the watershed.

On-site location is generally preferred over off-site location. It is more important, however, to achieve in-kind replacement of the project wetland; in some cases, off-site locations are better suited to accomplish this goal. In these situations, the replacement site is not adjacent to the project wetland. Off-site locations may be chosen because on-site locations may not be available, project wetland equivalency is more likely at an off-site location, or the off-site location (where equivalency is likely) benefits adjacent protected lands. Each case is unique and the particular circumstances affecting a given site should be well understood before choosing an on-site or off-site location for wetland replacement.

Variable 5: Identification of on-site and off-site locations

Typically, the issue of replacing a wetland community either "on-site" or "off-site" has been interpreted from a regulatory perspective. Ecological reasons, however, underlie the regulatory interpretation. Ecological replacement on-site or off-site is an extension of hydrologic, structural, and functional equivalency. Theoretically, the closer the distance of the replacement site to the project wetland, the more likely the replacement wetland will have many of the same hydrologic core and structural factors. The characteristics of the replacement site, including local land use and the type of compensatory mitigation, also influence whether an on-site location will enhance in-kind replacement. In some circumstances, an off-site location may provide a more appropriate environment to achieve in-kind replacement. Hydrogeomorphic factors are key elements in evaluating a site for wetland community replacement.

5A. ON-SITE LOCATION

The following general guidance is intended to clarify the relationship between on-site and off-site locations relative to in-kind and out-of-kind replacements. To achieve no net loss, locating the replacement wetland on-site is generally preferred. On-site locations are areas adjacent to the project wetland which will likely replace the ecological functions and societal values of the project wetland. Landscape-level processes throughout the watershed are then minimally disrupted, particularly in cases where on-site selection is closely allied to in-kind replacement.

5B. OFF-SITE LOCATION

A wetland community replaced off-site is located in an area not adjacent to the project wetland. Selection of an off-site location generally compounds the difficulty of replacing in-kind. An off-site location may result in out-of-kind replacement when the replacement site is in the same watershed but in a different hydrogeomorphic setting, (e.g., locating the replacement wetland in a headwater, first-order stream to replace a project wetland located downstream in a third-order reach). Sites not adjacent to the project wetland may be more conducive to achieving in-kind replacement than an on-site location.

In addition to site variables, the type of compensatory mitigation may further strengthen selection of an off-site location. The following considerations should assist in determining when selection of an off-site location is ecologically appropriate:

(1) a thorough investigation shows on-site locations are not available (note: selection of an off-site location should still emphasize hydrological, structural, and functional equivalency); or

(2) the achievement of hydrological, structural, and functional equivalency of the project wetland would be more successful at the off-site location (i.e., site conditions are more

conducive to achieving in-kind replacement than at an on-site location); or

(3) hydrological, structural, and functional equivalency are met at the off-site location and the compensatory mitigation site would benefit natural resources on adjacent protected lands (e.g., a NOAA-designated estuarine reserve, a site adjacent to Nature Conservancy land, etc.).

5C. CONSOLIDATED COMPENSATORY MITIGATION

In specific circumstances, such as the scale of a project, on-site and off-site replacement site constraints, or other limiting factors, the selection of an off-site location may be through the use of "consolidated compensatory mitigation" (e.g., joint mitigation projects, combined wetland replacement, aggregated wetlands replacement, mitigation banking, or watershed/ regional-level compensatory mitigation). Consolidated compensatory mitigation is the replacement of multiple wetlands losses resulting from several specific activities at one off-site location. Typically, consolidated compensatory mitigation locations are geographically defined within a watershed, hydrologic unit, or physiographic province, to replace the functions and values lost in the defined area as a result of these activities.

Possible sites for consolidated compensatory mitigation should be hydrogeomorphically defined and incorporate as many of the project wetland site selection variables as possible. A matrix comparing the site selection variables for the project wetland and those present at the consolidated replacement site will indicate whether in-kind or out-of-kind replacement is feasible. When out-of-kind replacement appears inevitable for the long term, the matrix can be used to help design ecologically significant wetland ecosystem replacement. If the consolidated compensatory mitigation site is selected for replacing wetland losses due to multiple projects, this matrix should be evaluated for each project wetland.

Several consolidated compensatory mitigation sites within a landscape subunit (e.g., subwatershed) may be needed to maintain the spatial and functional heterogeneity throughout the landscape reflected by existing wetland ecosystems. This approach requires an evaluation of trends in land practices (e.g., increasing infrastructure and subsequent development in a subwatershed) and an assessment of the site variables for those wetland ecosystems likely to be affected by potential land practices within the subwatershed. The identification of suitable consolidated compensatory sites throughout the subwatershed is also necessary.

Developing a common suite of baseline characteristics at a consolidated compensatory mitigation site to reflect the multiple functions and values provided by several wetland communities is very difficult. If selected consolidated compensatory mitigation sites exhibit only one or a few of the functions and values of the project wetlands, then quantitative measures of wetland ecosystems will be critical for "managing" the Chesapeake Bay watershed to ensure that a minimal range of wetland ecosystem functions and values continues to exist throughout the landscape.

5D. SELECTION OF ON-SITE OR OFF-SITE LOCATIONS

Determination of an on-site or off-site location is not separate from in-kind replacement considerations or from the selection of the appropriate type of compensatory mitigation. Again, evaluating the "right" mix of site selection variables should complement the dynamic processes affecting wetland ecosystems. The key to selecting this mix is to strive for ecological integrity at the wetland community and ecosystems levels and within a landscape context.

Variable 6: Identification of compensatory mitigation timing

Kruczynski (1989b) identified three time periods associated with compensatory mitigation implementation:

(1) Prior to permit issuance ("up front" compensatory mitigation);

(2) Simultaneous with carrying out the project ("concurrent" compensatory mitigation); and,

(3) After project completion ("post project" compensatory mitigation).

6A. UPFRONT COMPENSATORY MITIGATION

Implementing compensatory mitigation up front is most applicable when the impacts associated with the project are significant, the project wetland community is complex, or the ability to replace that community is uncertain or unproven.

6B. CONCURRENT COMPENSATORY MITIGATION

Concurrent compensatory mitigation is acceptable when up front compensatory mitigation is not feasible or applicable. Since the timing schedule of a compensatory mitigation may pose problems, particularly meeting optimal planting dates, some flexibility in permit conditions may be acceptable. For example, the Corps of Engineers or an appropriate state regulatory agency can impose conditions on a permit so that earthmoving associated with wetland community creation can occur simultaneously with any appropriate phase of project construction. Planting can be delayed until weather conditions ensure maximum vegetation survival.

6C. POST-PROJECT COMPENSATORY MITIGATION

Post-project compensatory mitigation is not generally recommended since it is very difficult to ensure permit compliance, ecological goals, and no net wetland loss. If this type of compensatory mitigation is the only option, the permit should include initiation and completion dates, posting of a performance bond, and any other necessary conditions. If the applicant does not comply with the critical date, the Corps or appropriate state agency should initiate appropriate enforcement actions. Post-project compensatory mitigation has historically failed to prove that it can achieve no-net-loss goals.

Variable 7: Identification of lands amenable to compensatory mitigation efforts

Land suitable for compensatory mitigation is relatively scarce and often competed for by other land use interests (e.g., residential development, stormwater management, waterfowl ponds, etc.). Locating compensatory mitigation projects on land with topographic and/or other physical conditions characteristic of wetland systems will enhance the success of replacing the wetland ecosystem hydrology, structure, and function. In addition, the relevance of locating the replacement wetland on-site or off-site compared to in-kind or out-of-kind replacement must be considered. The decision to select a site for compensatory mitigation must incorporate these factors if the no-net-loss goal is to be achieved. The following discussion provides general information on the kinds of lands that may be appropriate compensatory mitigation sites under the conditions discussed.

7A. PRIOR-CONVERTED CROPLANDS

Prior-converted croplands are common throughout the lower Coastal Plain of Maryland and Virginia. Two types of these croplands are generally recognized. Some still function as wetlands (i.e., the land has not been "effectively drained"). Conversely, other prior-converted croplands have been effectively drained and no longer provide wetland functions and values. It is often difficult to determine whether a prior-converted wetland is effectively drained without extensive hydrologic studies. Both types of cropland, however, occupy topographic positions which increase the likelihood of successful compensatory mitigation. Use of prior-converted croplands for compensatory mitigation is, therefore, encouraged. Restoration carried out on prior-converted croplands has a high probability of success.

7B. FORMER DREDGED MATERIAL DISPOSAL SITES

Former dredged material disposal sites which are not wetlands and are no longer used or planned for use as disposal sites are also good candidates as compensatory mitigation lands. The amount of fill to be removed, location of another disposal site, and the potential for contaminated sediments are factors that must be thoroughly evaluated before selecting dredged material disposal sites as compensatory mitigation lands. In addition, some filled former wetlands on federal and state lands no longer serve the purpose for which they were filled and should be identified as potential compensatory mitigation sites. Former wetlands which were unnecessarily altered (i.e., channelized streams and concrete channels constructed for flood control) are also potential sites for compensatory mitigation. Many of these former wetland communities exist on small streams in urban settings and could be restored as greenways. Along with vegetated buffers, these greenways provide stormwater management benefits.

