Appendix B

Additional Wetland Functional Assessments Critically Reviewed

Appendix B: The 20 wetland assessment methods that were considered appropriate for the study area, and had sufficient documentation to consider further for usefulness, comparability and efficiency of application.

Methods Implemented:

Wetland Rapid Assessment Procedure (WRAP - Florida)
Technique for Functional Assessment of Nontidal Wetlands in the Coastal Plain of Virginia (VIMS)
Wetland Functions and Value – A Descriptive Approach
Wisconsin Rapid Assessment Method (WI RAM)
Wetland Evaluation Technique (WET)
Guidance for Rating the Values of Wetlands in North Carolina (NC Guidance)
Maryland Department of Environment – Method for the Assessment of Wetland Function (MDE Method)
Wetland Mitigation Quality Assessment (WMQA)

Other Methods Evaluated in Detail:

Landscape Framework for Assessing Cumulative Impacts to Food Chains
GIS-based Landscape Scale Functional Assessment Procedure
Environmental Monitoring and Assessment Program for Wetlands (EMAP – Wetlands)
Watershed-based Wetland Assessment Method for the New Jersey Pinelands (NJ Watershed Method)
Method for Assessing Wetland Characteristics and Values
Model for the Assessment of Visual/Cultural Values of Wetlands (Visual/Cultural Assessment)
Index of Biotic Integrity (IBI - for streams)
Habitat Evaluation Procedure (HEP - Pennsylvania)
Wildlife Habitat Assessment and Management System (WHAMS)
Indicators of Hydrologic Alteration (IHA)
Wetland Index Biotic Integrity (WIBI - Minnesota)
New England Fresh Water Invertebrate Biomonitoring Protocol (NEFWIBP)

Below is a brief description of each of the wetland assessment methods that were initially evaluated in detail but were not implemented in this study.

Landscape Framework for Assessing Cumulative Impacts to Food Chains

The Landscape Framework for Assessing Cumulative Impacts to Food Chains proposes models to predict the impacts to wetland food chain support. Food chain support is defined as the biomass that is available for consumption at a wetland or that is available for transportation from the wetland. The method identifies four habitat and food support attributes of wetlands to be measured in order to evaluate potential impacts: patch (wetland) size, shape/edge, connectivity and conductivity, and spatial relationship or distance between wetlands. Habitat suitability index (HSI) models have been developed for many wetland vertebrates to determine whether a habitat can provide adequate support. These models can be used as static predictors of a wetland's food chain support. Interaction-redistribution models provide information on the location of animal populations relative to food resource distributions. The food chain support curve from the HSI model can be used in conjunction with spatial location models to evaluate impacts to food chains by determining the potential movements of species to adjacent wetlands due to changes in their current resource base (Klopatek 1988).

GIS-based Landscape Scale Wetland Functional Assessment Procedure

The North Carolina Division of Coastal Management developed a GIS-based wetland functional assessment procedure as a component in their Wetlands Conservation Plan for the North Carolina Coastal Area. This assessment assists regulatory agencies in determining the importance of protecting a particular wetland by evaluating a wetland's relative ecological significance within a watershed (NC Division of Coastal Management 2001). Three wetland functions: water quality, hydrology, and wildlife habitat, are evaluated based on parameters such as wetland type, size, soil characteristics, landscape position, water source, land use, and landscape patterns. The wetland's contribution to the overall quality of the watershed is also determined. The landscape-scale of this method allows for the assessment of wetlands over larger geographic regions (Wuenscher and Sutter 1995).

Environmental Monitoring and Assessment Program for Wetlands (EMAP-Wetlands)

The goal US Environmental Protection Agency's EMAP-Wetlands program is to assess the current condition and long-term trends of the status of wetland resources at both regional and national levels (Novitzki 1995). There are four steps in achieving that goal: to identify indicators of wetland condition for each wetland class in a region, to develop a framework for comparing a wetland's status with the status of reference wetlands in its region, to monitor the status of regional wetland populations, and to develop procedures to annually report program results. There are four main wetland functions identified by EMAP-Wetlands: biological integrity, productivity, hydrologic function, and water quality improvement (Novitzki 1994). The scope of EMAP was scaled back due to a lack of funds, poor understanding of the relationship between indicators and the effect of stressors on the environment, and difficulty in determining the

appropriate scale of monitoring. The program has changed its focus to researching what should be monitored, why, and at what frequency (Newman 1995).

