

**KANSAS
INTERIM HYDROGEOMORPHIC (HGM)
FUNCTIONAL ASSESSMENT MODEL**

SLOPE WETLANDS

October 1, 2007

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Section I. Introduction

General

Wetlands have properties of both aquatic and terrestrial ecosystems. Their most widely valued function is providing habitat for fish, birds, and other wildlife (contributing to the maintenance of biodiversity). In addition to this “food chain support” function, wetlands carry out hydrologic functions and water quality improvements - all of which are important to society as a whole. They also provide recreational, educational, research, and aesthetic functions.

Wetland Functions

Wetland functions are the normal or characteristic activities that take place in wetland ecosystems or simply the things that wetlands do. Wetlands perform a wide variety of functions in a hierarchy from simple to complex as a result of their physical, chemical, and biological attributes. All wetlands do not perform all functions to the same degree of magnitude, if at all. The functions selected for assessment should reflect the characteristics of the wetland ecosystem and landscape under consideration and the assessment objectives. By narrowing the focus to a regional subclass, it is possible to identify the functions that are most likely to be performed and of greatest benefit to the public interest.

The hydrogeomorphic system of wetland classification recognizes three broad wetland functions. They include functions related to hydrology, biogeochemical processing, and wildlife/biological habitat. Specific wetland functions have been identified with respect to the three broad functions. Moderation of groundwater flow is an example of a slope wetland function. It can be defined as “the capacity of the wetland to regulate the outflow of groundwater. Effects on-site include contribution to the maintenance of characteristic soils, vegetation, invertebrate and vertebrate communities, and the moderation of groundwater flow. Effects off-site include modification of off-site hydrology of wetland and Riverine systems within the groundwater and surface water flow network.

Summary of HGM Approach

The three main components of the HGM approach include: (1) hydrogeomorphic (functional) classification; (2) reference standards for wetlands; and (3) assessment models/functional indices.

HGM Classification

HGM classification is based on three factors: geomorphic setting, water source, and hydrodynamics.

Section I. Introduction, continued

HGM Classification, continued

Regardless of how they are defined, all wetlands share some common hydrologic, soil, and vegetative characteristics. Beyond these similarities, however, wetlands exhibit wide variation in terms of their size, complexity, and physical, chemical, and biological characteristics and processes.

At the highest level of HGM classification, wetlands are grouped into hydrogeomorphic wetland classes. Seven hydrogeomorphic classes are recognized. They include depressions, lacustrine fringes, tidal fringes, slopes, riverines, mineral soil flats, and organic soil flats.

Reference Standards

In order to assess impacts to wetland functions, standards of comparison must be defined for what constitutes chemical, physical, and biological integrity in the context of a wetland. Establishing reference standards has two complications.

First, wetland ecosystems and their surrounding landscapes are dynamic and constantly changing. As the characteristics that influence function change, functional capacity may increase or decrease. These changes are the result of natural short-term processes such as seasonal cycles of precipitation and temperature; and long-term processes that include population dynamics, erosion and depositional processes, succession, drought/wet cycles, or sea level rise. In establishing reference standards, the variability that occurs as a result of natural processes must be taken into account.

Second, establishment of reference standards is further complicated by the variability exhibited by wetland ecosystems and landscapes in response to anthropogenic disturbance. Land-use changes and hydrologic alteration of wetland ecosystems and their surrounding landscapes and the resultant lack of undisturbed wetland ecosystems and landscapes make it difficult to establish reference standards that reflect the functional capacity of a regional subclass under undisturbed conditions.

Because wetland ecosystems exhibit a wide range of conditions as a result of natural processes and anthropogenic disturbances, and few undisturbed wetland ecosystems or landscapes exist, this assessment approach establishes reference standards based on reference wetlands. Reference wetlands are actual wetland sites that represent the range of variability exhibited by a regional wetland subclass as a result of natural processes and anthropogenic disturbances.

In establishing reference standards, the geographic area from which reference wetlands are selected is the reference domain. The reference domain may include all, or part, of the geographic area in which the regional subclass actually occurs.

Section I. Introduction, continued

Reference Standards, continued

Once the reference domain has been defined, there are a variety of approaches for selecting reference sites, establishing the variability of a regional subclass in a reference domain, and defining reference standards.

Assessment Models/Functional Indices

Assessment models are simple representations of the relationship between attributes of the wetland ecosystem and the surrounding landscape, and the functional capacity of the wetland. Variables in the assessment model, such as plant species composition, over bank flow, and soil type, represent the attributes. Variables are assigned a sub-index ranging from 0.0 to 1.0 based on the relationship between the variable and functional capacity. To determine the index values for each variable reference Appendix C.

Variables in the assessment model are assigned a sub-index based on a quantitative (i.e., interval or ratio) or qualitative (i.e., nominal or ordinal) scale data. When it is impossible or impractical to assign a sub-index based on direct, quantitative or qualitative data, it may be possible to assign a sub-index based on an indicator. Indicators are easily observed or measured characteristics that are correlated with a quantitative measure of a variable.

In addition to defining the relationship between variables and functional capacity, the assessment model defines how variables interact to influence functional capacity. The interaction between variables is defined using an aggregation function or logical rules. The result is a Functional Capacity Index (FCI), which is the ratio of the functional capacity of a wetland under existing conditions, and the functional capacity of a wetland exhibiting reference standards for the regional subclass in the reference domain.

Recommended Tools to Use for Wetland Assessment

Office Tools

- United States Geological Survey (USGS) quadrangle maps
- United States Fish and Wildlife Service (FWS) National Wetland Inventory (NWI) maps
- Aerial photography of wetland and surrounding watershed area
- County soil survey publication
- Engineering field manual
- Engineers scale
- Tools for acreage calculation
- Farm Service Agency (FSA) color slides
- Natural Resources Conservation Service (NRCS) wetland inventories

Section I. Introduction, continued

Recommended Tools to Use for Wetland Assessment, continued

Other Considerations

- Insect repellent
- Sunscreen
- Hip or chest waders or rubber boots
- Binoculars
- Global positioning system (GPS)
- Containers for plant collection
- Local representative knowledgeable about area resources and land uses
- Kansas Biological Survey Plant Identification Services

Field Tools

- Slope Wetland Interim Functional Assessment Model
- Aerial photography of wetland and surrounding area
- surveying equipment such as; hand, abney, or transit level, rod or stadia board, measuring device (100 foot chain)
- National list of plant species
- Plant identification handbooks
- Plant press, plastic bags, and labeling materials
- Spade, soil probe, or auger
- Soil field kit including; Munsell color book, tape measurer (English or metric), steel spatula or knife, acid, water, field indicators of hydric soils in the United States, hand lens
- Field recording sheets
- Clipboard, paper, and pencils
- Flags (two or more colors suggested)
- Tube markers
- Calculator
- Photographic equipment (optional)
- Tile probe (optional)

Discussion of Slope Wetland

This functional assessment can be used to evaluate slope wetlands. The slope wetland class has been defined by Brinson, (1993). After testing and revising the model, the reference domain for its application may be expanded.

Slope wetlands normally are found where there is a discharge of groundwater to the land surface. They normally occur on sloping land; elevation gradients may range from

Section I. Introduction, continued

Discussion of Slope Wetland, continued

steep hillsides to slight slopes. They commonly occur at “nick points” on the landscape, or areas where the land surface changes or where stratigraphic discontinuities occur. Slope wetlands are usually incapable of depressional storage because they lack the necessary closed contours, although they may provide some connectivity between depressional wetlands. Principal water sources are usually groundwater return flow and interflow from surrounding uplands, as well as precipitation.

Hydrodynamics of slope wetlands are dominated by down slope unidirectional water flow. Slope wetlands can occur in nearly flat landscapes if groundwater discharge is a dominant source of water to the wetland. Slope wetlands lose water primarily by evaporation of subsurface water, surface flows, and by evapotranspiration. Slope wetlands may develop channels, but the channels serve only to convey water away from the wetland. Most slope wetlands have an entrance and/or an exit to an outside ecosystem.

Surface runoff from the surrounding uplands carries sediment and nutrients into slope wetlands, where they are then trapped within the wetland by vegetation and microtopography. Nutrients carried by surface runoff and by subsurface flow are intercepted and cycled by the vegetation and microorganisms within the wetland. Sediment trapped within the wetland helps reduce sedimentation downstream.

Section II - Discussion of Slope Wetland Functions and Associated Functional Capacity Index Scores (F1 - F7)

F1: Moderation of Ground Water Flow

Definition: The capacity of the wetland to regulate the outflow of groundwater.

Effects On-Site: Contributes to the maintenance of characteristic soils, vegetation, invertebrate and vertebrate communities, and provides for the moderation of groundwater flow.

Effects Off-Site: Modifies off-site hydrology of wetland and riverine systems within the groundwater and surface water flow net.

Discussion of Function and Variables: A combination of geological material and regional water balance affects the groundwater and surface water flow within the wetlands. The principal water sources for these sloped wetlands are from groundwater and precipitation and the principal water losses are through evapotranspiration and surface runoff. These hydrological elements produce an inter- and intra-annual cycle of water storage within the wetland boundaries. This cycle supports the diverse plant

Section II - Discussion of Slope Wetland Functions and Associated Functional Capacity Index Scores (F1 - F7), continued

F1: Moderation of Ground Water Flow, continued

Discussion of Function and Variables, continued

and animal habitats as well as biogeochemical processes. These sloped wetlands sustain the hydrological cycle.

The variables associated with the performance of this function focus on land use and on the physical integrity of soil conditions. Human activities at nearby lower elevations and above or within the wetland affect the rate and quantity of surface and subsurface water entering and leaving the wetland. V_{upuse} , V_{wetuse} , and V_{source} are used to describe potential alterations of water flow to the wetlands. Land use activities also affect erosion and sediment import into the wetlands by water and wind. Soil conditions within the wetland affect water storage and the ability of the soil to transmit and hold water interstitially. This soil condition is described in the V_{pore} variable. Finally, constructed drainage features in and adjacent to the wetland directly impact the subsurface flow of water to and from the wetland. The V_{subalt} variable reflects this aspect of the function.

Functional capacity Index (FCI) Score: $FCI\ Score = \{V_{subalt} \times [(V_{source} + V_{upuse})/2 + (V_{pore} + V_{wetuse})/2] / 2\}^{1/2}$

F2: Velocity Reduction of Surface Water Flow

Definition: Reduces the velocity of surface runoff from storm events and/or snowmelt run-off.

Effects On-Site: Maintains characteristic soils, vegetation, invertebrate and vertebrate communities, provides for erosion reduction in the wetland, and aids in the nutrient and chemical cycling process.

Effects Off-Site: Erosion reduction and retention of elements and compounds on site decreases probability of export to aquatic ecosystems downstream.

Discussion of Function and Variables: Vegetation and microtopographic changes within the wetland provide a structural roughness to reduce the velocity of overland flow in and out of the wetland. Reduction of overland flow within the wetland allows time for the settlement of water-borne sediments and nutrients within the wetland. The vegetation within the wetland also provides for erosion control.

The variables within this function reflect the land use and the physical condition of the watershed or catchments' area. Land use is reflected by upland land use, wetland land use, sediment delivery, and vegetation density variables V_{upuse} , V_{wetuse} , V_{sed} , and V_{pcover} respectively. Alterations to the surface hydrology within the wetland $V_{surfalt}$ affect

Section II - Discussion of Slope Wetland Functions and Associated Functional Capacity Index Scores (F1 - F7), continued

F2: Velocity Reduction of Surface Water Flow, continued

Discussion of Function and Variables, continued

the rate of surface water movement through the wetland. The physical conditions for this function are reflected by the V_{source} and V_{micro} variables.