7C. ENHANCING *PHRAGMITES*-DOMINATED WETLANDS

Enhancement of existing wetland communities is possible on several types of lands. Common reed (*Phragmites australis*) wetland communities are commonplace in the Chesapeake Bay landscape; replacing this invasive hydrophyte with a vegetation community which existed previously (e.g., *Spartina alterniflora*) is possible. Intensive site manipulation and long-term management of the site, and surrounding area, however, may be necessary to ensure dominance of the newly established wetland plant community. These management measures must be included in the compensatory mitigation plan if common reed wetland communities are selected as replacement sites.

7D. DEGRADED WETLAND COMMUNITIES

"Degraded" wetland communities are often cited as prime candidates for compensatory mitigation activities. Such sites are often altered by toxic substances or other pollutants (e.g., water quality deterioration resulting from increased mercury or other heavy metal loadings and subsequent burial within the wetland) and no longer function adequately to provide values to society. The degradation process is usually the result of land use changes within the watershed rather than a single causative factor. Degraded wetland communities can often be enhanced, although compensatory mitigation efforts may be more successful if the proximate causes of degradation are identified and remediated.

Variable 8: Identification of lands not amenable to compensatory mitigation

Lands not suitable for compensatory mitigation include rare or threatened habitats such as: old-growth forests; old fields; habitat used by federal or state-listed endangered, threatened, or rare species; or habitat used by unlisted species but demonstrating a documented population decline. Uncommon habitat in an ecologically important landscape should also be avoided (e.g., upland pine or holly stands scattered throughout an estuarine marsh which provide cover or optimal nesting sites). In addition, habitats which may be common but provide diverse structure and interactive ecosystem functions should not be selected as compensatory mitigation sites (e.g., second-growth forests contiguous to wetlands in an urban landscape which provide inter-system habitat diversity and allochthonous material for trophic structure support).

Existing or proposed stormwater management facilities are not generally successful as compensatory mitigation sites. For example, highway interchanges may serve as excellent stormwater facilities but do not provide optimal habitat, particularly for wildlife with home ranges exceeding the acreage within the interchanges. More appropriate sites to replace the lost wetlands should be investigated.

Glossary

Advanced Identification (ADID): The process by which wetlands or other waters of the U.S. are identified as either possible future disposal sites or are generally unsuitable for disposal. See Section 230.80 of the 404(b)(1) Guidelines for additional information concerning this process.

Chesapeake Bay Executive Council: Signatories to the Chesapeake Bay Agreement of 1987, composed of the governors of Maryland, Pennsylvania, and Virginia, the mayor of the District of Columbia, the administrator of the U.S. Environmental Protection Agency (for the federal government) and the Chair of the Chesapeake Bay Commission.

Community: Similar to an ecosystem (see below). The scale may be smaller and the boundaries determined individually or in combination using vegetation composition, hydroperiod, geomorphic setting, or other factors such as biotic assemblages.

Creation: A type of compensatory mitigation which involves the establishment of a wetland where one did not formerly exist. Creation generally takes place in upland environments.

Cumulative Impacts: Human activities which individually may have insignificant adverse effects but collectively result in significant impacts to wetland acreage and function; disturbance mechanisms causing adverse spatial or temporal effects to ecosystems.

Degraded wetland: A wetland which no longer provides any societal benefits due to the input of toxic materials or other pollutants that have caused significant impairment of the wetland ecosystem function and values.

Disturbed wetland: A wetland with physically altered structural factors and ecosystem processes which continues to provide benefits to society.

Effectively drained: Drainage manipulation activities which completely alter the hydrology of a site so that it no longer functions as a wetland.

Ecosystem: An area with similar functional, physical, chemical, and biological forces and interactions which are self-maintaining. (Adapted from Gosselink et al. 1990.) As used in this document, a grouping of wetland communities within a landscape.

Enhancement: A type of compensatory mitigation which involves any activity conducted in an existing wetland with the goal of manipulating one or more physical characteristics of the wetland to increase one or more of the wetland functions.

Exchange: A type of enhancement which results in the trading of one wetland type for another.

Farmed Wetland: Wetlands that are seasonally flooded or ponded (i.e., surface water is present for at least 15 consecutive days or 10% of the growing season, whichever ever is less under average conditions) and have been manipulated prior to December 23, 1985 to produce or with the intent of producing an agricultural commodity crop, but otherwise meet wetland criteria.

Federal Action: Any federally funded, permitted, licensed, or otherwise sponsored activity, regardless of project size or potential impact.

Individual Permit: Authorization by the U.S. Army Corps of Engineers for specific activities in "waters of the U.S." and "navigable waters." Individual permits may be issued for activities which involve significant individual or cumulative impacts to wetlands.

In-kind replacement: Compensatory mitigation activities which replace the hydrologic core and structural factors, ecosystem processes, functions, and values of a project wetland.

Landscape: A spatial mosaic of ecosystems which interact functionally and are typically measured in kilometers. Examples are watersheds, physiographic provinces or ecoregions (adapted from Gosselink et al. 1990).

Mitigation: The sequential process of avoiding, minimizing, and compensating for impacts to wetlands and other waters of the United States.

Mitigation Banking: A type of off-site compensatory mitigation which involves restoration or creation activities to compensate for future wetland losses and is established for certain types of activities, impacts, and wetland types.

Monitoring and Evaluation Program: A formalized plan which identifies the short and long-term efforts to oversee the construction, establishment, and functioning of a wetland mitigation site. The plan becomes part of an issued federal or state permit, agreement, or other legal document.

Nationwide Permit: A type of authorization regulated by the U.S. Army Corps of Engineers for work in "waters of the U.S." and "navigable waters" which does not result in significant individual or cumulative impacts.

No-net-loss Goal: Goal established in the Chesapeake Bay Wetlands Policy which is one temporal component of the policy to conserve wetland function and acreage in the short term (no net loss) and long term (net resource gain). With mitigation, no net loss is achieved first by avoiding impacts and secondly by minimizing impacts to wetlands. Implementing compensatory mitigation for all remaining unavoidable impacts must then take place.

Off-site Location: Locating the replicated wetland in an area which is not in close proximity to the altered wetland and which may result in a wetland that functions differently than the altered one.

On-site Location: Locating the replicated wetland in an area which is adjacent to the altered wetland where the ecological functions and societal values are more likely to be replicated.

Out-of-kind replacement: Creating, restoring, or enhancing a project wetland with a wetland which is not structurally and functionally equivalent (or is not so initially) or with another habitat type which may not provide wetland structural and functional equivalency.

Prior-converted cropland: Wetlands that were drained, dredged, filled, leveled, or otherwise manipulated (including removing woody vegetation) before December 23, 1985, for the purpose or to have the effect of producing an agricultural commodity crop. Prior-converted cropland includes wetlands which pond or flood for less than 15 consecutive days during the growing season and which have been manipulated for commodity crop production. In addition, the term includes wetlands which are only saturated by groundwater and were drained or otherwise manipulated prior to December 23, 1985, and 1) have been used to produce an agricultural commodity crop; 2) have not been abandoned; and 3) are not currently flooded or ponded for at least 15 consecutive days.

Project Wetland: A wetland which is proposed for alteration and to which the sequential mitigation process applies. Synonymous with "altered wetland."

Restoration: A type of compensatory mitigation which involves reestablishment of a wetland through hydrological modification in an area where the wetland previously existed.

Section 404: Section of the Clean Water Act which addresses the regulation of activities involving the disposal of dredged or fill material into a wetland or other "waters of the U.S."

Structural and Functional Equivalency: Wetland replacement activities which are intended to replicate as closely as possible the structural factors, ecosystem functions, and societal values of a wetland.

Unmitigable: Types of wetlands which cannot be replaced due to their intrinsic value to society. Defined by the U.S. Fish and Wildlife Service's Mitigation Policy as "unique and irreplaceable" habitat.

Wetland: Areas that are inundated or saturated by surface water or groundwater at a frequency or duration sufficient to support, and under normal circumstances do support, vegetation typically adapted for life in saturated soil (40 CFR Part 232, Federal Register 53(108): 26764-20787).

Wetland Parcel: A portion of a wetland community under evaluation for the mitigation process.

Wetland Ecosystem Functions: Groups of ecosystem processes performed by wetlands.

Wetland Ecosystem Processes: The biogeochemical interactions operating within wetland ecosystems which contribute to wetland ecosystem functions and, ultimately, the values provided by wetland systems.