Watershed-based Wetland Assessment Method for the New Jersey Pinelands (NJ Watershed Method)

The New Jersey Watershed Method utilizes GIS and watershed-level landscape variables to assess the ecological integrity and potential impacts to wetland systems. It was developed by the Pinelands Commission to provide a relative comparison of all Pinelands watersheds and associated wetlands. Four landscape variables determine the watershed integrity score (WIS): land use (LUS), water quality (WQS), ground water withdrawal (GWS), and biodiversity (BDS). Each variable score is determined from digitized data sources and entered into the following equation to calculate the primary watershed integrity score (WIS°):

$$WIS° = 0.70\ (LUS) + 0.20\ (WQS) + 0.10\ (GWS) + 0.25\ (BDS)$$

The potential impact score (PIS) is evaluated using three variables: future land use pattern (LPS), transitional soils (TSS), and the basin and wetland dimension (WDS). These variables are entered into the following equation to calculate the primary potential impact score (PIS°):

$$PIS° = LPS + 0.01\ (LPS)(TSS) + 0.01\ (LPS)(WDS)$$

The WIS and PIS can be transformed into a range of wetland buffer distances that can help guide regulatory decisions. The NJ Watershed Method has been developed to rank and compare drainages at the landscape-level and is not applicable for small, site-specific projects. The availability of data sources required for the evaluation of landscape variables influences preparation time, and the evaluation may take months of office work by a team of experts. Although future revisions are not planned, the method's author recommends revisions before implementation (Bartoldus 1999).

Method for Assessing Wetland Characteristics and Values

The Method for Assessing Wetland Characteristics and Values was developed to provide policy-makers with rapid, preliminary information on inland wetland values based on available data and few sources. The method is based on the concept that a wetland's physical characteristics and functional attributes change predictably in relation to its position in the landscape. Each wetland is classified based on its landscape position: valley, hillside, or hilltop, and the relative importance of a wetland to provide each of three functions is evaluated: surface water protection, flood control, and wildlife value. Surface water protection is a rating of High, Medium, or Low determined by the erodability of adjacent soils and wetland shape. Flood control function is based on a wetland's landscape position. The peak flow of a two-year storm is reduced by 14% by valley wetlands, 12% by hillside wetlands, and 11% by hilltop wetlands. A wetland's wildlife value is given an overall rating of High, Medium, or Low based on its size and diversity of vegetation classes (Marble and Gross 1984). There is no overall score assigned to each wetland. The information from this method can be used to identify potential threats to a wetland from adjacent development activities (Marble and Gross 1984). The authors, Marble and Gross (1984), state that this method does evaluate some wetland values that are important to an overall assessment of a wetland, such as recreational, scenic, and educational value.

Model for the Assessment of Visual/Cultural Values of Wetlands (Visual/Cultural Assessment)

The Visual/Cultural Assessment Model was developed in Massachusetts as part of an overall inland-wetland assessment model to incorporate the visual-cultural resources of wetlands into the decision making process to facilitate better land use decisions regarding inland wetlands. Visual/cultural resources are "the finite natural resources available for human use that are perceived, found within, or associated with wetland areas (Smardon and Fabos 1983)." The Visual/Cultural Model is comprised of two parts: a two-part wetland classification system, and the visual/cultural resource evaluation. The first part of the classification system describes the wetland's interior landscape through the identification of the wetland's type (i.e. fresh marsh, wooded swamp). The second classification identifies the wetland's surrounding landscape context by incorporating surrounding land use and the underlying landforms. The visual/cultural resource evaluation consists of a three-level elimination process. Level 1 identifies wetlands with outstanding value that warrant top priority for protection. Three values are assessed: outstanding wetland natural area, general landscape value, and wetland system value. These values are qualitatively evaluated based on criteria unique to each value. Outstanding wetland natural area is determined based on best professional judgment and existing criteria from the Natural Areas Criteria Committee of the New England Botanical Club (1972) and the USDI National Park Service (1954) for identifying outstanding natural areas. General landscape value is determined by the scarcity and visual contrast of the wetland type based on a list of scarce wetland types and wetlands with outstanding visual contrast within each of the physiographic provinces in Massachusetts. The wetland system value is based on the criteria for the identification of large wetland systems within New England. All wetlands within a large wetland system should be protected. If a wetland does not meet the criteria for Level 1 protection, it is evaluated at Level 2, which rates it's visual, recreational, and educational value. Ten resource variables are measured and rated on a scale from 1 to 5, with 5 being the highest and 1 the lowest. The score for each variable is weighted by two significance coefficients: immutability, or the likelihood of the variable to change by humans or natural actions, and its multiple value, or number of values for which the variable is significant (visual, recreational, and educational). From these scores, the overall visual resource score is calculated. Higher scores indicate greater value and wetlands can be ranked from the highest to lowest values. Wetlands that do not achieve a high enough score from protection from Level 2 are evaluated at Level 3, which assesses the wetland's cultural value based on three variables: education proximity, physical accessibility, and ambient quality. Each variable is rated on a scale of 1 to 5, with 5 being the highest, and assigned a significance coefficient based on the number of values for which the variable is significant. The overall cultural value of the wetland is then calculated from an algebraic equation. The total visual-cultural resource value for a wetland is determined from the sum of the scores from the Level 2 (visual resource) and Level 3 (cultural resource) evaluations. This score can be expressed in dollars as part of economic valuation of the wetland and incorporates wildlife-habitat, visual-cultural, and water-resource values (Smardon and Fabos 1983).