Functional capacity Index (FCI) Score: $FCI\ Score = [V_{micro} + V_{surfalt} + (V_{source} + V_{upuse} + V_{pcover})/3 + (V_{sed} + V_{wetuse})/2] /4$

F3: Retention, Conversion, and Release of Elements and Compounds

Definition: Short- and long-term cycling and removal of elements and compounds on-site through the abiotic and biotic processes that convert elements from one form to another.

Effects On-Site: Net effects of retention, conversion, and release are balanced between gains through import processes and losses through hydrologic export, efflux to the atmosphere, and long term retention in persistent biomass and sediments.

Effects Off-Site: Retention of elements and compounds on-site decreases probability of export to other aquatic ecosystems downstream and consequent nutrient loading.

Discussion of Function and Variables: The use of the term cycling refers to the annual turnover of nutrients and retention refers to the relatively long-term accumulation or loss through conversion or removal of elements and compounds from incoming water sources. Elements include macronutrients essential to plant growth (nitrogen, phosphorous, potassium) and other elements such as heavy metals (zinc, chromium, etc.) that can be toxic at high concentrations. Compounds include herbicides, pesticides, and other imported materials. Mechanisms of nutrient cycling, retention, conversion, release and removal include sorption, sedimentation, denitrification, burial, decomposition to inactive forms, decay, uptake and incorporation into short and long lived annual and perennial herbaceous biomass, and similar processes [Brinson et al., (1985)].

The variables within this function reflect land use, abiotic, and biotic components. Land use activities impact the magnitude of elements and compounds entering the system and the natural cycling and removal processes of the elements and compounds. Land use is reflected by the upland land use and wetland land use variables V_{upuse} and V_{wetuse} , respectively.

Biotic components of the wetland ecosystem cycle and retain elements and compounds through biomass accumulation and litter production. Elements and compounds are

Section II - Discussion of Slope Wetland Functions and Associated Functional Capacity Index Scores (F1 - F7), continued

F3: Retention, Conversion, and Release of Elements and Compounds, continued

Discussion of Function and Variables, continued

recycled annually through decay and decomposition. Neely and Baker (1989) report decay rates for some emergent plants in the Prairie Pothole region to be greater than one year, indicating retention. These decomposition rates facilitate both cycling on an annual basis and retention on a longer than one year basis within the wetland. Biotic components consist of the vegetative cover and detritus variables V_{pcover} and $V_{detritus}$, respectively.

The abiotic components assist reduction and oxidation processes that biogeochemical cycle and retain elements and compounds. Abiotic components are represented by sorptive properties of the soil V_{sorpt} , soil quality V_{pore} , and by the amount and presence of water (represented by the $V_{surfalt}$ and V_{source} variables).

Functional capacity Index (FCI) Score: $FCI\ Score = [(V_{source} + V_{surfalt} + V_{upuse} + V_{wetuse})/4 + (V_{pcover} + V_{detritus})/2 + (V_{sorpt} + V_{pore})/2] /3$

F4: Retention of Particulates

Definition: Deposition and retention of inorganic and organic particulates (>45 um) from the water column, primarily through physical processes.

Effects On-Site: Organic matter may be retained for decomposition, nutrient recycling, and detritus food web support. Sediment accumulation contributes to the nutrient capital of the ecosystem. Deposition increases surface elevation and changes topographic complexity. Natural rates of accumulation are slow.

Effects Off-Site: Reduces potential export of sediment and other particulates to downstream wetland and aquatic ecosystems and groundwater systems.

Discussion of Function and Variables: Retention applies to particulates arising from both on-site and off-site sources, but excludes in situ production of peat. The Retention of Particulates function contrasts with the Retention, Conversion, and Release of Elements and Compounds function in that the emphasis is more dependent on physical processes such as sedimentation and particulate removal. Sediment retention occurs through burial and chemical precipitation (i.e., removal of phosphorous by Fe^{+++}). Dissolved forms may be transported as particles after undergoing sorption and chelating (heavy metals mobilized with humic and fulvic compounds). Imported sediment can undergo renewed pedogenesis on-site, which potentially involves weathering and release of elements that were previously inaccessible to mineral cycling (Brinson, 1995).

Section II - Discussion of Slope Wetland Functions and Associated Functional Capacity Index Scores (F1 - F7), continued

F4: Retention of Particulates, continued

Discussion of Function and Variables, continued

The variables associated with the performance of this function focus primarily on components of the system that affect the physical processes of particulate removal and sedimentation. Because of the position on the landscape occupied by these wetlands, a primary source of sediment would be from uplands as particulates transported in overland flow. Therefore, use of the uplands V_{upuse} has a direct influence on the potential delivery of sediment to these ecosystems. The presence, absence, continuity, and condition of the buffer zone, V_{bcond} , V_{bcont} , and V_{bwidth} , respectively, around the margin of the wetland affects surface flow into the wetland from adjacent uplands. Use of the wetland V_{wetuse} will affect the ability of the wetland ecosystem to perform this function, and will have an influence on the variability of related functional indices. As water flows over surfaces, friction and shear forces create turbulent flow and reduce velocities, both of which are conducive to sediment deposition. The variables used to determine sediment deposition as related to reduced velocities include the density of the vegetative cover V_{pcover} , and the microtopographic complexity or roughness V_{micro} of the ground. Sedimentation is represented by direct evidence V_{sed} .

Functional capacity Index (FCI) Score: $FCI \text{ Score} = \{ V_{sed} \times [(V_{upuse} + V_{wetuse})/2 + (V_{bcond} + V_{bcont} + V_{bwidth})/3 + (V_{pcover} + V_{micro})/2] / 3 \}^{1/2}$

F5: Organic Carbon Export

Definition: Export of dissolved and particulate organic carbon and detritus from the wetland. Mechanisms include processes such as leaching, flushing, displacement, and erosion.

Effects On-Site: The removal of organic matter from living biomass, detritus, and soil organic matter contributes to carbon turnover (plant storage) and food web support.

Effects Off-Site: Provides support for food webs and biogeochemical processing from the wetland ecosystem.

Discussion of Function and Variables: Wetlands export organic carbon at higher rates per unit area than terrestrial ecosystems (Mulholland and Kuenzler, 1979) in part because surface water has greater contact time with organic matter in litter and surface soil. While the molecular structure of most organic material is not well known because of its chemical complexity (Stumm and Morgan, 1981), organic matter nevertheless plays important roles in geochemical and food web dynamics. For example, organic carbon complexes with a number of relatively immobile metallic ions that facilitate transport in soil (Schiff et al., 1990). Organic carbon is a primary source of energy for

Section II - Discussion of Slope Wetland Functions and Associated Functional Capacity Index Scores (F1 - F7), continued

F5: Organic Carbon Export, continued

Discussion of Function and Variables, continued

microbial food webs (Dahm, 1981; Edwards, 1987; Edwards and Meyer, 1986) which form the base of the detritus food web in aquatic ecosystems. These factors, in combination with the proximity of wetlands to aquatic ecosystems, make wetlands critical sites for supplying both dissolved and particulate organic carbon.

Two factors are required in order for slope wetlands to function as a source of organic carbon for export. These factors are a source of organic material and water flow for transport. The density of the plant community within and surrounding the wetland influences the input of organic material V_{pcover} into the wetland. This input is in the form of both the living and dead vegetation $V_{detritus}$. The plant community present and the organic material it supplies to the wetland ecosystem are a direct function of the use and condition of the wetland V_{wetuse} . Water movement into and through the wetland can be characterized by wetland surficial complexity V_{micro} and by restrictions in or alterations to subsurface and surface hydrology V_{subalt} and $V_{surfalt}$, respectively. When precipitation rates exceed soil infiltration rates, overland flow in uplands adjacent to slope wetlands can transport both dissolved and particulate organic carbon into and through a wetland. Subsurface inflow contributes to organic carbon export. Displacement of existing soil water within alluvium may create outflow through surface and subsurface pathways to downstream localities.

Functional capacity Index (FCI) Score: $FCI\ Score = [(V_{pcover} + V_{detritus} + V_{wetuse})/3 + (V_{micro} + V_{subalt} + V_{surfalt})/3] / 2$

F6: Maintenance of Characteristic Plant Community

Definition: The species composition and physical characteristics of living plant biomass. This function not only reflects the plant community, but also is assumed to be an indicator of the presence or potential presence of vertebrates and invertebrates. Characteristic plant communities are not dominated by exotic or nuisance species. Vegetation is maintained by mechanisms such as seed dispersal, seed banks, and vegetative propagation, which respond to variations in hydrology, and disturbances such as fire and herbivores. The emphasis is on the temporal dynamics and structure of the plant community as revealed by vegetative species composition, abundance, and percent cover.

Effects On-Site: Creates microclimatic conditions that support plants and animals; converts solar radiation and carbon dioxide into complex organic carbon that provides energy to drive food webs; provides habitat for feeding, nesting, resting, escape, and breeding for resident and migratory vertebrates and invertebrates.

Section II - Discussion of Slope Wetland Functions and Associated Functional Capacity Index Scores (F1 - F7), continued

F6: Maintenance of Characteristic Plant Community, continued

Effects Off-Site: Provides a source of vegetative propagules for adjacent ecosystems, which assists in revegetation following drought or disturbance and provides for gene flow between populations; provides habitat for vertebrates and invertebrates from adjacent ecosystems.

Discussion of Function and Variables: Vegetation accounts for most of the biomass of slope wetland systems. The physical characteristics of living and dead plants are closely related to ecosystem functions associated with hydrology, nutrient cycling, and the abundance and diversity of animal species (Lillie and Evard, 1994). Vegetation is not static, however, and species composition and physical characteristics can change in space and time in response to natural and anthropogenic influences (Weller, 1987).

The variables within this functional index address plant community characteristics and potential anthropogenic disturbance.

Plant community characteristics alter with various types of perturbation. The ratio of native to non-native plant species V_{pratio} indicates the health of a plant community. A healthy plant community is comprised of a high percentage of native noninvasive plants. As a system becomes perturbed, invasive native and non-native species out compete sensitive native species. Plant abundance, as measured by percent cover V_{pcover} , captures the ability of the system to remain self-sustaining. Detritus $V_{detritus}$ maintains thermal regulation of rhizospheres and propagules, and is essential for nutrient cycling.

The elements of a healthy plant community may be compromised by anthropogenic activities. Land use within the wetland V_{wetuse} directly impacts plant communities. Upland use V_{upuse} indirectly impacts plant communities, particularly when activities have caused impacts such as increased or decreased runoff or increased sediment movement into the wetland. Accumulation of excess sediment within the wetland, as indicated by the variable V_{sed} , influences the ability of wetland vegetation to regenerate by burying or disrupting detritus, seed banks, rhizomes, etc. Finally, hydrophytic plants are directly affected by water level and soil moisture regime. The altering of wetland hydrology impacts groundwater and surface water levels within the wetland, and is reflected in the variables V_{subalt} and $V_{surfalt}$.

Functional capacity Index (FCI) Score: $FCI\ Score = (V_{wetuse} + V_{upuse} + V_{sed} + V_{subalt} + V_{surfalt} + V_{pratio} + V_{pcover} + V_{detritus}) / 8$

Section II - Discussion of Slope Wetland Functions and Associated Functional Capacity Index Scores (F1 - F7), continued

F7: Maintenance of Habitat Interspersion and Connectivity among Wetlands

Definition: The spatial relationship of an individual wetland with respect to adjacent wetlands in the complex.

Effects On-Site: The assessed wetland contributes to habitat features of the wetland complex by virtue of its position in the landscape.

Effects Off-Site: Contributes to overall landscape diversity of habitat for aquatic and terrestrial organisms.

Discussion of Functions and Variables: Wetlands provide water and other life requirements for motile species. In addition, all vegetative strata in wetlands, from herbaceous layer to tree canopy, provide wildlife corridors (connections) between different wetland types, between uplands and wetlands, and between uplands (Sedell et al., 1990).