Wetland Ecosystem Values: The benefits provided by wetland ecosystems which are advantageous to society. Wetland ecosystem values come from the mechanisms affecting wetland ecosystem processes and functions, such as hydrology, vegetation dynamics, and landscape setting.

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Appendix A

FEDERAL LEGISLATION OR RELATED PROGRAMS AFFECTING CHESAPEAKE BAY WETLANDS

A. Emergency Wetlands Resources Act of 1986

The Emergency Wetlands Resources Act was enacted by Congress in 1986 to:

> "... promote, in concert with other Federal and state statutes and programs the conservation of wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions with Canada, Mexico, Japan, the Union of Soviet Socialist Republics and with various countries in the Western Hemisphere by-
>
> (1) intensifying cooperative efforts among private interests and local, state and Federal governments for the management and conservation of wetlands; and
>
> (2) intensifying efforts to protect the wetlands of the Nation through acquisition in fee, easements or other interests and methods by local, state and Federal governments and the private sector."

Section 301 of the act requires the establishment of a National Wetlands Priority Conservation plan. This plan specifies regional wetland types and interests which should be given priority acquisition by federal and state agencies. In 1990, the U.S. Fish and Wildlife Service, Northeast Region published a "Regional Wetlands Concept Plan" (i.e., Regional Plan) to complement the National Plan. The Regional Plan identifies 850 privately-owned wetlands in 13 northeastern and mid-Atlantic states. Most of these sites meet the criteria for acquisition as outlined in the act. In addition, these sites may be proposed as "Wetlands Conservation Projects" for acquisition, easement, enhancement, or restoration pursuant to the North American Wetlands Conservation Act.

B. North American Waterfowl Management Plan and the Atlantic Coast Joint Venture

In May 1986, the U.S. and Canada signed the "North American Waterfowl Management Plan" which provides a framework for the conservation and management of waterfowl. It addresses actions both countries must undertake to reverse declining waterfowl populations. Chief among the principles of the plan is the protection, enhancement, and management of wetlands as important waterfowl habitat. Specifically, the thrust of this continental effort is to protect habitat for 62 million breeding ducks, over 100 million migratory birds. In addition, habitat protection is needed to support more than 6 million over-wintering geese. To achieve these goals, the plan recommends establishment of "joint ventures." Joint ventures are cooperative efforts between government and private organizations to both finance priority research and plan, fund, and implement management projects to benefit waterfowl.

The plan identified five geographic areas where the problem of habitat loss is in need of immediate attention to increase waterfowl populations. These areas are termed "priority areas." Priority areas are historically important waterfowl breeding and wintering habitats where significant habitat degradation has occurred. The mid and northern Atlantic Coast were jointly identified as one priority area. This priority area is historically significant as migration and wintering habitat for black ducks (Anas rubripes).

To address the black duck population decline in the Atlantic Coast priority areas the "Atlantic Coast Joint Venture Plan" (ACJV Plan) was developed. As stated in the ACJV (p.11) the goal of this cooperative government-private effort is to:

"Protect and manage priority wetland habitats for migration, wintering, and production of waterfowl with special consideration to black ducks, and to benefit other wildlife in the joint venture areas."

To meet the ACJV Plan goal, the following two objectives were developed:

1. To protect, manage, and enhance consistent with the goal, 879,128 acres... of wetland and upland buffer habitats within the joint venture area over the next 15 years.
2. To improve and enhance an additional 165,977 acres... of federal and state wetland habitats currently managed for waterfowl to maximize carrying capacity for waterfowl and other wildlife.

The ACJV Plan summarizes several strategies to achieve the above objectives, including:

> **"Review migratory legislation and enforcement: Evaluate existing wetland protection legislation and work with ongoing programs to strengthen or improve existing federal-state wetland protection efforts and to facilitate wetland management activities...."**
>
> **"Wetland restoration: Implement measures to restore natural vegetation and improve the health and productivity of wetland habitats that have deteriorated due to hiliman impact ...."**
>
> **"Watershed protection and management: Degradation of wetland health and productivity by municipal waster, agricultural runoff, sedimentation, and industrial contaminants needs to be eliminated by developing guidelines and providing input to watershed management plans."**
>
> **"Mitigation: Work with federal and state regulatory agencies to ensure mitigation policies and mitigation actions resulting from development projects enhance wetland management opportunities."**

The ACJV Plan identifies several wintering, migration and breeding areas important to black ducks as well as other waterfowl, shore and wading birds, raptors, anadromous fish, and other fish and wildlife species. These lands are termed "focus areas". Appendix E lists the ACJV Plan focus areas along with acreage and characterization as "protection"[1] or "enhancement"[2]

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[1] Protection measures refer to acquisition, easement, agreements, leases or donations.

[2] *Enhancement activities, such as open water marsh management, noxious weed control, and* impoundment improvement are intended to improve an area's capacility to support waterfowl and other fish and wildlife.

C. North American Wetlands Conservation Act

The North American Wetlands Conservation Act was enacted to:

> " ... conserve North America's wetland ecosystems and waterfowl and the other migratory birds and fish and wildlife that depend upon such habitats."

The Act recognizes the importance of wetlands in the "maintenance of healthy populations of migratory birds "throughout North America. As such, its purposes are:

(1) " ... to protect, enhance, restore, and manage appropriate distribution and diversity of wetland ecosystems and other habitats for migratory birds and other fish and wildlife in North America;

(2) to maintain current or improved distributions of migratory bird populations; and

(3) to sustain an abundance of waterfowl and other migratory birds consistent with the goals of the North American Waterfowl Management Plan and the international obligations contained in the migratory bird treaties and conventions and other agreements with Canada, Mexico, and other countries."

A key feature of this legislation is to recommend "Wetlands Conservation Projects." The projects must meet the purposes of the Act, the North American Waterfowl Management Plan, or the Tripartite Agreement of 1988 between the U.S., Canada, and Mexico, for funding purposes. Wetlands Conservation Projects can take the form of acquisition, easement, management, restoration, or enhancement of wetlands, and must be conducted for the "long-term conservation of wetlands and fish and wildlife." "Long-term conservation" is interpreted to mean[3] projects which reserve habitat in perpetuity. The establishment of easements to conserve wetlands for 25 years of more is also viewed as a long term conservation project, although less desirable than perpetual easements. Short-term easements (i.e., less than 25 years) may be appropriate when the landowner is likely to agree to a longer term conservation agreement when the short-term agreement expires.

Wetland Conservation Projects which involve enhancement are defined as those which result in "the modification of a wetland ecosystem to improve its value for migratory birds and other fish and wildlife." Wetland Conservation Projects involving restoration are those which rehabilitate "a naturally occurring but degraded wetland ecosystem."

Implementation of federally-funded conservation projects is not intended to imply blanket approval of such projects pursuant to Section 404 authorization, or any other federal or state wetland laws, regulations, or requirements.[4] In addition, the act is not intended to support the alteration of existing viable wetlands to achieve single-purpose benefits at the expense of the variety of benefits provided by existing functioning wetlands. This it particularly relevant with respect to

[3] Information contained in the Senate Committee on Environment and Public Works report 1101-161, October 15, 1989, on the North American Wetlands Conservation Act.

[4] Ibid.

waterfowl production.[5] Conversely, degraded habitats are considered prime candidates for restoration (e.g., former disposal sites vegetated with *Phragmites communis.*

D. The Food Security Act of 1985 and the Food, Agriculture, Conservation, and Trade Act of 1990

The Food Security Act (1985 Farm Bill) dramatically changed the public approach to wetland conservation. For the first time, receipt of most federal farm program benefits - including commodity price supports, agricultural credit, and crop insurance - became contingent on the application of land stewardship practices by agricultural producers, including the protection of wetlands. Partially in response to the 1985 Farm Bill, the protection, restoration and management of wetlands has become an important USDA priority.

The main provisions of the Conservation Title of the 1985 Farm Bill were: the Conservation Reserve Program, Swampbuster, Sodbuster, and Conservation Compliance. The 1990 Farm Bill added the Wetland Reserve Program to these previously authorized provisions.

Swampbuster Provisions:

Basically, swampbuster includes provisions designed to discourage the draining of wetlands for agriculture. Under the 1985 Farm Bill, a wetland could be converted only if an agricultural commodity crop was not planted. In addition, the penalty for a violation was complete denial of all federal farm program benefits regardless of the size of the violation.

The 1990 Farm Bill strengthened Swampbuster by stipulating that violations include the act of draining or manipulating a wetland to make planting an agricultural commodity crop possible. The 1990 Farm Bill also instituted a system of graduated fines that ranged from $750 to $10,000, depending on the severity of the violation.