Index of Biotic Integrity (IBI – for streams)

The Index of Biotic Integrity (IBI) assesses the biotic integrity of a habitat and evaluates the impact of anthropogenic actions on a biological system. Reliable and measurable metrics that indicate human influence are selected and developed. For example, ten invertebrate metrics are used as indicators of the habitat's ability to support and maintain a natural functioning biological system. Each metric is given a rating of 1, 3, or 5. A score of 5 indicates similar to or slight deviation from the reference standard; a score of 3 signifies a moderately degraded site; and a score of 1 indicates severe degradation. The overall IBI is calculated by the sum of all metric scores. IBI scores can be used to compare habitats that have the same classification type and are within the same geographic region (Bartoldus 1999).

Habitat Evaluation Procedure (HEP)

HEP was developed in 1980 by the US Fish and Wildlife Service in order to provide a method to evaluate the suitability of available habitat for selected wildlife species. HEP may be used to assess the habitat value of different areas at the same point in time, or the value of the same area at future points in time. Combining these two evaluations can determine the impact of proposed or anticipated changes on habitat suitability (Shoemaker et al. 1997). A team of evaluators delineates the cover types present in the assessment area and selects representative evaluation species that could potentially utilize the available cover types. A Habitat Suitability Index (HSI) model is applied to the assessment area for each evaluation species. Evaluators can use existing HSI models or develop new ones. The HSI score, expressed as a number between 0 and 1, is multiplied by the area of available habitat to determine the Habitat Units (HUs) for a species. Calculations can also be used to document value judgments in trade-off analysis and to perform compensation analysis. Evaluators must be HEP certified and have experience in wildlife biology (Bartoldus 1999).

Wildlife Habitat Assessment and Management System (WHAMS)

WHAMS evaluates existing wildlife habitat conditions specifically for the development of wildlife management plans on Pennsylvania State Game Lands and Farms Games Projects. It is based on the HEP methodology, but is modified to reduce application time. WHAMS does not allow for HSI model development, which is time consuming and complex. Evaluators may only use HSI models approved by the PA Game Commission. Evaluation species are selected for only the two major cover types, thereby reducing the number of HSI calculations required. Calculation of the relative value index is not included, which is required for trade-off and compensation analyses. In addition, WHAMS users do not have to be HEP certified (Bartoldus 1999).

Indicators of Hydrologic Alteration (IHA)

The Nature Conservancy developed IHA to assess the degree of alteration to ecosystem hydrology attributable to anthropogenic impacts. IHA results can be used to improve research on the biotic implications of hydrologic alteration, and to support ecosystem management and restoration plans. The method is based on 32 parameters, which are based on five fundamental hydrologic characteristics: magnitude, timing, frequency, duration, and the rate of change. Parameters are calculated from data

available either from existing measurement points (i.e. stream gauges) or from model-generated data. Measures of central tendency and dispersion are calculated for each of the 32 parameters, resulting in 64 inter-annual statistics. The inter-annual statistics can be used to compare the state of one system to itself over time, the state of one system to another, or the current conditions of a system to a simulation of future impacts to the system (Richter et al. 1996). Computer software is available to facilitate data analysis. Three basic types of analysis are available: pre-impact vs. post-impact analysis (IHA analysis), range of variability analysis (RVA), and trend analysis. The IHA and RVA analyses can utilize both parametric and percentile statistical measures (The Nature Conservancy and Smythe Scientific Software 1997).