Uninterrupted corridors are critical for movement of animals within and between wetlands. The integrity of these corridors may be disturbed through human-induced perturbations both within and around the assessment area. The extent of these perturbations is represented by the variables V_{upuse} , V_{wetuse} , V_{bcont} , V_{bcond} , and V_{bwidth} . V_{upuse} represents the land use within the wetland watershed. V_{wetuse} represents the land use within the wetland. Maintenance of water levels within the wetland is important to maintenance of habitat functions. Alterations that impact water levels are reflected in the V_{subalt} and $V_{surfalt}$ variables. V_{bwidth} represents the vegetative buffer width along the wetland. V_{bcont} represents the continuity of the vegetative buffer along the wetland. V_{bcond} represents the condition of the buffer along the outermost edge of the wetland.

The pattern of different types of wetlands in the landscape, and their contribution to habitat and the frequency of distribution of wetland sizes within a radius of one mile relates to the animal guilds that use the wetlands. Wetlands are dynamic, integrated systems that provide habitat for numerous wildlife species.

Functional capacity Index (FCI) Score: $FCI\ Score = [V_{upuse} + V_{wetuse} + V_{subalt} + V_{surfalt} + (V_{bwidth} + V_{bcont} + V_{bcond})/3] / 5$

Section III - Functional Capacity Index (FCI) Score Equations

Function 1: Moderation of Groundwater Flow

$$\text{FCI Score: } \{V_{\text{subalt}} \times [(V_{\text{source}} + V_{\text{upuse}})/2 + (V_{\text{pore}} + V_{\text{wetuse}})/2] / 2\}^{1/2}$$

Function 2: Velocity Reduction of Surface Water Flow

$$\text{FCI Score: } [V_{\text{micro}} + V_{\text{surfalt}} + (V_{\text{source}} + V_{\text{upuse}} + V_{\text{pcover}})/3 + (V_{\text{sed}} + V_{\text{wetuse}})/2] / 4$$

Function 3: Retention, Conversion, and Release of Elements and Compounds

$$\text{FCI Score: } [(V_{\text{source}} + V_{\text{surfalt}} + V_{\text{upuse}} + V_{\text{wetuse}}) / 4 + (V_{\text{pcover}} + V_{\text{detritus}}) / 2 + (V_{\text{sorpt}} + V_{\text{pore}}) / 2] / 3$$

Function 4: Retention of Particulates

$$\text{FCI Score: } \{V_{\text{sed}} \times [(V_{\text{upuse}} + V_{\text{wetuse}}) / 2 + (V_{\text{bcond}} + V_{\text{bcont}} + V_{\text{bwidth}}) / 3 + (V_{\text{pcover}} + V_{\text{micro}}) / 2] / 3\}^{1/2}$$

Function 5: Organic Carbon Export

$$\text{FCI Score: } [(V_{\text{pcover}} + V_{\text{detritus}} + V_{\text{wetuse}}) / 3 + (V_{\text{micro}} + V_{\text{subalt}} + V_{\text{surfalt}}) / 3] / 2$$

Function 6: Maintenance of Characteristic Plant Community

$$\text{FCI Score: } (V_{\text{wetuse}} + V_{\text{upuse}} + V_{\text{sed}} + V_{\text{subalt}} + V_{\text{surfalt}} + V_{\text{pratio}} + V_{\text{pcover}} + V_{\text{detritus}}) / 8$$

Function 7: Maintenance of Habitat Interspersion and Connectivity Among Wetlands

$$\text{FCI Score: } [V_{\text{upuse}} + V_{\text{wetuse}} + V_{\text{subalt}} + V_{\text{surfalt}} + (V_{\text{bwidth}} + V_{\text{bcont}} + V_{\text{bcond}}) / 3] / 5$$

Section IV - Field Guide for the Measurement of Indicators: A Procedure for the Assessment of Slope Wetlands

This section is intended to be used as an aid in the hydrogeomorphic assessment of functions pertaining to dominantly ground water discharge. Information recorded will be used as the basis for determining gains and losses in wetland functional capacity.

Prior to proceeding with the office review of the functional assessment, an initial review of the project or site proposal needs to be done to fully understand the reason for doing the functional assessment and the scope of assessment needed.

Recommended Steps in the Functional Assessment of Slope Wetlands

Step 1: Office Preparation

- Review the recommended tools list (page 6) and assure needed tools are available to do the assessment.
- Prior to performing the office review, it is important to collect the documents and information relevant to the site. Pay particular attention to the land use of the assessment site, noting any differences in land use within or surrounding the wetland.
- Gather and record any pertinent information on variables V_{source} , V_{subalt} and $V_{surfalt}$ in the office. Prepare the tools needed for the field assessment.
- Take recorded comments and data to the field with you.

Step 2: Field Assessment

The interim functional assessment model for slope wetlands contains 15 indicators or variables, which are used in various combinations (equations) in order to assess functional capacity of the wetlands. A series of steps is recommended for use in the rating of these indicators. The indicators themselves are independent of each other, although similar measurements and/or conditions are used to rate several of them. These indicators have been identified as being important to the overall function of slope wetlands.

Before evaluating each of the indicators, a general evaluation of the wetland assessment area should be made. The evaluator(s) should first separate the wetland area from the upland, and determine that the area to be assessed is a slope wetland. Most slope wetlands are easily identifiable. Some wetlands associated with riparian (Riverine) ecosystems may require more extensive evaluation. The FWS NWI maps should aid in making difficult classification determinations.

The wetland area should be visually examined by walking through and around it. Check location and condition of assessment indicators such as buffer area, source area, adjacent uplands, and the wetland area. A representative assessment area within the wetland needs to be identified. In most circumstances one assessment will

Section IV - Field Guide for the Measurement of Indicators: A Procedure for the Assessment of Slope Wetlands, continued

Step 2: Field Assessment, continued

be sufficient. Some circumstances, such as with long, linear slope wetlands, may require evaluation of two or more assessment areas.

After the assessment area has been identified, follow the detailed instructions on the measurement of indicators. Variable index scores can be recorded in the worksheet (Form 1) and FCI's calculated from the worksheets contained in Form 3 or from the accompanying computer program. Before leaving the site, check to insure that you have the entire needed field data collected and recorded. Review the data to see if it makes sense and recheck data that appears questionable.

Assessment Indicators (Variables)

Wetland Buffer Condition, Continuity, and Width

The buffer is considered the zone of transition between the jurisdictional wetland boundary and the surrounding upland landscape. It is, technically speaking, part of the upland and not the wetland. Thus, establishment of the jurisdictional wetland boundary, and determination of the wetland assessment area, is necessary in order to determine the buffer area. Three variables relating to the buffer are rated in this model. They are condition V_{bcond} , continuity V_{bcont} , and width V_{bwidth} . The indexing of the condition and continuity variables involves both objective and subjective methods. In other words, recorded measurements and best professional judgment are used. Indexing the buffer width variable is essentially derived from a distance measurement, although in some instances evaluator judgment may be needed to arrive at an average width when actual measurements are variable.

Where to Measure

For purposes of evaluation using this model, the buffer zone should be considered as the area from the wetland boundary outward to a distance of 100 feet. After the wetland assessment area is established, the buffer zone adjacent to the assessment area should be established and evaluated. An imaginary line can be drawn on the landscape to establish this area or, if desired, flags can be placed at the wetland boundary and 100 feet out from that boundary.

When to Measure

Evaluation of the condition, continuity, and width of the buffer can be done at any time during the assessment procedure. For efficient use of time, it is best to collect measurements for these variables simultaneously, after establishment of the jurisdictional wetland boundary.

Section IV - Field Guide for the Measurement of Indicators: A Procedure for the Assessment of Slope Wetlands, continued

What and How to Measure

Visual observations and actual measurements should be made in order to score this variable. In most situations on agricultural land, the buffer zone will either be herbaceous and/or woody vegetation, tilled, or a combination of these.

Buffer Condition

If the entire buffer zone is herbaceous and/or woody vegetation adjacent to the assessment area, an estimation of the native vegetative canopy cover is all that is needed. In many instances, buffers are seldom continuous adjacent to wetlands in only one condition. In areas of intensive agriculture, the buffer may be something less than 100 feet in width, or it may be absent altogether. In these situations, the evaluator often must use some discretionary judgment in scoring this variable. If the condition of the buffer varies along the length of the wetland assessment area, representative sites in the buffer zone should be selected, native canopy estimated at each site, and a representative average calculated for the entire buffer. In situations where partial tillage (or other partial manipulation) of the buffer has occurred, an average width of the buffer should be determined and recorded.

Buffer Continuity

When assessing this variable, the buffer on all sides of the wetland assessment area should be considered. The evaluation of buffer continuity involves examining the 100 foot-wide buffer strip, and determining to what extent it occurs along the length of the assessment area. The first step is to determine whether the buffer is in permanent vegetative cover 100 feet from the edge of the wetland, for the length of the assessment area. If it is not, an average width should be determined. The second step is to determine if a permanently vegetated buffer occurs along the entire length of the wetland, or if there are breaks in the occurrence. Best professional judgment should be employed by the evaluator to determine percent continuity when the buffer is less than one hundred percent continuous.

Buffer Width

The width of the buffer zone can be determined by field measurements. The buffer on all sides of the assessment area should be considered. If the buffer width is variable along the length of the assessment area and is less than 100 feet wide, measurements should be taken and averaged and best professional judgment used to determine an average width.

Section IV - Field Guide for the Measurement of Indicators: A Procedure for the Assessment of Slope Wetlands, continued

What to Record

Representative or Average Width of the Buffer _____ ft., **or**

Percent of Buffer Zone Disrupted by Tillage _____ %.

Estimated Percent Canopy Cover of Native Vegetation in the Buffer _____ %.

Detritus

Where to Measure

Detritus is to be measured within the wetland. The assessment area should be scouted, and a representative site selected for sampling. If it appears that the thickness of the detritus layer is highly variable, several sampling points should be selected, and an average thickness determined.

When to Measure

Measurement of detritus can be taken at any time during the assessment procedure. For efficient use of time, it is best to collect measurements in conjunction with the delineation procedure or in conjunction with collecting data for the V_{sed} and V_{sorp} variables.

What and How to Measure

Detritus is the dead plant (excluding the current year's growth) and animal material that is in contact with the soil surface. It occurs in various stages of decomposition. Two methods for determining detritus thickness work equally well, depending on the thickness of the detritus layer.

Preferred Method

The index finger can be used to measure detritus if the thickness doesn't exceed about 8 cm. Carefully insert the finger through the detritus until it comes in contact with the surface of the soil (commonly characterized by a cool, damp, slippery feeling). Care should be taken not to compact the detritus layer. The thickness can be noted on the finger, measured, and recorded. If the detritus layer exceeds about 8 cm. thicknesses, a ruler or tape measure can be used directly. A narrow slit should be made through the layer and a measuring device inserted until it comes to rest on the soil surface.

Section IV - Field Guide for the Measurement of Indicators: A Procedure for the Assessment of Slope Wetlands, continued

Detritus, continued

Alternate Method

A spade can be used to remove a plug of soil and the overlying detritus layer. This method disturbs the layer and commonly causes some compaction. An estimate of the amount of disturbance should be made, and the detritus layer measured and recorded.

If the sampling site is inundated with water, the use of a soil probe with a 1.5" diameter tube would be more practical than use of a spade. Compare the cored samples to the detritus mass in the wetland. Coarse or fibrous material may slide around the probe tip. If the core samples do not match the source area, another one of the previous sampling techniques should be used.

What to Record

Month or season measurement is taken _____

Representative or Average Thickness of Detritus in the Wetland _____ cm.

Microtopographic Complexity

Where to Measure

This variable will be measured within the wetland.

When to Measure

These measurements can be taken at anytime during the assessment, but for efficiency, could be performed in conjunction with the delineation procedure.