Wetland Reserve Program Provisions of the 1990 Farm Bill:

The 1990 Farm Bill contains provisions which require the U.S. Department of Agriculture "to implement a voluntary wetland easement program to assist owners of reliable lands in restoring and protecting wetlands." Lands eligible for enrollment in the Wetland Reserve Program include the following:

> **"Farmed and converted wetlands, excluding those that were not commenced prior to December 23, 1985, where the wetland value and the likelihood of successful restoration merit inclusion, taking costs into consideration."**
>
> **"Functionally dependent adjacent lands (to be kept to a minimum)."**
>
> **"Other associated wetlands, if they would significantly add to the value of an easement (to be kept to a minimum)."**
>
> **"Riparian corridors that link protected wetlands."**
>
> **"Farmed and prior-converted wetlands which are presently enrolled in the Conservation Reserve Program."**

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[5] Ibid.

Landowners willing to enroll lands under a permanent easement which protect and enhance migratory bird and other wildlife habitat are given priority over those whose lands which may be enrolled at the minimum 30-year time period for this program.

Landowners are required to record the easements on the land deed, implement the wetland restoration and protection plan, provide an access route for easement management, and preclude activities on adjacent lands that decrease wetland benefits.

Easement plans will include details regarding restoration management and other applicable measures, identify permitted uses (e.g., periodic haying, grazing, or fishing) and the conditions of such uses, and other relevant information to provide for the restoration and maintenance of wetland functions and values.

Appendix B

APPLICABILITY OF SELECTED FEDERAL WETLANDS LEGISLATION AND PROGRAMS TO THE MITIGATION TECHNICAL GUIDANCE FOR CHESAPEAKE BAY DOCUMENT

The goals of the Chesapeake Bay Wetlands Policy are supported by the requirements of the Emergency Wetlands Resources Act, the North American Waterfowl Management Plan and Atlantic Coast Joint Venture, North American Wetlands Conservation Act, and the Wetlands Reserve Provisions of the 1990 Farm Bill.

In the wetlands regulatory arena, applications may be submitted for work in wetlands listed in the Regional Wetlands Concept Plan. These plans provide wetland values information used to determine if the site has received special recognition by a federal or state agency.

The values information for the Regional Wetlands Concept Plan sites should supplement information gathered from other sources. It should not substitute for site reconnaissance or quantitative function or values information.

Many of these sites are viewed by various federal and state natural resource agencies as viably functioning wetlands which provide important public benefits. As such, efforts to avoid impacts which would result in diminution of public benefits should be exhausted.

Where the sites comprise significant or critical portions of a watershed (e.g., Patuxent River marshes, Chickahominy River swamp), landscape-level planning efforts are necessary to ensure that neither physical or functional fragmentation of the wetland system will occur as a result of numerous disjunct human activities.

Many prior converted wetlands[1] on the Delmarva peninsula are prime candidates for restoration activities. Where the hydrology has been altered so that the area is "effectively drained"[2], restoration activities can reestablish wetland hydrology, vegetation, and at least periodically, reduced soil conditions. Many of the areas could be managed for waterfowl, wading birds, shorebirds, and other wildlife with little manipulation of existing site conditions (e.g., removal of tile drainage structures, plugging existing drainage ditches). Additionally, where conditions are feasible, terrestrial habitat restoration is encouraged, particularly where such restoration results in a naturally vegetated buffer adjacent to the wetland site. When possible, acquisition of these lands by conservation organizations, land trusts, educational institutions, or other nongovernment organizations is encouraged to protect them in perpetuity. When acquisition is not feasible,

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[1] "Prior-converted croplands" are defined in the Food Security Act Manual as "...wetlands that were drained, dredged, filled, leveled or otherwise manipulated before December 23, 1985 for the purpose, or to have the effect of, making the production of an agricultural commodity possible. This applies if (i) such production was not possible before the action, (ii) an agricultural commodity has been produced (planted) at least once, and (iii) the area has not been abandoned.

[2] Regulatory Guidance Letter No. 90-7, September 26, 1990.

easements, agreement, or leases between government agencies or conservation organizations (e.g., Ducks Unlimited, The Nature Conservancy, local land trusts) and the landowners should be sought.

Restoration of prior-converted croplands would help meet one of the objectives of the Atlantic Coast Joint Venture Plan:

> **To protect, manage, and enhance, consistent with the goal, 879,138 acres... of wetland and upland buffer habitats within the joint venture area over the next 15 years.**

Both the North American Waterfowl Management Plan and the Atlantic Coast Joint Venture Plan recognize that project implementations must consider other wildlife and wetland values. As such, the following guidelines, in addition to those listed above, should be followed in the design of restoration and enhancement plans on prior-converted wetlands:

- The basic ecological principals and guidance provided in this handbook should be followed.
- Federal and state natural resource agencies and conservation organizations are encouraged to develop a "Prior-converted Wetland Restoration Plan." The plan should complement the Atlantic Coast Joint Venture focus area plans and satisfy the purpose of the North American Wetlands Conservation Act (i.e., restoration activities should not solely address waterfowl). The plan should also identify lands with willing sellers and lands that could be managed cooperatively via easements, agreement, or leases. Prior-converted wetlands adjacent to existing state or federal lands should also be identified. Where possible, the target lands should connect or lie adjacent to other wetlands which are protected.

Appendix C

TECHNICAL SUMMARY OF WETLAND ECOSYSTEM PROCESSES

Organic Matter Production

Organic matter production generally refers to the ability of plants, primarily macrophytes, and various algae to fix carbon during photosynthesis to produce an organic energy source usable by heterotrophs (Adamus and Stockwell 1983; Larcher 1983). In tidal wetland systems, phytoplankton also serve as an important organic energy source for heterotrophic organisms (Odum 1984). Nitrogen-fixing prokaryotes (cyanophytes and bacteria, such as the actinomycete *Frankia*) are able to fix atmospheric nitrogen (i.e., dinitrogen - N_2) which is incorporated into carbon compounds to form amino acids. The amino acids are synthesized to produce proteins, nucleic acids and other nitrogen compounds for plant growth and maintenance (Larcher 1983). In general, organic matter production in wetlands is dominated by vascular plants (Moran et al. 1988).

Organic matter production in wetlands (or other community types) is measured as "primary productivity" - the rate at which biomass is produced by plants per unit area . The total rate at which carbon is fixed via photosynthesis is "gross primary production" (GPP). Gross primary production minus community respiration equals "net primary productivity" (NPP) (Barbour et al. 1987). Estimates of net primary production are but one indicator of a wetland's viability, however and should not constitute the only variable to determine the inherent "value" of a wetland (Brinson et al. 1981). For example, an ombrotrophic peatland typically has a lower NPP than does a riparian wetland, but both systems contribute to the regional landscape productivity (Brinson et al. 1981). In addition, such peatlands, because of their extreme physical conditions, are typically inhabited by endangered, threatened, and rare species, particularly plants.

As discussed more fully below, organic matter production together with decomposition, energy flow, and nutrient cycling and transformation processes support complex and diverse food webs. The trophic levels dependent upon these wetland functions exist beyond the physical wetland boundary, involving a variety of downstream and adjacent aquatic and terrestrial fish and wildlife species.

Organic Matter Decomposition

Much of the fixed carbon in live plant material is unavailable as an energy source and requires further biological and chemical breakdown to become assimilated by other organisms. While herbivory (i.e., feeding upon live plant material by herbivores and omnivores) does constitute an important component of wetland food webs, decomposing plant tissue provides the substrate upon which the majority of wetland trophic structures exist.

Decomposing plant matter is known as "detritus." Detritus can take several forms: coarse particulate organic matter (CPOM), such as leaves and twigs which are >1 mm; fine particulate organic matter (FPOM), leaves and twigs which have been processed to particle sizes <1 mm; and dissolved organic matter (DOM), particles in solution which are <0.5 microns (Wharton et al. 1982). The particulate organic matter (POM) is first processed by microorganisms such as fungi, with further particle size reduction occurring by "shredders" such as amphipods.

The production of detritus is controlled by a variety of physical factors including temperature, oxygen, and water (Mitsch and Gosselink 1986). High temperatures enhance rates of decomposition. In addition, fluctuating water and oxygen levels, such as those occurring in regularly flooded tidal wetlands or nontidal wetlands with alternating wet/dry periods, provide optimum physical conditions for increased rates of decomposition in many wetland systems.

Biological factors also affect vegetation decomposition. The plant tissue nutrient composition and physical structure (e.g., high nitrogen content, low lignin content) are very important in determining the rate of decomposition as well as the types of microorganisms responsible for the initial decomposition process.

Energy Flow

Once organic carbon is produced and available via plants, various pathways exist to distribute the food energy. Depending upon the wetland type, detrital or grazing food chains may predominate (Odum 1971). Many wetlands have both detrital and grazing food chain linkages, resulting in complex trophic interactions.