What and How to Measure

This variable measures changes in the ability of the wetland surface to slow the rate of surface water flow. When rating, observations should include use and management of the wetland, as well as evidence of high water flows, flow path characteristics, distribution of natural surficial variability (such as with hummocks) versus variability or lack thereof under disturbed conditions, and changes in slope. Although cross-sectional surveys and measurements can be taken of the wetland surface, best professional judgment should be employed when evaluating the condition of the wetland and rating this variable.

Section IV - Field Guide for the Measurement of Indicators: A Procedure for the Assessment of Slope Wetlands, continued

Microtopographic Complexity, continued

Wetland Management

Discussion with the owner/operator and local specialists may provide insight as to past management of the assessment area. If the wetland is grazed, hayed, tilled, etc., find out as much about site and unit management as possible. When on-site, observe the wetland and record whether the wetland is in its natural state or whether it has been disturbed. Use best professional judgment to determine such things as condition of the vegetation and whether dominated by native or non-native species (if vegetated); if grazed or hayed, the apparent level of management; and, if tilled, frequency and effectiveness of tillage operations through the wetland.

Wetland Topography

Variability in, and changes to, the microtopographical roughness of the wetland surface should be observed on-site. Cross-sectional surveys of the assessment area aid in the determination of "highs" and "lows", their occurrence in the wetland landscape, and their frequency of occurrence. Average annual peak discharge depth can be calculated using methods found in the Engineering Field Manual Chapter 2 (EFM 2), or technical releases 20 or 55 (TR 20 or TR 55). When observing the assessment area, record the presence or absence of naturally occurring hummocks, evidence of peak discharge depth, variability in the principal surface water flow path, and abrupt changes in slope. Also note severe disturbances such as channelization.

What to Record

Land Use of Wetland _____

Distribution and Frequency of Naturally-Occurring Hummocks

Frequency of Meanders, or Changes in the Main Surface Water Flow Path

Section IV - Field Guide for the Measurement of Indicators: A Procedure for the Assessment of Slope Wetlands, continued

Microtopographic Complexity, continued

If permanently vegetated,

Native or Non-Native Dominants _____

Level of Management _____

Grazing Pressure _____

Mowing Frequency _____

Does the average annual, peak discharge depth exceed the average annual height of the vegetation present (Yes/No)? _____

If tilled,

Frequency of Tillage _____

Other Notes:

Vegetation Density

Where to Measure

Ground cover is to be measured within the wetland. The assessment area should be scouted, and a representative site (or sites) selected for sampling. Ground cover can be relatively contiguous throughout a wetland, or it can be variable. In addition, species composition can be diverse and uniformly distributed, or monogamous and clustered (such as in the case of dense stands of cattails). In instances when species composition and density of vegetation present in the assessment area is variable, several sampling points should be selected and averaged in order to capture the variability.

When to Measure

Measurement of vegetative ground cover can be taken at any time during the assessment procedure. For efficient use of time, it is best to collect measurements in conjunction with the delineation procedure or in conjunction with collecting data for the V_{pratio} variable. Measurement of this variable will be more difficult during the

Section IV - Field Guide for the Measurement of Indicators: A Procedure for the Assessment of Slope Wetlands, continued

Vegetation Density, continued

non-growing season, particularly winter and early spring, due to the disruption of standing vegetation and vegetative remnants by snow, wind, and other climatic factors.

What and How to Measure

The evaluation of ground cover needs to be based on the typical inter-seasonal and intra-seasonal conditions of the wetland. Wetlands that are covered with perennial vegetation are easy to rate. Wetlands that are cultivated intermittently may be more difficult to assess. Events such as fire, tillage, extended wet or dry periods, and abrupt changes in precipitation may culminate in a plant cover that is much more or much less than average for the site. In these cases, additional information should be sought and best professional judgments used when assessing the site. Document observations from aerial, color slides and infrared photography from the current and previous years, and the observations of reliable persons familiar with the site.

Outline the assessment area, either using flags or mentally. Evaluate the plant cover on the entire assessment area, but not beyond. Avoid being thrown off by tillage lines or other pseudo-boundaries.

Look at the wetland from a vantage point to be able to identify areas with significantly more or less cover than the predominant situation. Determine the relative size of each such area by visual estimation or by measurement such as pacing, and record findings. Assess the plant cover on each portion individually; assign a weighted index score for the wetland as a whole.

If the wetland has been cultivated or otherwise disturbed in a manner that reduces vegetative growth, observe the amount of plant material present on the surface, and record observations on the site. A mental or other comparison of the assessment site and a comparable native site in excellent condition is helpful.

Consider the temporal aspects of vegetative cover. While native wetlands in excellent condition are usually covered with growing vegetation for most of the growing season, plant cover on cultivated sites is widely variable. Best professional judgment is critical for assigning the index score that represents the inter- and intra-seasonal average for the wetland.

What to Record

Is the assessment area in permanent vegetative cover or has it been tilled?

Section IV - Field Guide for the Measurement of Indicators: A Procedure for the Assessment of Slope Wetlands, continued

Vegetation Density, continued

What to Record, continued

If permanently vegetated,

How many significantly different vegetative canopies occur on the site?

Estimate the ground cover over the entire wetland assessment area. _____%

If tilled,

Partially tilled _____ (What percent of area _____%) or completely tilled _____

Estimated ground cover present over the entire wetland assessment area _____%

Soil Pores

Where to Measure

Soil pores will be measured within the wetland. The entire wetland assessment area should be evaluated, and representative sites selected for sampling. If the wetland assessment area has been partially tilled (in other words, part of the area is or has been tilled and part hasn't), evaluations should be made in both tilled and untilled portions of the wetland. Site selection will depend upon the size and the uniformity of the wetland area. In most situations, the soils within an undisturbed slope wetland will vary only slightly from the wetland boundary to the bottom of the wetland. A site approximately midway between these two points will normally suffice. Measurements taken should be evaluated and averaged in order to assign the typical or representative conditions for the wetland.

When to Measure

Soil pores can be measured at any time during the assessment procedure. For efficient use of time, it is best to collect measurements in conjunction with the delineation procedure or in conjunction with collecting data for the V_{detritus} , V_{sed} , and V_{sorpt} variables.

What and How to Measure

Pores are naturally occurring voids in the soil which facilitate the occurrence and movement of air and water. The number, size, and continuity of pores in soil may vary

Section IV - Field Guide for the Measurement of Indicators: A Procedure for the Assessment of Slope Wetlands, continued

Soil Pores, continued

What and How to Measure, continued

considerably from an undisturbed site to one that is or has been in agricultural production. In assessing this variable, look for topographical highs and lows in the wetland, remnant crop residues, or other features that may indicate past tillage.

A spade can be used to dig a hole and extract a vertical slab of soil. The slab should extend to a depth of 16 inches. In many instances, particularly if the site is inundated with water, a soil probe (preferably one with a 1.5 inch diameter tube) can be used to extract a sample. When working with coarse textured soils (loamy sands and coarser), a soil probe may not work.

Apply a moderate thud to the back of the spade to help show the natural structure cleavage of the soil. Record the presence or absence of an Ap horizon (plow layer), or other evidence of past tillage. Look for smooth, horizontal layer(s) in this zone that could indicate presence of a plow layer. Observe the 4 to 10 inch layer and pay special attention to evidence of a plow pan. Horizontal root growth is a good indicator of a highly compacted layer (plow pan). Record any observations from this zone.

Examine the slab of soil and note the size, shape, and grade (distinctness) of the soil peds in the A horizon. Note if the structure parts to medium and fine granular, as well as the size of any blocks and/or prisms. Record the size, grade, and type of structure present in the A horizon. (Note: If using a soil probe with a 1.5 inch diameter tube, larger structural units such as blocks and prisms may not be easily observed.)

Examine horizontal **ped** surfaces for tubular pores. Concentrate on the layer with the least amount of pores and the most compaction if an **Ap** horizon is present. Count the number of very fine and fine pores in a square centimeter and the number of medium and coarse pores in a square decimeter. Also examine the pores to determine their continuity. Record the number of pores and their continuity. (Note: Roots are a surrogate for pores. Abundance and distribution of roots in the A horizon can be used to indicate pore abundance.)

Determine rupture resistance (consistence) in the upper 16 inches of the soil. Obtain a soil ped approximately one inch cube that has not been compressed or deformed. Crush it between your forefinger and thumb, noting the strength needed to deform or rupture it. Record the effort needed to crush the **ped** as very friable (very slight force needed), friable (slight force needed), firm (moderate force needed), or very firm (strong force needed). Record the most resistant measurement found within the upper 16 inches of the soil. (Note: If the assessment site is tilled, this will probably be in a 4 inch thick layer found just below the tillage zone. This may extend to a depth of 12 inches.)

Section IV - Field Guide for the Measurement of Indicators: A Procedure
for the Assessment of Slope Wetlands, continued

Soil Pores, continued

What to Record

Primary Indicators:

Evidence of Past Tillage (yes/no) _____

Ap Horizon Present (yes/no) _____

Evidence of Plow Pan (yes/no) _____

Secondary Indicators:

Texture of A Horizon

0 to 6-inch Depth _____

6 to 12-inch Depth _____

Soil Structure

Size _____

Type _____

Grade _____

Soil Pores

Number _____

Continuity _____

Rupture Resistance _____

Ratio of Native to Non-Native Species

Where to Measure

Plant species ratio is to be measured within the wetland. The entire wetland assessment area should be considered and evaluated when rating this variable.

Section IV - Field Guide for the Measurement of Indicators: A Procedure for the Assessment of Slope Wetlands, continued

Ratio of Native to Non-Native Species, continued

When to Measure

Measurement of the ratio between native and non-native species present in a wetland can be taken at any time during the assessment procedure. For efficient use of time, it is best to collect measurements in conjunction with the delineation procedure or in conjunction with collecting data for the V_{pcover} variable.

What and How to Measure

This measurement needs to take into account the typical inter-seasonal and intra-seasonal conditions of the wetland. Wetlands covered with perennial vegetation are relatively easy to rate. Events such as fire, tillage, extended wet or dry periods, and abrupt changes in precipitation can change the species composition in part or all of the wetland. In these cases, seek additional information and use best professional judgments. Local experts who are familiar with the site may be able to provide useful information.

Rating this variable requires a determination of the percent occurrence of native and non-native species in the wetland. The evaluator has the option of choosing to run a species transect survey through the wetland, or of using visual observations to estimate species composition. Less experienced evaluators may wish to use scientific methods of determining species composition and percentages, such as a point-intercept transect, until experience is gained and the evaluator is confident that visual observations will provide reasonably accurate figures.

Method 1: Transecting the Area

Traverse the wetland assessment area and note the occurrence and distribution of plant species present on the site. An area in perennial vegetation will usually require more time to survey than one that is tilled. If the site is undisturbed, select one or more sites at which to collect transect data. Selection and number of transect sites will depend on the number of significantly different plant communities present in the wetland assessment area, distribution of individual species, and size of the area. A well-distributed native plant community may only require one sampling point, whereas a conglomerate of different plant communities may require more. Also, larger wetland areas may require more sampling points when different plant communities are present. Disturbed sites, such as sites that have been seeded to hay land or pasture species or tilled, may require only a visual determination of specie(s) present. Decide which transect method will work best in the assessment area. Record all species present, identify whether each is a native or non-native, and determine percent composition of

Section IV - Field Guide for the Measurement of Indicators: A Procedure for the Assessment of Slope Wetlands, continued

Ratio of Native to Non-Native Species, continued

What and How to Measure, continued

Method 1: Transecting the Area, continued

each species. In most instances, the four dominant species present will be used to determine a rating for this variable.