Detrital pathways involve numerous trophic levels, and the transportation of organic materials. The concept of detrital food webs in wetlands begins with the colonization of decomposing plant material by microorganisms, such as protozoa, bacteria and fungi. These in turn are fed upon by meiobenthic detritivores (e.g., nematodes), which further process the material for consumption by macroinvertebrates, such as filter-feeders and deposit-feeders. Some organisms directly ingest the organic material (e.g., crayfish). Macroinvertebrates may also ingest meiobenthic detritivores. Detritivores include springtails, mites, isopods, annelids, and crayfish in forested wetlands (Wharton et al. 1982; Brinson et al. 1981); chironomids (larvae) and amphipods in tidal freshwater wetlands (Odum 1984); and isopods, turbellarians, gastrotrichs and ostracods in salt marshes (Mitsch and Gosselink 1986; Gosselink 1984). Vertebrate species within, adjacent, or downstream of a wetland feed upon detritivores, macrobenthics, and other vertebrate species. For example, crayfish which ingest detritus as well as other detritivores are fed upon by raccoons, wading birds, and humans.

In addition, diatoms and other algae may colonize the decomposing plant litter, enriching it as a food source for "scrapers" such as snails and other grazers. Wading and shore birds feed upon the grazers. The particulate matter ingested, processed and excreted also becomes FPOM, a source of energy for deposit feeders (Mitsch and Gosselink 1986; Wharton et al. 1982).

Dissolved organic matter (DOM), particularly dissolved organic carbon, can also be utilized by various organisms directly. Under appropriate conditions, DOM may form aggregates of FPOM through physical flocculation (Wharton et al. 1982; Cummins 1974). The FPOM is then filtered from suspension by filter-feeders (McArthur 1989) or ingested by deposit feeders as a component of the particulate detrital pathway.

Grazing food chains involve direct feeding upon live plant material by herbivores and omnivores, termed "herbivory" (Odum 1971). Herbivory may be an important pathway for converting fixed carbon in plants to energy for certain heterotrophs. Muskrat, Canada goose, beaver, deer, marsh rabbit, several passerine bird species, and insects ingest live wetland vegetation, including fruits, twigs, shoots, leaves, and tubers (Mitsch and Gosselink 1986; Wharton et al. 1982). Such herbivores also contribute to the detrital pathway via excrement deposited in the wetland and subsequent colonization of this excrement by decomposers.

Biogeochemical Cycling and Transformation

Studies of nutrient dynamics in wetlands are often intended to characterize the wetland as a nutrient "source," "sink," or "transformer" (Mitsch and Gosselink 1986). Nutrient studies may show that a wetland serves as a sink for any particular element if there is a net retention of that element (or a specific form of that element). If a wetland exports more of an element to downstream or adjacent systems than would be exported if the wetland were absent then the wetland is characterized as an exporter. If the amount imported and exported for any element (or its specific form) remains the same (but the chemical form is changed), the wetland is termed a transformer (Mitsch and Gosselink 1986). There is little agreement in the literature on whether wetlands are sources, sinks, or transformers of various nutrients. Wetlands do serve as sinks for certain inorganic nutrients, export organic materials to downstream and adjacent systems, or transform inorganic inputs to organic forms for export (Mitsch and Gosselink 1986).

At the soil-water interface of wetlands, a thin layer of oxidized soil exists. It is this layer which is important in wetland nutrient cycling and chemical transformations (Mitsch and Gosselink 1986). The lower anaerobic soil layers are characterized by reduced forms of nitrogen, sulfur, iron, and manganese. The oxidized ions of these elements occur at the soil surface. Phosphorus is not directly altered by spatial or temporal redox potential fluctuations, but is affected by those elements which do fluctuate (Mitsch and Gosselink 1986).

Nitrogen transformations involve the following processes: mineralization, nitrification, nitrate reduction, denitrification, fixation, and ammonia volatilization (Bowden 1986; Mitsch and Gosselink 1986; Brinson et al. 1981). Both biological and chemical activities are responsible for the cycling of nitrogen in wetlands via these transformation processes.

Sulfur is rarely limiting in wetland systems, but in reduced form (i.e., sulfides) can be highly toxic to both microbes and rooted emergents (Mitsch and Gosselink 1986). The familiar smell of rotten eggs in salt marshes is reduced hydrogen sulfide. In wetland soils with high ferrous iron (Fe^{++}) concentrations, the sulfur binds with the iron to form insoluble sulfides which can be less toxic than hydrogen sulfide. The black color characteristic of many wetland soils is due to the presence of ferrous sulfide (Mitsch and Gosselink 1986). Oxidation of sulfides to elemental sulfur and sulfates is accomplished by chemoautotrophic and photosynthetic microorganisms in wetland soil aerobic zones (Mitsch and Gosselink 1986).

Reduced forms of manganese (Mn^{++}) and iron (Fe^{++}) are characteristically present in wetland soils. These forms are soluble and therefore more obtainable by organisms (Mitsch and Gosselink 1986). The presence of Fe^{++} in wetland soils results in a bluish-green color characteristic of reduced soil conditions.

Phosphorus occurs in soluble and insoluble inorganic and organic forms in wetland soils (Mitsch and Gosselink 1986). The soluble inorganic forms, orthophosphates, are biologically available. The insoluble inorganic and organic forms and the soluble organic forms of phosphorus must undergo transformation processes before rendering them available for biological uptake (Mitsch and Gosselink 1986). Much of the literature for freshwater marshes, forested wetlands, and salt marshes suggests that phosphorus is retained within a wetland, with much of it found within the soil (Mitsch and Gosselink 1986), characterizing such wetlands as phosphorus "sinks." Odum et al. (1984), however, hypothesized that tidal freshwater systems transform inorganic oxidized forms of phosphorus via microbial activity to organic forms with a net export of the organic phosphorus to tidal waters for further biological processing and uptake. Decaying plant litter serves as a site for long-term or seasonal immobilization of phosphorus by microbes in both tidal (Odum et al. 1984) and nontidal wetland systems (Brinson 1977; Day 1982; Odum et al. 1982).

Appendix D

ATLANTIC COAST
JOINT VENTURE FOCUS AREAS

Pennsylvania
The Atlantic Coast Joint Venture encompasses the eastern one-third of Pennsylvania. Within this boundary are eight focus areas.

Southeastern Area
The Southeastern Area is in the Delaware River and Susquehanna River drainage systems. The lower part of the Susquehanna is just above the Chesapeake Bay. The Delaware River empties into the Delaware Bay. The lower part of the Delaware River in Pennsylvania is tidal freshwater and has accompanying marshes.

This area is a non-glaciated section of Pennsylvania. The major forest type is oak-hickory. The area has fertile soils (Alfisols, Ultisols, and Inceptisols) and much of it is underlain with limestone. The land-use regime in this area is cropland (60%), forest (25%), urban (10%), and idle and wetlands (5%). Beaver are scattered throughout this area in limited numbers, especially in the northern part and along the Susquehanna and Delaware Rivers.

Waterfowl use the Southeastern Area in all seasons - breeding, migrating, and wintering. Mallards, wood ducks, Canada geese, and black ducks are the principle breeding waterfowl, in that order. Limited numbers of other dabblers, especially teal, also nest here. Forty years ago, black ducks and wood ducks were the most common breeders; now it is mallards and Canada geese. During migrations, spring and fall, tens of thousands of waterfowl move through the Southeastern Area, many stopping. It is common to have 50,000-100,000 ducks and 100,000-150,000 Canada geese on the ground during migration. While black ducks and mallards are the most plentiful ducks migrating, most species of dabbling and diving ducks and mergansers are present, some in good numbers. Also, thousands of whistling swans stop during their travels. Some may stay as long as a month during spring migration. During the late fall migration and into winter, there often are as many and sometimes more, black ducks in the area as there are mallards. Depending upon icing conditions, tens of thousands of waterfowl, again chiefly mallards, black ducks, and Canada geese are present; often many divers (e.g., canvasbacks, goldeneyes) and mergansers are present.

Many other birds (waterbirds, shorebirds, rails, snipe, birds of prey, ruffed grouse, wild turkey, and songbirds) use this area throughout the year. Native species abound in the area: cottontail rabbits, squirrels, goundhogs, deer, and furbearers. Muskrats, ring-necked pheasants, and bob-white quail are present, but their abundance is limited by habitat factors.

Four focus areas have been identified of which the Susquehanna River is the top priority.

1. **Susquehanna River Lowlands (Lancaster, Dauplin, York, and Chester Counties)**

This focus area includes the Susquehanna River from Sunbury to the Maryland state line and adjacent and nearby lands, including the Octararo Reservoir and Muddy Run Reservoir. This whole complex will be referred to as the Susquehanna River Lowlands (SRL). There is a good waterfowl marsh on Department of Defense land at New Cumberland.

The SRL is an important staging, migrating, and wintering area for large numbers of waterfowl. A good number of ducks (i.e., mallards, wood ducks, and black ducks) and Canada geese also breed here and on adjacent lands. Thousands of Canada geese, ducks, and whistling swans rest and feed on the SRL and in nearby fields during spring and fall migrations. The SRL is heavily used by black ducks and canvasbacks. SRL is becoming an important area for migrating and wintering bald eagles and osprey. In 1988, a bald eagle nested on the lower reaches of the Susquehanna River. Herons and egrets nest on the river islands. Yellow-crowned night herons nest here, the only known site in the state. Other waterbirds and shorebirds migrate through here. Upland sandpipers used to nest and many still nest in nearby fields. Many small marshes and wetlands, bottomland hardwoods, idle land, agricultural land, islands, and old canal beds need to be secured in the SRL. A main threat is human development and degradation of this environment. Unwise use of the floodplain continues.

Several state management areas exist in this area and many opportunities exist to enhance the quality of these areas via water control structures, diking, and small impoundments. Being a major waterfowl migration, wintering (until freeze up), and breeding (some) area, a major management effort within the SRL can add to the numbers of waterfowl using it, especially black ducks. Proper management can also add to the well-being of waterfowl, especially by sending them back to the breeding grounds in good condition. Approximately 8,300 acres have been identified for protection and 2,500 acres for enhancement with this focus area.

2. **Middle Creek Wildlife Management Area Ontelaunee Reservoir Corridor (Lebanon, Lancaster, and Berks Counties)**

This area is comprised of fertile farmland, low-lying fields, and numerous wet areas. Current public lands - Middle Creek WMA (Pennsylvania Game Commission), Blue Marsh Lake (COE), and Ontelaunee Reservoir (Reading Water Co.) - currently have large numbers of ducks and Canada geese. During migration, numbers may peak at 30,000-50,000 geese and 10,000-15,000 ducks. Mallards, wood ducks, and black ducks are the common species, but reasonable numbers of other species also occur. These four species also nest in the area in good numbers. Many shorebirds, waterbirds, birds of prey (including osprey and eagles), and songbirds migrate through. Threatened bog turtle populations occur on Middle Creek. The area also contains good habitat for muskrats, bobwhite quail, and ring-necked pheasants, all of which are at low levels.

This land needs to be protected, not only for wildlife, but for water table maintenance and watershed flood control. It is continually under threat of development, degradation, and pollution. An additional minimum 2,000 acres needs to be protected. Approximately one-fourth of this amount should be enhanced.

3. **Marsh Creek (Chester County)**

The large marsh (perhaps the largest marsh in the Southeast Area), adjacent Marsh Creek State Park, and surrounding area are extremely important to waterfowl. Excessive encroachment, pollution, and habitat degradation by people threaten the rich environment of this area. Several thousand Canada geese and hundreds of ducks (many black ducks and mallards) use this area for migration and wintering (when ice-free). Many waterfowl also breed here.

A minimum of 1,500 acres needs to be protected via acquisition, lease, or cooperative agreement on marsh and adjacent upland and 300 acres enhanced.

4. **Bucks and Montgomery County Wetlands**

These two counties have a number of county parks with reservoirs that harbor tens of thousands of Canada geese and thousands of ducks (many black ducks and mallards) during migration and often through winter. A number of these waterfowl interact with New Jersey, Delaware, and Maryland. Many waterfowl breed here, especially wood ducks, and their habitat desperately needs protection. For example, in Bucks County, the 1987 Christmas Bird Count noted 35,000 geese. There are a number of small wetlands associated with these reservoirs and also scattered throughout the county and attractive adjacent uplands. These areas need protection from rapidly expanding human development, pollution, flood problems, water regime deficit, and habitat degradation. These areas are especially attractive to shorebirds and birds of prey. There is also limited nesting of Virginia and sora rails.

Approximately 1,500 acres need to be protected via acquisition, lease, or cooperative agreements. Enhancement activities could include impoundments, nest boxes, predator and people control, sharecropping, and information/education with local landowners. Much of this work would be done in cooperation with the counties, electric companies, and watershed groups.

Northeastern Area

The Northeastern Area is also in the Susquehanna and Delaware River drainage systems. This area is experiencing a booming local economy fueled by second home development, recreational/resort development (e.g. ski areas), and peat mining. Approximately 80-90% of this focus area is forested.

While wetlands are generally small in size in this area, they are numerous. A number of formerly productive waterfowl marshes have been converted to recreational ponds. This area is the best black duck breeding area in the state. In some locations, black ducks outnumber mallards. Overall, mallards outnumber black ducks in a 65:35 proportion. Wood ducks also are plentiful and breed in this area in numbers that are at least equal to those of mallards. A pilot breeding pair survey was conducted on sample plots in this area in 1988. The results suggested good numbers of breeding pairs of wood ducks, mallards, and black ducks. Green-winged teal and hooded mergansers breed in limited numbers. Local breeding Canada geese populations also are increasing. Due to a successful hacking program, ospreys now breed in this area. American bittern (state-threatened species), Virginia rail, great blue heron, and green-backed heron are some of the water birds that breed in the area. These water birds, plus other shorebirds, ospreys, eagles, and hawks migrate through the area. Otter, beaver, and black bear are frequent.

5. **Tobyhanna-Gouldsboro Project (Wayne, Monroe, and Lackawanna Counties)**

   This high-priority focus area is divided into two tracts - the northern tract (primarily Silkman's Swamp) is all private land. The southern tract is 3/4 private land with the remainder included in Tobyhanna State Park and Tobyhanna Army Depot (just south of the State Park). State Game Lands #127 (Game Commission owned) adjoins the State Park on the southwest edge of the park.

   The habitat is mostly forested with non-wooded marshes, timbered wetlands, beaver dams, and streams. This area is most valuable for waterfowl breeding, especially for black ducks and wood ducks. Mallards, green-winged teal, and hooded mergansers also breed here. Preservation and enhancement of this habitat will also benefit waterbirds, rails, and snipe. Other important wildlife in the area include otter, bear, muskrat, beaver, osprey, other birds of prey (especially red-shouldered hawks), and songbirds associated with wetlands. Approximately 26,666 acres have been identified for protection primarily via acquisition, easement, and cooperative agreements. Enhancement measures are needed on 5,200 acres of private, state park, and Army Depot lands.

6. **State Game Lands #13, 57, and 66 (Wyoming, Sullivan, and Luzerne Counties)**

   The habitat in this focus area is approximately 75% forested; the remainder are open lands (farmland, reverting land) and marshes. Beaver dams occur in forested and non-forested areas. The land is about equally divided among private ownership and public (State Game Lands).

   This focus area has more value for breeding than for migrating waterfowl. The area (totaling 94,000 acres of State Game Lands) is an important core for breeding black ducks and wood ducks. Acquisition of adjacent wetlands and enhancement of State Game Lands wetlands could make this a much more significant area for waterfowl. Protection and enhancement of this whole area could contribute significantly to populations of otter, muskrats, rails, bittern, other waterbirds and waterfowl, red-shouldered hawks, osprey, bald eagles, and other wildlife associated with quality wetlands. An additional 3,000 acres are identified for protection, primarily via acquisition, and 15,000 acres are in need of enhancement

7. **State Game Lands #180 (Pike County)**

   The focus area consists of State Game Lands #180 (12,000 acres) and approximately 12,000 acres of private land and public land surrounding State Game Lands 180. The habitat is approximately 80% forested. The remainder is grasslands, reverting land, and non-wooded marshes. Beaver impoundments occur in forested and non-forested areas. The public land includes Pecks Pond, Promised Land State Park, and the Delaware State Forest.

This State Game Lands once attracted many waterfowl for breeding and during migration. Waterfowl usage has decreased over the years due to uncontrolled public use and deteriorating waterfowl habitat. An uncontrollable factor that also may have affected waterfowl usage is the second home/recreational development around and on other wetlands in the vicinity of State Game Lands #180. Acquisition/public use control of key wetlands near State Game Lands #180 and enhancement of wetlands on the State Game Lands could significantly improve waterfowl production in this project area. Aquatic mammals, waterbirds, and birds of prey would certainly benefit. This State Game Lands also is an eagle hacking site. Three thousand acres need to be protected and 5,000 acres enhanced.

8. Wayne County

This focus area is the remainder of Wayne County, not included in the Tobyhanna-Gouldsboro project. There are many wetlands, including beaver impoundments, along with a good breeding waterfowl population (wood ducks, black ducks, mallards). Approximately 40% of Wayne County is forested (with forested wetland areas and impoundments). The remaining area is farmland, reverting land, and wetlands. State Game Lands acreage in Wayne County totals 16,600 acres.

With the many wetlands in Wayne County, it is primarily important as a waterfowl production area. Migrants, waterfowl and songbirds, aquatic mammals, birds of prey, and other water birds also are important fauna in this county. Eleven thousand acres are in need of protection and 15,000 acres for enhancement.