Method 2. Visual Observations

Traverse the assessment area and note the occurrence and distribution of plant species present on the site. If the evaluator chooses to use best professional judgment in making a visual survey of the site, thorough coverage of the assessment area is required to obtain a complete list of the plant species present. Unlike transecting, especially when two or more transects are required, visually evaluating the plant community within the wetland should produce only one set of data. Wetlands that contain segregated plant communities with significantly different components will require more time in the observation process than those wetlands with relatively homogenous communities. Likewise, wetlands with little diversification, such as with introduced species or monogamous stands of plant species (such as cattails), will require little time in the evaluation process. As with the vegetative transect method, record all species present, identify whether each is a native or non-native, and determine percent composition of each species.

What to Record

<u>Species Present On-Site</u>	<u>Native or Introduced</u>	<u>Percent Composition</u>
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Section IV - Field Guide for the Measurement of Indicators: A Procedure for the Assessment of Slope Wetlands, continued

Ratio of Native to Non-Native Species, continued

What to Record, continued

<u>Species Present On-Site</u>	<u>Native or Introduced</u>	<u>Percent Composition</u>
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Percent Native Species Present On-Site _____ percent

Sediment Delivery to Wetland

Where to Measure

Sediment is to be measured within the wetland. The entire wetland assessment area should be evaluated, and representative sites selected for sampling. Measurements taken should be evaluated and averaged in order to assign the typical or representative conditions for the wetland.

It will be necessary to predict the most likely place to find sediment in the wetland. This will provide an accurate measurement with the least amount of effort. Attention should focus on identifying sources of greatest sediment yield and points where runoff will be the greatest. If parts or all of the adjacent uplands are cropped, or have been cropped in the past, it is likely that areas in the wetland with the greatest deposition of sediment will be adjacent to those cropped uplands. Points where ephemeral drainages enter the wetland from adjacent uplands will also likely exhibit the greatest deposition of sediment, especially if the uplands are cropped.

Section IV - Field Guide for the Measurement of Indicators: A Procedure for the Assessment of Slope Wetlands, continued

Sediment Delivery to Wetland, continued

When to Measure

Measurement of sediment can be taken at any time during the assessment procedure. For efficient use of time, it is best to collect measurements in conjunction with the delineation procedure or in conjunction with collecting data for the V_{detritus} , V_{pore} , and V_{sorpt} variables.

What and How to Measure

Sediment is soil material displaced by wind and water. In areas of intensive agricultural production, sediment deposition in low areas such as slope wetlands is common. In many instances, culturally accelerated sedimentation is easily discernible. There are times, however, when sediment deposition may not be as easily identifiable.

Visual observations of the wetland area can provide clues as to recent and/or historic, culturally accelerated deposition of sediment. A few of the more common trademarks to look for include: small, stabilized deltas or sediment fans; small, dune-like drifts from windblown deposits; sediment staining of or thin silt deposits on detritus; accumulations of sediment along plant stems; and, partial to complete burial of plant crowns, stems, detritus, and other debris.

Preferred Method

A spade can be used to dig a hole and extract a vertical slab of soil. The slab should extend to a depth of 16 inches or more. In certain instances, particularly if the site is inundated with water, a soil probe (preferably one with a 1.5 inch diameter tube) can be used to extract a sample. When working with coarse textured soils (loamy sands and coarser), a soil probe may not work. A spade or hand auger should be used in these situations (although sediment is usually harder to detect in an auger sample).

Color and textural differences in the surface layer are often good indicators of sediment deposition. Sediment overlying an A horizon is usually lighter colored than the A horizon. A fairly narrow, definitive boundary between the two layers may also be observed. In many situations, the overlying sediment will feel gritty compared to the underlying A horizon. This is due to the deposition of more sand-sized particles during overland flow/runoff events and removal of more of the silt and clay. When the boundary between the two layers is determined, the thickness of the overlying sediment is measured and recorded as sediment delivered to the wetland. (Note: The presence of calcium carbonate, or lime, in the sediment layer is not a reliable indicator of deposition. Slope wetlands are groundwater discharge wetlands and thus are typically calcareous in their natural state.)

Section IV - Field Guide for the Measurement of Indicators: A Procedure for the Assessment of Slope Wetlands, continued

Sediment Delivery to Wetland, continued

Alternate Method

There may be situations when it is evident or suspected that there has been some delivery of sediment to the wetland, but a determination can not be made based on field observations. Consult the local soil survey and see if the assessment area has been delineated as a separate mapping unit. If it has, it may be possible to compare the thickness of the A horizon for that soil in the survey to that observed on site. These will only work if an abrupt (or other readily discernible) boundary between the A and B horizons is observed. The difference between the average thickness of the A horizon observed on site and that reported in the soil survey could be used to estimate the amount of sedimentation which has occurred in the assessment area.

If none of the above provides a reasonable measure of sedimentation, best professional judgment, based on surficial observations, should be used.

What to Record

Representative or Average Thickness of Sediment in the Wetland _____ (inches)

Other Visual Observations:

Sorptive Properties of Wetland Soils

Wetland soil sorptive properties directly influence the ability of the soil, and hence wetland, to retain and release elements and compounds. Soil texture and organic matter content in the upper part of the soil profile affect the ability of the soil to perform this function.

Where to Measure

Soil sorptive properties are to be evaluated within the wetland. The wetland assessment area should be evaluated and a representative site selected for sampling. Site selection will depend upon the size and the uniformity of the wetland area. In most situations, the soils within a slope wetland will vary only slightly from the wetland boundary to the bottom of the wetland. A site approximately midway between these two points will normally suffice. Measurements taken should reflect the typical or representative conditions for the wetland.

Section IV - Field Guide for the Measurement of Indicators: A Procedure for the Assessment of Slope Wetlands, continued

Sorptive Properties of Wetland Soils, continued

When to Measure

Measurement of soil properties for determination of sorptive capacity can be taken at any time during the assessment procedure. For efficient use of time, it is best to collect measurements in conjunction with the delineation procedure or in conjunction with collecting data for the V_{detritus} , V_{pore} , and V_{sed} variables.

What and How to Measure

Soil properties, of concern, when evaluating this variable are texture and organic matter content. Begin by digging a hole and extracting a vertical slab of soil. The slab should extend to a depth of at least 16 inches. In certain instances, particularly if the site is inundated with water, a soil probe (preferably one with a 1.5 inch diameter tube) can be used to extract a sample. When working with coarse textured soils (loamy sands and coarser) a soil probe may not work. A spade or hand auger should be used in these situations.

The extracted sample should be examined in a moist state, and not wet (saturated) or dry. Determine whether the texture of the 0 to 12 inch surface layer is sandy (textures of loamy fine sand or coarser) or loamy/clayey (textures of sandy loam and finer). If the texture of this layer is loamy or clayey, record this and use the 0 to 12 inch layer for the next step. If the texture is sandy, record this and use the 0 to 6 inch layer for the next step.

Using the Munsell Soil Color Charts, examine the colors of the layer identified above (the 0 to 12 inch layer for loamy or clayey soils, or the 0 to 6 inch layer for sandy soils). Record the hue, value, and chroma. If the color varies within the observed depth, record the dominant color (the color that occurs in 50 percent or more of the layer). (In the case of sandy soils, check for neutral colors in the A horizon and note whether there is a darker colored A horizon below and contiguous to the surface layer within the upper 6 inches.)

List the hydric soil indicator used to identify the hydric soil if found in the publication, Field Indicators of Hydric Soils in the United States. If EDTA is used for determining the level of soil organic matter in the field, use the field method outlined by R. A. Bowman, United States Department of Agriculture (USDA)-ARS, Akron, Colorado.

Section IV - Field Guide for the Measurement of Indicators: A Procedure for the Assessment of Slope Wetlands, continued

Sorptive Properties of Wetland Soils, continued

What to Record

Texture of "A" Horizon:

0 to 6-inch depth _____

6 to 12-inch depth _____

Soil Color

Hue _____

Value _____

Chroma _____

Is a darker "A" horizon contiguous below 6 inches? _____

Percent Organic Matter (EDTA Method, if used) _____

Source Area of Flow Intercepted by Wetland

Where to Measure

This variable reflects the catchments or watershed of the wetland. Measurement of this variable will be compared to the unaltered catchments area of the wetland.

When to Measure

These measurements can be taken at any time during the assessment, but for efficiency, they could be done in the office and checked in the field. If small wetlands on flatter topography that do not show contour lines on the USGS maps, sketch the catchments area on an aerial photo in the field.

What and How to Measure

Review aerial photography, United States Geological Survey (USGA) quad sheets, slope and effect maps and the NWI maps. Outline the original (natural or unaltered) catchments area on a topographic map. Note and document any surface alterations (roads, surface ditches, terraces, etc.), irrigation

Section IV - Field Guide for the Measurement of Indicators: A Procedure for the Assessment of Slope Wetlands, continued

Source Area of Flow Intercepted by Wetland, continued

systems, and subsurface alterations (tile, wells, etc.) within 500 feet, or within the catchments area of, the wetland. Estimate the amount of catchments area that has been structurally altered to prevent flow to wetland (such as roads without culverts, terraces, etc.). Determine and document wetland subclass. From the USGS quad map, delineate the original (natural or unaltered) catchments area.

If the office review can determine that the catchments area has been altered, determine the amount of catchments area that has been structurally altered to prevent or add flow to the wetland. In most cases, the variable index is calculated based on percent of catchments from which water is added to or prevented from reaching the wetland. (If ten percent of the catchments have been “cut-off”, or if ten percent additional catchments have been added to the source area, the index rating would be a 0.9).

In the field, verify all alterations noted during the off-site review and document any additional alteration found during the field investigation.

What to Record

Type and effect of surface alteration(s) within watershed _____

Type and effect of subsurface alteration(s) within watershed _____

Change in NWI wetland subclass (YES or NO) _____

Addition to, or subtraction from, original watershed area _____ percent

Subsurface and Surface Hydrology Alterations

Alterations to wetland hydrology have an impact on the surface and subsurface hydrologic regime, or flow network, within the wetland. These variables assess the impacts that subsurface V_{subalt} and surface V_{surfalt} alterations have on wetland hydrology.

Where to Measure

Measurement of the subsurface alteration V_{subalt} variable will be made from the wetland boundary. Measurement of surface alterations V_{surfalt} is done within the wetland

Section IV - Field Guide for the Measurement of Indicators: A Procedure for the Assessment of Slope Wetlands, continued

Subsurface and Surface Hydrology Alterations, continued

assessment area. Scope and effect equations documentation may be used to determine extent of drainage in conjunction with field verification

When to Measure

These measurements can be taken at any time during the assessment procedure, but for efficiency, could be performed in conjunction with delineation of the wetland assessment area. It is best to evaluate these variables simultaneously. Distances to drainage features may be measured from aerial photography prior to going to the field.

What and How to Measure

Alterations to wetland hydrology can occur in several forms. The most common manipulations are tiling, ditching, and fill placement within the wetland. These manipulations impact lateral movement of subsurface flow (or saturation) and/or surface water flow, and generally result in a decrease of water to the wetland. Approved surveying methods and equipment should be used to determine elevations and distances.

The wetland assessment area should be scouted, along with the adjacent non-wetland area, and evidence of the presence of artificial drainage and/or fill noted. Depending on the type of manipulation that has been identified and whether it is a subsurface or surface alteration or both, follow the steps outlined below.

Subsurface Hydrology Alterations

Elevations of buried subsurface drainage features (tile) should be determined as follows:

- Determine the tile size from scope & effect equations or local information.
- Determine the shortest distance between the tile and the wetland.
- Determine the depth the tile is below the ground surface.
- Shoot the elevation at this location and subtract the depth to tile and the tile diameter from the ground elevation.

Elevations of surface drainage features (road ditches, accelerated gullies, etc.) should be determined as follows:

- Determine the shortest distance between the surface drainage feature and the wetland.

Section IV - Field Guide for the Measurement of Indicators: A Procedure for the Assessment of Slope Wetlands, continued

Subsurface and Surface Hydrology Alterations, continued

- Shoot the elevation of the lowest point in the surface drainage feature at this distance.