PENNSYLVANIA FOCUS AREA SUMMARY

Focus Area	Protect	Enhance	Total
Susquehanna River Lowlands	8,300	2,500	10,800
Middle Creek WMA - Ontelaunee Resevoir Corridor	2,000	500	2,500
Marsh Creek	1,500	300	1,800
Bucks and Montgomery County Wetlands	1,500	500	2,000
Tobbyhanna - Gouldsboro Project	26,666	5,200	31,866
State Game Lands #'s 13, 57, and 66	3,000	15,000	18,000
State Game Lands # 180	3,000	5,000	8,000
Wayne County	11,000	15,000	26,000
Total	**56,966**	**44,000**	**100,966**

Delaware

The Milford Neck/Big Stone Beach focus area is composed of 12,000 acres of wetlands and agriculture lands. The wetland type is primarily regularly to irregularly-flooded tidal wetlands composed of salt marsh cordgrass, salt hay, salt marsh shrubs, and common reed. The area contains about 5.7

miles of Delaware Bay shorefront consisting of a low duneline behind a silty-sand beach and is heavily used by waterfowl and shorebirds. Approximately 11,270 acres need to be protected and 730 acres enhanced.

During fall and winter, tens of thousands of waterfowl utilize this area for feeding and resting. This area is also important for the production of black, mallard, and wood ducks; shorebird species such as clapper, king and black rails, willets, killdeer, least terns, and oyster catchers; numerous song birds, woodcock, and wild turkey. Both bald and golden eagles are known to feed in the area, and they could eventually nest here.

A significant proportion of North America's shorebird population stops to feed and rest in this area during migrations. The spring stopover is a critical "refueling" stop where hundreds of thousands of shorebirds feed on horseshoe crab eggs along the shoreline. Because of the area's importance in this regard, it has been included in the proposed acquisition area of the International Western Hemisphere Shorebird Reserve Network.

If the land remains in private ownership, attempts will be made to fortify the shoreline (bulkheads, rip-rap, etc.) for development purposes. This development and associated activity will result in the loss of these critical shorebird feeding and resting areas, as well as valuable nesting and wintering habitat for black ducks and other waterfowl. Future attempts to create a deepwater port just offshore, if successful, will substantially degrade this area's environmental value.

At present, this focus area is composed of 2,300 acres of land owned and managed by the Delaware Division of Fish and Wildlife, 1,760 acres of land owned and managed by the Delaware Wildlands (a local conservation organization), and 9,500 acres of privately owned wetland (60%) and agricultural land (40%).

Maryland

1. Sinepuxent and Chincoteague Bay Marshes (Worcester County)

Coastal embayed marshes adjacent to these coastal bays are used by large numbers of wintering waterfowl, particularly black ducks. This focus area contains the 7,100-acre Assateague Island National Seashore which adjoins Chincoteague National Wildlife Refuge in Virginia, Assateague State Park (680 acres) and E.A. Vaughn Wildlife Management Area (1,751 acres). Approximately 15,000 acres of wetlands and potential upland buffers remain in private ownership.

Black ducks, buffleheads, canvasbacks, Canada geese, Atlantic brant, and greater snow geese are the most numerous wintering waterfowl species within this area. This is an important area for waterfowl, egrets, herons, shorebirds, woodcock, and peregrine falcons migrating along the Atlantic coast. Over 30 nesting colonies of 17 species of gulls, terns, herons, and egrets have been documented within this area. A small population of brown pelicans and one pair of bald eagles also nest within this area.

Private land within and adjacent to Assateague Island State Park and Assateague National Seashore should be protected by means of acquisition or long-term conservation easements. The salt marsh habitat and adjacent buffer of wooded uplands and agricultural fields along the west shoreline of Newport and Chincoteague Bays need to be protected from development. Approximately 20,000 acres need to be protected and 2,650 acres enhanced.

2. **Blackwater and Nanticoke River Marshes (Dorchester and Wicomico Counties)**

Vast expanses of fresh and brackish estuarine marshes are the outstanding feature of this area. Four major types of waterfowl habitat are well represented: the fresh estuarine bay marsh, brackish estuarine bay marsh, brackish estuarine river marsh, and brackish estuarine bay. Many of these marshes are adjoined by large tracts of sawtimber used by nesting bald eagles and good sized agricultural fields.

The Blackwater-Nanticoke section is an important waterfowl area. Canada geese, mallards, black ducks, and canvasbacks are most important. Large numbers of blue-winged teal use this area during their fall and spring migration. Approximately 8,000 canvasbacks roost on Fishing Bay and the Nanticoke River along the east shore of Elliotts Island. Black ducks are well distributed over all three types of estuarine marsh, although most occur in the brackish bay marsh. A fairly large number of black ducks breed in brackish, estuarine bay marshes. Additional breeding waterfowl include mallards, blue-winged teal, gadwall, and wood ducks. Large numbers of wood ducks concentrate at the head of the Blackwater, Little Blackwater, and Transquaking Rivers during their fall migration.

Breeding peregrine falcons have been reintroduced to this area. At least three pairs of bald eagles nest within this area. It is an important wintering area for 60-70 bald eagles. The Nanticoke River, Marshyhope Creek, lower Blackwater River, and Transquaking River are important spawning areas for striped bass and shad. Other major species include blue crabs and finfish such as white perch, alewife, grey seatrout, and eels. The shallow pond, tidal creeks, and mud flats of this area are important to feeding and migrating herons, egrets, and shorebirds.

This area contains the 11,216-acre Blackwater National and the 17,208-acre Fishing Bay Wildlife Management Area. Several impoundments on Blackwater NWR require adequate water supply to achieve full management potential for producing moist soil foods. Several open marsh water management (OMWM) projects have been completed in this area. The long-term effects of this management upon waterfowl and wetland communities need to be evaluated. Protection of these habitats should be accomplished through acquisition or long-term leases. The waterfowl carrying capacity of this area can be improved through OMWM projects in high-phase marshes, reduction of insecticide use (mosquito spray), improved management of existing state and federal impoundments, and improved management of adjacent agricultural uplands in this area. Protection of private wetlands and adjoining buffers is best accomplished by either conservation easements, tax incentive programs, or acquisition. Due to the importance of this area for a wide variety of wildlife, 53,500 acres are identified for protection and 5,000 acres for enhancement.

3. **Lower Eastern Shore Marshes (Wicomico, Somerset, and Worcester Counties)**

Salt estuarine bays and salt estuarine bay marshes are the principal habitats of this area. The broad marshes along the estuarine bay shores and on the offshore islands are the only large areas of salt estuarine bay marsh in the entire upper Chesapeake Bay region. Numerous brackish estuarine river marshes border tidal streams that extend into the interior. There are two fairly large brackish estuarine bay marsh - the Broad Creek marsh and the Marumsco Creek marsh.

This area is most important to waterfowl during unusually cold winters, when other waterfowl habitats in other areas become frozen over. The saltwater areas ordinarily do not have the high densities of waterfowl that are characteristic of other habitats in this region, but they are so extensive that they contain more than 75% of the black ducks observed in the winter. Black ducks are common in this area during the fall, winter, and early spring. Scattered black ducks also breed in this habitat later in the season. Large numbers of blue-winged teal, widgeon, and gadwall utilize impoundments managed in this area for widgeon grass. Wintering waterfowl include canvasbacks, scaup, common goldeneyes, buffleheads, widgeon, gadwall, and green-winged teal.

This area contains 23 active nesting colonies of terns, herons, and egrets. Eight breeding pairs of nesting bald eagles occur within this area. An additional 40-50 bald eagles use this area as wintering habitat.

This area contains seven state wildlife management areas totaling 24,650 acres plus an additional 2,573 acres of state-owned lands. Martin National Wildlife Refuge (4,423 acres), Bloodsworth Island (5,361 acres), and Smith Island are located within this area.

Water bodies in this area include the Pocomoke, Manokin, and Big Annemessex Rivers, Dividing and Nassawango Creeks, and large embayments, including Pocomoke and Tangier sounds. The estuarine portion is a prime area for production of oysters and clams, and many of the upper tributaries are prime spawning and nursery areas for a variety of fishes.

Protection of wetlands and adjoining upland buffers should be accomplished via conservation easements, tax incentives to landowners, and acquisition. The carrying capacity of this area might be increased by the development of impoundments at carefully selected sites. The habitat quality of the 2,800-acre impoundment at Deal Island Wildlife Management Area could be improved by the development of interior dikes dividing this large impoundment into several smaller manageable cells. A total of 34,000 acres are in need of protection. Enhancement is needed on 6,100 acres.

4. Dickenson Bay (Talbot County)

This brackish estuarine bay on the north shore of the Choptank River has been one of the State's most important wintering areas for Canada geese, black ducks, and canvasbacks. The adjoining uplands and tidal creeks provide additional feeding areas for wintering black ducks, mallards, and Canada geese. The small island (10 acres) in Dickenson Bay is utilized by nesting black ducks, common terns, and green herons. At least one pair of bald eagles nest nearby and use this area for feeding. Protection of this area should be accomplished by conservation easements and acquisition. Upland buffers should be established to protect the value of this area to wintering waterfowl. This area is in private ownership. Presently, commercial gunning and residential development are threatening the value of this area to wintering waterfowl. Approximately 1,250 acres have been identified for protection.