Surface Hydrology Alterations

Office Procedures:

- From USGS topographic map determine wetland watershed (use same procedures as in V_{source}).
- Using procedures outlined in the Engineering Field Manual (EFM), Section 2, calculate the peak discharge for the five and ten year, 24 hour storm.

Field Procedures:

- Shoot sufficient elevations of the surface alterations to determine cross-sectional area.
- Shoot sufficient elevations to determine slope of alteration.
- Using the cross-section, slope, and storm peak discharge information to determine if the constructed channel will handle the storm discharges (either calculate the channel capacity manually or use the waterway design capacity tables found in the EFM, Section 7).

What to Record

Type of Alteration Present (Subsurface, Surface, or Both) _____

If a Subsurface Alteration is present:

Type of subsurface alteration(s) _____

Distance from wetland edge to subsurface alteration _____ feet.

Elevation of bottom of wetland _____

Invert elevation of subsurface alteration _____

Subsoil Texture (2-3 ft. depth, from soil survey publication or field determination)

Distances from lateral effects table _____ feet.

Section IV - Field Guide for the Measurement of Indicators: A Procedure for the Assessment of Slope Wetlands, continued

Subsurface and Surface Hydrology Alterations, continued

If a Surface Alteration is present:

Type of surface alteration(s) _____

Distance from wetland edge to surface alteration _____ feet.

Elevation of bottom of wetland _____

Invert elevation of surface alteration _____

Surface alteration cross-sectional area _____ feet².

Slope of surface alteration _____

Percent of wetland affected by fill _____ percent

Percent of wetland affected by dugout _____ percent

Upland Land Use

Where to Measure

Upland land use refers to the land use within the wetland watershed area (the area that contributes to the wetland hydrology), excluding the wetland. For evaluation of this variable, the dominant land use and condition of the land within this area will be noted.

When to Measure

Information on present land use is needed to accurately measure and determine the condition of this variable. The land use in the wetland watershed area can be checked in the office from aerial photography and other maps, but will need to be verified in the field. The observation of land use condition may vary by season and is subject to best professional judgment during some time periods.

What and How to Measure

This variable considers a disturbance gradient from well-managed native prairie to an impervious surface such as is found with urbanization. Type of tillage, cropping system, haying, level of grazing management, amount of bare ground and composition of

Section IV - Field Guide for the Measurement of Indicators: A Procedure for the Assessment of Slope Wetlands, continued

Upland Land Use, continued

species present will need to be observed. Thickness of sediment within the wetland may provide an indication of the past management of the upland. Information on best management practices in use should be noted.

Upland land use categories considered in this variable include the following:

- Permanent native or non-native vegetation; grazed; well managed or under some system of grazing management
- Idle non-native grassland
- Permanent hay land
- Cropland, rotations, and type of tillage
- Other disturbances (urbanization)

What to Record

Dominant Upland Land Cover Type

Use (such as idle, grazed seasonally, hay land, etc.)

Level of Management

Cropland Rotation

Tillage in Use

Other Notes, such as evidence of accelerated erosion, excessive (>50%) bare ground, etc.

Wetland Land Use

Where to Measure

Wetland land use refers to the use within the actual wetland assessment area. For evaluation of this variable, the dominant use and condition within this area will be noted.

Section IV - Field Guide for the Measurement of Indicators: A Procedure for the Assessment of Slope Wetlands, continued

Wetland Land Use, continued

When to Measure

Information on past and present wetland use is needed to accurately measure and determine the condition of this variable. Past or historical use within the wetland assessment area should be checked in the office by viewing current and old aerial photography and other land use maps. The owner or operator of the tract may be able to supply information regarding historic wetland use. Current wetland use will be determined in the field. The observation of use and condition may vary by season and is subject to best professional judgment during some time periods.

What and How to Measure

This variable considers a disturbance gradient from well-managed native prairie to an impervious surface such as is found with urbanization. Evidence and type of tillage (past or present), cropping system, haying, level of grazing management, amount of bare ground and composition of species present will need to be observed. In addition, anthropogenic disturbances within the wetland, such as excessive trampling by livestock or rutting and compaction by farm machinery, should be noted.

Generally, visual observation of the assessment area will suffice for determining the current wetland use and condition. Wetland use categories considered in this variable include the following:

- Wetland use (such as grazing, hay land, cropland, idle)
- Level of management
- Permanent hay land, and frequency of haying
- If in cropland, rotations and type of tillage in use
- Other disturbances (urbanization)

What to Record

Use of Wetland (idle, grazed seasonally, hay land, cropland, etc.)

Level of Management

Section IV - Field Guide for the Measurement of Indicators: A Procedure
for the Assessment of Slope Wetlands, continued

Wetland Land Use, continued

Cropland Rotation

Tillage in Use _____

Other Notes (such as evidence of accelerated erosion, compaction, trampling, rutting,
etc.)

Appendix A. Variable Score Field Form

Field Office _____ Producer/Landowner _____

County _____ Assessment Area ID. _____

Date _____ Wetland and Acres (Pre-) _____

Wetland Acres (Post-) _____

Variable	Measurement Result	Variable Score		Discussion/Rationale
		Pre-Project	Post-Project	
V _{bcond} : Grassland Buffer Condition				
V _{bcont} : Grassland Buffer Continuity				
V _{bwidth} : Grassland Buffer Width				
V _{detritus} : Detritus				
V _{micro} : Microtopographic Complexity				
V _{pcover} : Vegetation Density				
V _{pore} : Soil Pores				
V _{pratio} : Native to Non-Native Species				
V _{sed} : Sediment Delivery to Wetland				
V _{sorpt} : Sorptive Properties of the Soil				
V _{source} : Source area of Overland Flow				
V _{subalt} : Subsurface Hydrology Alterations				
V _{surfalt} : Surface Hydrology Alterations				
V _{upuse} : Upland Land Use				
V _{wetuse} : Wetland Land Use				

**Appendix B(1)
Variables with Index Values**

Model Variable	Buffer Condition ($V_{buffcon}$) Measurement or Condition	Index
<p>Definition: Dominant land use condition within 100 feet of the outermost edge of the wetland.</p>	<p>No change to wetland buffer from natural conditions. Vegetative canopy present is 90 to 100 percent. Vegetation consists of native grasses, forbs, and/or shrubs/trees.</p>	<p align="center">1</p>
	<p>Tillage disrupts 1 to 25 percent of wetland buffer area, or Native vegetative canopy present (grasses, forbs, and/or shrubs/trees) is 75 to 89 percent.</p>	<p align="center">0.75</p>
	<p>Tillage disrupts 26 to 50 percent of wetland buffer area, and no-till or minimum till practices are used on buffer area, or Native vegetative canopy present (prasses, forbs, and/or shrubs/trees) is 50 to 74 percent.</p>	<p align="center">0.5</p>
	<p>Tillage disrupts 51 to 75 percent of buffer area, and conventional tillage practices are used on buffer area, or Native vegetative canopy present (grasses, forbs, and/or shrubs/trees) is 25 to 49 percent.</p>	<p align="center">0.25</p>
	<p>Tillage has disrupted > 75 percent of buffer area; conventional tillage used; best management practices (BMP's) are used in area adjacent to wetland, or Native vegetative canopy present (grasses, forbs, and/or shrubs/trees) is 1 to 24 percent.</p>	<p align="center">0.1</p>
	<p>No buffer present and no BMP's used in area adjacent to wetland.</p>	<p align="center">0</p>

**Appendix B(2)
Variables with Index Values**

Model Variable	Buffer Continuity (V_{bcont}) Measurement or Condition	Index
Definition: Continuity of the buffer within 100 feet of the outermost edge of the wetland.	Continuity is 76 to 100 percent.	1.0
	Continuity is 51 to 75 percent.	0.75
	Continuity is 26 to 50 percent.	0.5
	Continuity is 1 to 25 percent.	0.25
	No continuity; however, there is potential for recovery.	0.1
	No continuity and no potential for recovery.	0.0

Model Variable	Buffer Width (V_{bwidth}) Measurement or Condition	Index
Definition: Width of the buffer surrounding the outermost edge of the wetland.	Average width of the buffer is > 100 feet.	1.0
	Average width of the buffer is 75 to 99 feet.	0.75
	Average width of the buffer is 50 to 74 feet.	0.5
	Average width of the buffer is 25 to 49 feet.	0.25
	Average width of the buffer is 10 to 24 feet.	0.1
	Average width of the buffer is < 10 feet.	0.0

Appendix B(3) Variables with Index Values

Model Variable	Detritus (V_{bwidth}) Measurement or Condition	Index
<p>Definition: The presence of litter from herbaceous, shrubby, and woody plants in the wetland in various stages of decomposition. Only plant debris that is prostrate and in direct contact with the soil surface should be considered. A histic epipedon, or a soil layer with histic properties, is considered organic material and should be included in the detritus layer. NOTE: The entire wetland assessment area should be considered. If the detritus layer within the assessment area is highly variable, use an average thickness for rating.</p>	<p>Litter layer thickness in: winter/spring (December - May) is 6 to 10 centimeters, summer (June - August) is 4 to 7 centimeters, fall (September - November) is 2 - 5 centimeters.</p>	1.0
	<p>Litter layer thickness in: winter/spring (December - May) is 3 to < 6 or >10 centimeters, summer (June - August) is 2.5 to < 4 or > 7 centimeters, fall (September - November) is 1 to < 2 or > 5 centimeters.</p>	0.75
	<p>Litter layer thickness in: winter/spring (December - May) is 1.5 to < 3 centimeters, summer (June - August) is 1 to < 2.5 centimeters, fall (September - November) is 0.5 to < 1 centimeters.</p>	0.5
	<p>Litter layer thickness in: winter/spring (December - May) is > 0 to < 1.5 centimeters, summer (June - August) is > 0 to < 1 centimeter, fall (September - November) is > 0 but < 0.5 centimeter, or if wetland is cultivated, no-till practices are in use.</p>	0.25
	<p>No measurable litter is present in the assessment area. However, the wetland is relatively intact and has vegetation present (or is able to support vegetation) capable of producing detritus, or if wetland is cultivated, minimum or conventional tillage practices are in use.</p>	0.1
	<p>There is no detritus present, and the wetland has been altered or eliminated (as from urbanization) so there is no potential for recovery.</p>	0.0

**Appendix B(4)
Variables with Index Values**

Model Variable	Microtopographic Complexity (V_{micro}) Measurement or Condition	Index
Definition: The microtopographic surface roughness of the wetland.	Natural conditions occur within wetland. (Indicator: Well-managed, native vegetation with no anthropogenic disturbances evident as from overgrazing, excessive livestock trampling, or machinery crossing.)	1.0
	Vegetation consists of native or non-native species with above-average management. (Indicator: Rotational grazing, < 50 percent use of vegetation, minor evidence of livestock trampling, no evidence of overgrazing); or if hay land, is mowed every other year or less often.	0.75
	Area consists of native or non-native species under average grazing management. (Indicator: evidence of over-grazing within wetland < 50 percent of total area, 50 - 75 percent use of vegetation over most of wetland, moderate evidence of livestock trampling); or if hay land, is mowed no more than once a year.	0.5
	Area is tilled occasionally (no greater than 2 years out of 5); or area consists of severely over-grazed native or non-native species; or area is burned to remove current season's plant growth.	0.25
	Area is tilled most years (3 years out of 5 or more); or area has been channeled and is vegetated; or area consists of a non-wetland (i.e., upland) site (mitigation).	0.1
	Area has been channeled and is not vegetated, or has been obliterated by urbanization (i.e., paved, filled and leveled, etc.)	0.0