5. **Patuxent River Marshes (Prince George's, Anne Arundel, and Calvert Counties)**

The principal habitats are the open estuarine bays and the estuarine river marshes. The freshwater portion of the marsh is the largest of its type in the upper Chesapeake Bay region, occupying approximately 2,000 acres. A great variety of diving ducks and dabbling ducks winter in this area. Total waterfowl populations, however, are lower than would be expected in habitats of such quality. Black ducks, mallards, and Canada geese are abundant during the winter period. Excessive human disturbance and residential development threaten the value of this habitat. Conservation easements on private lands would be beneficial.

This area has been designated as one of the State's Scenic Rivers. Approximately 5,125 acres are under state ownership and managed for wildlife. An additional 6,300 acres is managed by county governments.

The Patuxent River marshes are a major migration area for rails, particularly sora rails. Four breeding pairs of bald eagles nest within this area. Approximately 14,500 acres have been identified for protection and 500 acres for enhancement actions.

MARYLAND FOCUS AREA SUMMARY

Focus Area	Protect	Enhance	Total
Sinepuxent & Chincoteague Bay Marshes	20,000	2,650	22,650
Blackwater & Nanticoke River Marshes	53,500	5,000	58,500
Lower Eastern Shore Marshes	34,000	6,100	40,100
Dickenson Bay	1,250		1,250
Patuxent River Marshes	14,500	500	15,000
Total	**123,250**	**14,250**	**137,500**

Virginia

1. **Virginia Eastern Shore (Seaside) including Assawoman, Metomkin, and Cedar Islands (Accomack County)**

The area includes extensive coastal salt marshes, barrier beach, and interior marshes adjacent to the mainland. The area provides high value habitat to wintering, migratory, and breeding black ducks, and wintering habitat for a diversity of other waterfowl species such as Atlantic brant, Canada geese, greater snow geese, goldeneyes, buffleheads, mergansers, and seaducks. The beach areas provide nesting habitat for nearly two dozen species of colonial nesting birds and other migratory birds including the endangered piping plover, brown pelican, and Wilson's plover. Migrating raptors including the endangered peregrine falcon make heavy use of these areas during migration.

Wading and shore birds abound in this habitat. The area is an important nursery area for numerous economically important finfish and shellfish species. Approximately 14,500 acres need protection and 500 acres need enhancement.

2. **Virginia Eastern Shore (Bayside) (Accomack County)**

This area primarily consists of tidal brackish high marshes bordering the eastern side of the Chesapeake Bay from Saxis south to Hack Neck. The marshes occurring in this area support populations of migrating, wintering, and nesting black ducks. Other dabbling ducks use the area during migration wintering as do Canada geese. Many of the marshes in this area hold good potential for enhancement utilizing management techniques. Associated wetlands are valuable to numerous species of finfish and shellfish as nursery and production areas. Seven thousand acres are identified for protection and 800 acres for enhancement.

3. **Pamunkey River Marshes (King William and New Kent Counties)**

The tidal fresh to brackish marshes and wooded swamps associated with this area provide important migration and wintering habitat to a significant portion of Virginia's puddle duck population including black ducks and mallard as well as Canada geese. Breeding wood duck populations are high. These marshes are valuable as both spawning and nursery areas for several anadromous fish species including striped bass, American shad, and river herring. The vicinity is used by nesting and wintering American bald eagles. Approximately 9,200 acres are in need of protection and 100 acres for enhancement.

4. **Chickahominy River Marshes (New Kent, Charles City, and James City Counties)**

The tidal fresh to slightly brackish marshes in this system provide migration and wintering habitat to a number of puddle duck species including black duck, mallard, pintail, green-winged teal, and blue-winged teal. The area is an important wood duck nesting area. The area is heavily used by nesting, summering, and wintering American bald eagles. Nesting ospreys are numerous as are wading birds. Several species of anadromous fish utilize the area for spawning and nursery phases of their life cycle. This focus area would include 3,650 acres for protection and 50 for enhancement.

5. **James River Marshes (Prince George, Charles City, and Surry Counties)**

The tidal fresh marshes in this system are important puddle duck migration and wintering habitat for black duck, mallard, pintail, green-winged teal, American widgeon, and gadwall. Canada geese make heavy use of these marshes. The highest summer concentration of American bald eagles in the mid-Atlantic states occurs in this stretch. Eagle nesting and wintering is also heavy in this area. Important anadromous fish species such as striped bass, American shad, river herring, and an occasional sturgeon utilize the area for spawning and nursery activities. Approximately 3,650 acres need protection and 50 acres need enhancement.

6. **Back Bay Marshes North Landing River (Virginia Beach)**

The freshwater marsh complexes in this area provide excellent habitat for migrating and wintering black ducks as well as a vast diversity of other waterfowl including mallard, pintail, American widgeon, gadwall, shoveler, green-winged teal, blue-winged teal, greater snow geese, Canada geese, and tundra swan. Highly productive wood duck breeding habitat is abundant adjacent to the North Landing River wetlands. The large open-water areas adjacent to these wetlands have historically been cast sources of submerged aquatic vegetation (SAV) although currently the supply is greatly reduced. Diving duck species such as canvasback, scaup, ring-necked duck, and ruddy are plentiful as are American coots in years of good SAV production. The area is utilized by nesting osprey and numerous other migrating raptors including the endangered peregrine falcon. The area is an important freshwater fish spawning and nursery area and supports economically important populations of white perch, eels, and blue crabs. The area is currently under great pressure from development interest from the fast-growing Virginia Beach/Hampton Roads urban complex. Much of the problem associated with the deterioration of SAV resources is linked to water quality degradation from residential and agricultural runoff. In addition to wetland protection, buffer strip protection is essential if the "Bay" is to be restored. A total of 8,800 acres have been identified in this focus area for protection (8,300) and enhancement (500).

7. **Rappahannock River Marshes (Essex, Middlesex, Richmond, and Lancaster Counties)**

   These tidal fresh to brackish marshes provide high-quality diverse migratory and wintering habitat for black ducks and other waterfowl such as mallards, blue-winged teal, green-winged teal, pintail, Canada geese, and tundra swan. The area provides high-quality wood duck breeding habitat. The area provides excellent bald eagle nesting, summering, and wintering habitat. The area is extremely important for spawning and nursery activities of striped bass, American shad, and river herring. Blue crabs and oysters abound in the downstream reaches. Approximately 4,150 acres are in need of protection efforts and 200 acres for enhancement.

8. **Mattaponi River Marshes (King and Queen, and King William Counties)**

   These tidal fresh to brackish marshes are very similar to the Pamunkey River complex; however, they do not support the numbers of waterfowl found on the Pamunkey. Migrating and wintering black ducks as well as mallards and teal use the area along with limited numbers of Canada geese. American bald eagles are observed year round in the watershed. Striped bass, American shad, hickory shad, and river herring utilize this area for spawning and nursery activities. This focus area includes 2,500 acres for protection and 100 acres for enhancement.

9. **York River Marshes (Gloucester, York, and James City Counties)**

   These areas are tidal brackish high marshes that support moderate numbers of migrating and wintering black ducks, mallards, and Canada geese. Adjacent open water areas are populated with canvasback, scaup, bufflehead, goldeneyes, and ruddy ducks. The marshes hold good enhancement potential for waterfowl. Several species of economically important finfish and shellfish utilize these areas for nursery activities. Fourteen hundred acres are in need of protection and 250 acres for enhancement.

10. **Western Bayshore Marshes (Reedville to Mobjack Bay) (Northumberland, Lancaster, Middlesex, and Matthews Counties)**

    These tidal brackish marshes are similar to the Eastern Shore Bayside wetlands. Although total waterfowl numbers are somewhat modest, they do provide important migration and wintering habitat for black duck as well as mallard, Canada geese, and tundra swan. The area is heavily utilized by nesting osprey and many shore and wading bird species. Virtually all of these marshes are adjacent to important finfish and shellfish nursery areas. These marshes possess good potential for waterfowl enhancement projects. This focus area includes a total of 2,475 acres for protection and 275 acres for enhancement.

VIRGINIA FOCUS AREA SUMMARY

Focus Area	Protect	Enhance	Total
VA Eastern Shore (Seaside)	14,500	500	15,000
VA Eastern Shore (Bayside)	7,000	800	7,800
Pamunkey River Marshes	9,200	100	9,300
Chickahominy River Marshes	4,400	50	4,450
James River Marshes	3,650	50	3,700
Back Bay/N. Landing River Marshes	8,300	500	8,800
Rappahannock River Marshes	4,150	200	4,350
Mattaponi River Marshes	2,500	100	2,600
York River Marshes	1,400	250	1,650
Western Bayshore Marshes (Reedville-Mobjack Bay)	2,475	275	2,750
Total	**57,575**	**2,825**	**60,400**