**Appendix B(5)
Variables with Index Values**

Model Variable	Vegetation Density (V_{pcover}) Measurement or Condition	Index
Definition: The abundance of herbaceous and woody plants in all vegetation zones within the wetland.	Ground and/or canopy cover is 75 to 125 percent.	1.0
	Ground and/or canopy cover is 50 to 74 percent, or >125 percent.	0.75
	Ground and/or canopy cover is 25 to 49 percent.	0.5
	Ground and/or canopy cover is 10 to 24 percent.	0.25
	Ground and/or canopy cover is 1 to 9 percent; or tilled or fallow cropland, with or without vegetation and/or clods in furrows.	0.1
	Plants absent, no ground or canopy cover.	0.0

**Appendix B(6)
Variables with Index Values**

Model Variable	Soil Pores (loamy and clayey soils) (V_{pore}) Measurement or Condition	Index
<p>Definition: The physical integrity of the soil in the surface layer and the upper part of the subsoil. This includes the number and continuity of pores, the type, grade, and size of soil structure, and moist soil consistence (rupture resistance). NOTE: <i>The conditions specified are for loamy and clayey soils (i.e., soils with textures of sandy loam and finer).</i> For soils with sandy textures (loamy fine sand and coarser), refer to the description of this variable on the next page.</p>	<p>Many medium, fine or very fine, continuous pores, AND/OR soil structure is one or more of the following: weak or moderate prismatic; moderate or strong, medium and fine, angular or subangular blocky; moderate or strong granular, AND rupture resistance is friable or very friable, OR (Indicator: No evidence of an Ap horizon, or plow layer, within the hydric soil boundary).</p>	1.0
	<p>Common fine and very fine, continuous and/or discontinuous pore, AND/OR soil structure is one or more of the following: weak or moderate prismatic; moderate or strong, medium and fine, angular or subangular blocky; moderate or strong granular, AND/OR rupture resistance is firm, OR (Indicator: An Ap horizon is present in wetland. Wetland is partially tilled or has been restored for < 20 years).</p>	0.5
	<p>Few fine and very fine discontinuous pores, AND/OR soil structure is weak coarse subangular blocky or massive (coarse clod-like or structure less), AND/OR rupture resistance is very firm or harder; AND/OR a plow pan is present in the wetland, evidenced by roots growing horizontally along the pan rather than vertically through it. (Wetland is tilled throughout most years.)</p>	0.1
	<p>The substrate is a non-porous medium (such as asphalt or concrete).</p>	0.0

**Appendix B(7)
Variables with Index Values**

Model Variable	Soil Pores (sandy soils) (V_{pore}) Measurement or Condition	Index
<p>NOTE: <i>Use this condition for soils with sandy textures (loamy fine sand and coarser).</i></p>	<p>Many fine and very fine, continuous pores (if observable), AND soil structure is one or more of the following: weak medium or fine subangular blocky; moderate or strong granular, AND rupture resistance is very friable or loose. (Indicator: No evidence of an Ap horizon, or plow layer, within the hydric soil boundary.)</p>	1.0
	<p>Common fine and very fine, continuous and discontinuous pores (if observable), AND soil structure is weak subangular blocky and or weak granular, AND rupture resistance is friable. (Indicator: An Ap horizon is present in wetland. Wetland is partially tilled or has been restored for < 20 years.)</p>	0.5
	<p>Few fine and very fine discontinuous pores (if observable), AND soil structure is one or more of the following: weak coarse subangular blocky; medium or coarse platelike, below a plow layer; massive (structure less) AND rupture resistance is firm or harder. (Indicator: An Ap horizon is present throughout the wetland. Wetland is tilled most years. A plow pan is present, as evidenced by roots growing horizontally along the pan, rather than vertically through it.)</p>	0.1
	<p>The substrate is a non-porous medium (such as asphalt or concrete).</p>	0.0

**Appendix B(8)
Variables with Index Values**

Model Variable	Ratio of Native to Non-Native Species (V_{pratio}) Measurement or Condition	Index
Definition: The ratio of native to non-native plant species present in wetland zones as indicated by the top 4 dominants or by a more extensive species survey.	Native species comprise 76 to 100 percent of the species in the wetland.	1.0
	Native species comprise 51 to 75 percent of the canopy in each zone.	0.8
	Native species comprise 26 to 50 percent of the canopy in each zone.	0.5
	Native species comprise 11 to 25 percent of the canopy in each zone.	0.3
	Native species comprise 1 to 10 percent of the canopy in each zone; OR <i>Lythrum salicaria</i> (Purple Loosestrife) is among the dominant species present; OR single dominant plant species (native or non-native) comprise a monotypic invasive stand within any wetland zone (such as cattails, reed canarygrass, etc.).	0.1
	Wetland unvegetated	0.0

Appendix B(9) Variables with Index Values

Model Variable	Sediment Delivery to Wetland (V_{sed}) Measurement or Condition	Index
<p>Definition: The extent of recent and/or historic, culturally accelerated sediment delivered to the wetland (as from human activities, including agriculture).</p>	No visual evidence of accelerated sediment delivery to wetland.	1.0
	Minor surficial evidence of sediment delivery to the wetland, primarily along the margin (such as minor accumulations of sediment in the form of small, stabilized deltas, sediment fans, or drift deposits from windblown sediments), OR visual observation indicates average deposition depth in wetland at < 3 inches.	0.75
	Surficial evidence of sediment delivery through most of the wetland (such as sediment staining of or silt deposits on detritus, or slight accumulations of sediment along plant stems); OR tillage through buffer to the outer edge of wetland (< 50 percent of wetland has been tilled), OR visual observation indicates average deposition depth in wetland at 3 to < 6 inches.	0.5
	Surficial evidence of sediment delivery through most of the wetland [such as partial burial (25 to 75 percent) of detritus, or burial of plant crowns and partial burial of stems]; OR tillage through buffer and partial or complete tillage through wetland (> 50 percent of area has been tilled), OR visual observation indicates average deposition depth in wetland at 6 to < 9 inches..	0.25
	Significant sediment delivery to the wetland, as indicated by nearly complete (> 75 percent) burial of detritus and/or vegetation in wetland. Presence of zones of sediment deposition, such as deltas, sediment fans, or drift deposits, common throughout wetland. Ephemeral or perennial gullies may be present on uplands adjacent to wetland. Best management practices lacking to control sediment delivery, OR visual observation indicates average deposition depth in wetland at 9 to 12 inches.	0.1
	Pronounced rise in bottom elevation of wetland due to accelerated sediment delivery from cultural sources such as agriculture and urbanization. Typical average deposition depth in wetland is > 12 inches.	0.0

**Appendix B(10)
Variables with Index Values**

Model Variable	Soil Sorptive Properties (loamy and clayey soils (V_{sorp}) Measurement or Condition	Index
Definition: The physical ability of wetland soils to retain and release elements and compounds. NOTE: <i>The conditions specified are for loamy and clayey soils (i.e. soils with textures of sandy loam and finer).</i> For soils with sandy textures (loamy fine sand and coarser), refer to the description of this variable on the next page.	Soil textures in the upper 12 inches are loamy or clayey (silt loam, loam, clay loam, sandy clay loam, silty clay loam, silty clay, excluding heavy silty clays and clays), and soil colors in 50 percent or more of the upper 12 inches have: value of 3 or less and chroma of 0; value of 2.5 or less and chroma of 1.	1.0
	Soil textures in the upper 12 inches are clayey (silty clay, clay, sandy clay, silty clay loam, clay loam, excluding heavy silty clay or clay textures). Cracks .5 inch wide or wider are common at the surface when dry, and soil color requirements are the same as 1.0 rating.	0.75
	Soil textures in the upper 12 inches are loamy or clayey (silt loam, loam, clay loam, sandy clay loam, silty clay loam, silty clay), and soil colors in 50 percent of more of the upper 12 inches have value of 3 or 4 and chroma of 1 or 2.	0.5
	Soil textures in the upper 12 inches are loamy or clayey (silt loam, loam, clay loam, sandy clay loam, silty clay loam, silty clay), and soil colors in 50 percent of more of the upper 12 inches have value > 4 and chroma > 2.	0.1
	The surface lacks soil or natural substrate properties (such as with asphalt, concrete, or buildings).	0.0

**Appendix B(11)
Variables with Index Values**

Model Variable	Soil Sorptive Properties (sandy soils) (V_{sorpt}) Measurement or Condition	Index
NOTE: <i>The conditions specified are for sandy soils (i.e. soils with textures of loamy fine sand and coarser).</i>	Soil organic matter content is ≥ 2 percent (measured or from published literature), AND/OR mineral soil colors in the upper 6 inches have: a neutral hue, with value of 2 or 3 or, a value of 2 or less and chroma of 1 or less, and no A horizon with darker colors occurs immediately or contiguously below 6 inches, OR the assessment area has not been drained or cropped.	1.0
	Soil organic matter content is 0.5 to 2 percent (measured or from published literature), AND/OR mineral soil colors in the upper 6 inches have value of 3 or 4 and chroma of 2 or less, OR the assessment area has been partially drained, or there is evidence of intermittent or historical tillage.	0.5
	Soil organic matter content is < 0.5 percent (measured or from published literature), AND/OR mineral soil colors in the upper 6 inches have value > 4 AND/OR chroma of > 2 , OR the assessment area has been "effectively" drained and frequently tilled.	0.1
	The surface lacks soil or natural substrate properties (such as with asphalt, concrete, or buildings).	0.0

**Appendix B(12)
Variables with Index Values**

Model Variable	Source Area of Flow Intercepted by Wetland (V_{source}) Measurement or Condition	Index
<p>Definition: The area surrounding a wetland that defines the catchment or watershed of that wetland. The entire watershed area should be considered when determining the functional index for this variable.</p>	<p>No alteration of upland watershed through surface alterations (such as water impoundment structures, terraces, roads), or subsurface alterations (such as tile drains or ditches), or additions (such as irrigation and associated practices or terrace outlets).</p>	<p align="center">1.0</p>
	<p>Presence of surface and subsurface alterations within upland watershed source area which impacts overland flow into wetland (such as terraces or roads. Less than 20 percent of watershed area is impacted.</p>	<p align="center">0.75</p>
	<p>The dominant surface and subsurface flow paths of water in the upland watershed have been altered, thus affecting the flow of water to the wetland (such as by drainage, terraces, or irrigation return). 20 to 50 percent of the watershed area is impacted.</p>	<p align="center">0.5</p>
	<p>The dominant surface and subsurface flow paths of water in the upland watershed has been altered, thus affecting the flow of water to the wetland (such as by drainage, terraces, or irrigation return), 51 to 80 percent of the watershed area is impacted.</p>	<p align="center">0.1</p>
	<p>Upland watershed extremely altered such that almost all water flow to wetland has been eliminated (such as from urbanization).</p>	<p align="center">0.0</p>

**Appendix B(13)
Variables with Index Values**

Model Variable	Subsurface Hydrology Alterations (V_{subalt}) Measurement or Condition	Index
Definition: Presence of a constructed <i>subsurface</i> drainage feature for the purpose of water transfer.	No subsurface drain present, OR float valve used for mitigation.	1.0
	Development of the assessment area for livestock water is planned (spring development reduces water flow less than 20 percent).	0.75
	Development of the assessment area for livestock water is planned. (spring development reduces water flow more than 20 percent, but less than 50 percent).	0.5
	Development of the assessment area for livestock water is planned. (spring development reduces water flow more than 50 percent, but less than 80 percent).	0.1
	Saturated conditions non-existent (spring development completely drained impacted wetland area), OR non-wetland (upland) area (mitigation purposes).	0.0

**Appendix B(14)
Variables with Index Values**

Model Variable	Surface Hydrology Alterations (V_{subfalt}) Measurement or Condition	Index
Definition: Presence of a constructed <i>surface</i> drainage feature or fill within the wetland. Depth of the surface drain, and depth of fill within the wetland, impacts wetland ground water surface elevation and movement of surface water through the wetland.	No surface drains or fills present.	1.0
	Fill exists within the wetland but affects less than 10 percent of the wetland, OR a dugout or dam exists within the wetland but affects less than 10 percent of the wetland area.	0.75
	A surface drain or gullies exist within the wetland, but are less than 1 foot in depth, OR fill exists within the wetland and affects more than 10 percent, but less than 50 percent, of the wetland.	0.5
	A surface drain or gullies exist within the wetland, and are greater than 1 foot in depth, or the natural meandering flow path has been straightened, and out of bank flow will occur for a 5 year, 24 hour storm, OR a constructed (grassed) waterway occurs or is planned within the wetland, and is designed to maintain the natural meandering flow path, OR fill or an excavation (pit) exists within the wetland and affects 50 percent or more of the wetland area.	0.25
	A surface drain exists within the wetland that is greater than 1 foot in depth, or the natural meandering flow path has been straightened, and out of bank flow will NOT occur for a 10 year, 24 hour storm, OR fill exists within the wetland and affects 50 percent or more of the wetland area.	0.1
	Armored or lined channel <u>or</u> wetland completely filled, OR non-wetland (upland) area (mitigation purposes).	0.0

**Appendix B(15)
Variables with Index Values**

Model Variable	Upland Land Use (V_{upuse}) Measurement or Condition	Index
<p>Definition: Dominant use and condition of the upland watershed that contributes to the wetland. The entire watershed area should be considered when determining the functional index of this variable.</p>	<p>Well managed, permanently vegetated native prairie. Management allows for adequate plant recovery between grazing periods.</p>	<p align="center">1.0</p>
	<p>Permanent vegetation under a system of management such as, native species under season long grazing with moderate use, OR idle non-native grassland cover, OR permanent native or non-native hay land.</p>	<p align="center">0.75</p>
	<p>Permanent native or non-native pasture which has been historically over-grazed, with some (< 50 percent) bare ground, low plant vigor, OR no-till small grain, OR minimum till small grain in a grass/legume rotation.</p>	<p align="center">0.5</p>
	<p>Permanent native or non-native pasture which has been severely over-grazed, with significant (\geq 50 percent) bare ground, low plant vigor, and evidence of soil erosion, OR no-till or minimum till row crop, minimum till small grain.</p>	<p align="center">0.25</p>
	<p>Conventional tillage small grain or row crop, OR overflow from cultural activities (industrial, urbanization, etc.).</p>	<p align="center">0.1</p>
	<p>Urban, semi-pervious, or impervious surface (this condition will result in maximum overland flow and a high rate of delivery to wetland). If best management practices employed, the impact may be somewhat less.</p>	<p align="center">0.0</p>

**Appendix B(16)
Variables with Index Values**

Model Variable	Wetland Land Use (V_{wetuse}) Measurement or Condition	Index
Definition: Dominant use and condition of the wetland.	No evidence of tillage in the wetland (adapted vegetation intact), OR if previously tilled, outermost (temporary) wetland zone presently Intact, OR if some use in the wetland (haying, grazing), no evidence of disruption to the wetland system (such as compaction, rutting by equipment, or excessive trampling by livestock).	1.0
	No evidence of tillage through innermost part of wetland (zones wetter than the temporary zone); and some evidence of disturbance (grazing, haying, or tillage) in a portion of the outermost part of wetland (temporary zone); and no evidence of ephemeral gullies in wet zone.	0.75
	Outermost part of wetland (temporary zone) is tilled or over-grazed most years; and innermost part of wetland (zones wetter than the temporary zone) is rarely tilled or are intact; and no evidence of ephemeral gullies in wet zone.	0.5
	Outermost part of wetland (temporary zone) is tilled or severely over-grazed most years; and innermost part of wetland (zones wetter than the temporary zone) is tilled or over-grazed most years; and visual evidence of ephemeral gullies present in wet zone.	0.25
	Wetland receives tillage in all zone(s) most years, and recently tilled crop and wetland vegetative remnants can be observed in area.	0.1
	Wetland more severely disturbed than indicated above (no vegetation, rutted, pig farm, feedlot, urban fill, etc.), OR non-wetland (upland) area (mitigation purposes).	0.0

Appendix E:

Instructions for filling out Excel Workbook for Interim Kansas Slope HGM Model

At the bottom of the workbook are the Excel spreadsheets associated with this model. They are to be used for documenting minimal effects determinations and mitigation using the HGM assessment method.

CALCULATION SHEETS

1) Minimal (Min) Effects sheet

This sheet is a stand alone calculation sheet used to determine if the alterations to a wetland site fall within the minimal effects criteria as stated in National Food Security Act Manual (NFSAM).

2) Impacted Site sheet

This sheet requires inputs for a wetland conversion that requires mitigation to replace lost Functional Capacity Indices (FCIs) and Functional Capacity Units (FCUs).

3) Mitigation Site sheet

This sheet requires inputs for the mitigation site that is being used to replace the lost FCUs for the impacted site.

4) FCU Change sheet

This sheet shows the data inputs for the impacted site sheet and the mitigation site sheet. It does not permit data entry, and shows the acres required to mitigate FCU losses for each function. The function(s) with the highest replacement acreage will determine the replacement acreage required for the mitigation.

SUPPORT SHEETS

1) “Flags” sheet:

This sheet lists the “yellow flags” and “red flags”, as shown in the NFSAM.

- Column B cells (B8 - B21) contains the yellow flags abbreviated expression used in the drop-down menu on the minimal effects and mitigation sheets.
- Column C (cells C9 - C21) contains the yellow flags complete statement listed in the NFSAM, page KS516-2a.
- Column B (cells E8 - E12) contains the red flags abbreviated expression used in the drop-down menu on the minimal effects and mitigation sheets.
- Column C (cells F9 - F11) contains the complete statement listed in the NFSAM.

SUPPORT SHEETS, continued

2) Variable (Var) Field Form sheet

This sheet can be printed and used in the field for entering the field variable index rating for each variable in the field. The variable rating values can then be entered in the appropriate spreadsheet.

3) Functions List sheet

This sheet is a chart listing all of the variables used in each FCI equation used in the model.

SAVING THE FILE

At the top of any of the sheets in the workbook,

1. click on the “File” option of the menu bar,
2. click on “Save As”,
3. in the “Save As” box, find the “Name as” box and enter a file name (for example the Landowner’s name),
4. in the “Save In” box at the top of the “Save As” screen, click on the “Down” arrow, and click on the directory/folder that you want the file saved in,
5. click “OK” in the upper right hand portion of the “Save As” screen.

Guidance for Data Entry in the Minimal Effects, Impacted Site, and Mitigation Site sheets

BUTTONS

Each of the three sheets has two buttons in row three at the top of the sheet.

- PRINT This button prints the contents of the specific sheet
- RESET INPUT This button clears all of the data entry cells and so that a set of new data can be entered.

NOTE: *It is recommended that the file be saved per the instructions above before resetting the sheet*

Wetland Area Clarification

- Minimal Effects Site area is listed for area reference. To qualify for Minimal Effects, there cannot be a reduction in wetland area.
- Impacted Site
 - Existing Conditions area is the size of the wetland prior to any alterations in the size and/or functions.
 - Predicted Conditions is the area that remains
 - after any area conversion, and/or
 - impact to functions as a result of changes within the wetland or outside of the wetland
- Mitigation Site area
 - Existing Conditions area is the size of the wetland at the mitigation site prior to any improvements in the size and/or functions.
 - Predicted Conditions is the area as a consequence of restoration, enhancement or creation.

Guidance for Data Entry in the Minimal Effects, Impacted Site, and Mitigation Site sheets continued

MINIMAL EFFECTS SHEET

Data Entry

CELL

E4	DATE	Enter date data collected
E5	WETLAND ID	Identification of person(s) for multiple calls per tract
E6	OBSERVERS	Person(s) collecting the variable ratings
E-F7	CONDITIONS	Site conditions
E-F8	PROJECT NAME	Name for project (could be landowner, etc.)
I-J4	REMARKS	Optional comments
I-J5	ASSESSMENT TYPE	Optional
I-J6	WETLAND TYPE NWI	National Wetland Inventory name (optional)
I-J7	WETLAND TYPE FSA	Optional
I-J8	OWNER/OPERATOR	Name of person(s) being assisted
E-K9	PLANNED ACTIVITY	Brief description of proposed practice
E-F10	YELLOW FLAG	DROP-DOWN MENU
H-I10	RED FLAG	DROP-DOWN MENU
E11	WETLAND AREA	Area of wetland to 0.001 acres
D14-D28	EXISTING CONDITIONS	Enter index ratings for each of the variables (index rating day before alteration)
H14-H28	PREDICTED CONDITIONS	Enter predicted post-project index ratings for each variable
H-J37 to H-J41	COMMENTS	Comments that help clarify function result

Guidance for Data Entry in the Minimal Effects, Impacted Site, and Mitigation Site sheets continued

IMPACTED SITE SHEET (location generating need for mitigation)

Data Entry

CELL

E4	DATE	Enter date data collected
E5	WETLAND ID	Identification of person(s) for multiple calls per tract
E6	OBSERVERS	Person(s) collecting the Variable ratings
E-F7	CONDITIONS	Site conditions
E-F8	PROJECT NAME	Name for project (could be landowner, etc.)
I-J4	REMARKS	Optional comments
I-J5	ASSESSMENT TYPE	Optional
I-J6	WETLAND TYPE NWI	National Wetland Inventory name (optional)
I-J7	WETALND TYPE FSA	Optional
I-J8	OWNER/OPERATOR	Name of person(s) being assisted
E-K9	PLANNED ACTIVITY	Brief description of proposed practice
E-F10	YELLOW FLAG	DROP-DOWN MENU
I-J10	RED FLAG	DROP-DOWN MENU
E11	WETLAND ACRES E	Existing wetland (just prior to conversion) to nearest 0.001 acres
I 11	WETLAND ACRES P	Remaining wetland (after conversion) to nearest 0.001 acres
E14-F15	COPY MINIMAL EFFECTS VARIABLES BUTTON	Transfers the “existing conditions” Copies variable ratings from the “minimal effects” sheet to “the impacted site” sheet
D14-D28	EXISTING CONDITIONS	Enter index ratings for each of the variables (index rating day before alteration)
H14-H28	PREDICTED CONDCTIONS	Enter predicted post-project index ratings for each variable for remaining wetland area
H-K39 toH-K45	COMMENTS	Comments that help clarify function result

Guidance for Data Entry in the Minimal Effects, Impacted Site, and Mitigation Site sheets continued

MITIGATION SITE SHEET (location used for mitigation of FCU's lost)

Data Entry

CELL

E4	DATE	Enter date data collected
E5	WETLAND ID	Identification of person(s) for multiple calls per tract
E6	OBSERVERS	Person(s) collecting the Variable ratings
E-F7	CONDITIONS	Site conditions
E-F8	PROJECT NAME	Name for project (copied from Impacted Site sheet)
I-J4	REMARKS	Optional comments
I-J5	ASSESSMENT TYPE	Optional
I-J6	WETLAND TYPE NWI	National Wetland Inventory name (optional)
I-J7	WETALND TYPE FSA	Optional
I-J8	OWNER/OPERATOR	Name of person(s) being assisted
E-K9	PLANNED ACTIVITY	Brief description of proposed practice
E-F10	YELLOW FLAG	DROP DOWN MENU
I-J10	RED FLAG	DROP DOWN MENU
E11	Wetland Acres E	Existing wetland (just prior to conversion) to nearest 0.001 acres
I 11	Wetland Acres P	Remaining wetland (after conversion) to nearest 0.001 acres
E14-F15	COPY MINIMAL EFFECTS VARIABLES BUTTON	Transfers the "existing conditions" Copies variable ratings from the "minimal effects" sheet to "the impacted site" sheet
D14-D28	EXISTING CONDITIONS	Enter index ratings for each of the variables (index rating day before alteration)
H14-H28	PREDICTED CONDCTIONS	Enter predicted post-project index ratings for each variable for remaining wetland area
H-K39 toH-K45	COMMENTS	Comments that help clarify function result