Wetland Index of Biotic Integrity (WIBI)

WIBI was developed by the Minnesota Pollution Control Agency (MPCA) to assess the ecological condition of freshwater depressional wetlands. The method utilizes two indexes, the vegetation WIBI and the invertebrate WIBI, to evaluate the degree of human impact on seasonal, semipermanent, and permanent depressional wetlands. The invertebrate WIBI is more appropriate for wetter depressional wetlands, while the vegetation WIBI is effective in vegetated depressional wetlands. The method needs to be modified for application in vernal pools, lake fringes, riparian wetlands, sedge meadows, fens, and bogs. The vegetation WIBI is comprised of ten metrics, which measure richness, life-form guild distribution, sensitive and tolerant species, and community structure. Each metric is rated 1, 3, or 5, where a score of 5 indicates slight or no degradation, and a score of 1 indicates severe degradation. The score of the individual metrics are summed to reach a total site score that defines the site condition. An overall vegetation WIBI score between 50 and 36 indicates excellent conditions that meet aquatic life expectations. Scores between 34 and 20 indicate good conditions that meet aquatic life expectations but may be threatened, and scores between 18 and 10 indicate poor conditions that do not meet aquatic life expectations. The invertebrate WIBI consists of ten metrics that measure invertebrate community proportions and richness. Similar to the vegetation WIBI, each metric is rated 1, 3, or 5, and the sum of all ten metric scores determines the overall invertebrate index score. Scores between 50 and 36 indicate excellent condition, between 34 and 24 indicate moderate conditions, and between 22 and 10 indicate poor conditions (Gernes and Helgen 1999).

New England Freshwater Invertebrate Biomonitoring Protocol (NEFWIBP)

The main goal of the New England Freshwater Invertebrate Biomonitoring Protocol (NEFWIBP) is to provide a standardized, cost-effective method to assess the impact of urbanization on permanently flooded freshwater wetlands. It can also be used to inventory the condition of wetlands within a watershed, to evaluate restoration success, to monitor wetland creation or mitigation progress, and to guide watershed management through risk assessment. NEFWIBP is comprised of an invertebrate community assessment and an overall habitat assessment to evaluate ecological integrity (Hicks 1997). Thirteen habitat quality indicators are rated on a scale from 0 to 6. The habitat assessment score is expressed as a percentage, calculated by the sum of all thirteen indicator scores divided by 78 (the maximum possible sum) and multiplied by 100. For the invertebrate assessment, aquatic invertebrates are sampled, sorted, identified, and

counted. Eleven invertebrate community metrics are scored from 0 to 6, and the overall invertebrate community index (ICI) is calculated from the sum of the scores for the eleven metrics divided by 66 (the maximum possible score) and multiplied by 100. The habitat assessment score and the invertebrate community index (ICI) are plotted on a wetland status summary graph to determine the overall ecological impairment to the wetland. NEFWIBP is directly related to the Index of Biotic Integrity (IBI) and may be considered a subset of IBI (Bartoldus 1999).

Appendix C

Sample Method Instruction and Data Sheets
for the Functional Assessment Methods
Implemented in WMA6

Wetland Functions and Values: A Descriptive Approach

Source: (U.S. Army Corps of Engineers 1995)

Wetland Function-Value Evaluation Form

Total area of wetland_____ Human made?_____ Is wetland part of a wildlife corridor?_____ or a "habitat island"?_____

Adjacent land use_____ Distance to nearest roadway or other development_____

Dominant wetland systems present_____ Contiguous undeveloped buffer zone present_____

Is the wetland a separate hydraulic system?_____ If not, where does the wetland lie in the drainage basin?_____

How many tributaries contribute to the wetland?_____ Wildlife & vegetation diversity/abundance (see attached list)

Wetland I.D._____

Latitude_____ Longitude_____

Prepared by:_____ Date_____

Wetland Impact:
Type_____ Area_____

Evaluation based on:
Office_____ Field_____

Corps manual wetland delineation completed? Y_____ N_____

Function/Value	Occurence Y	Occurence N	Rationale (Reference #)*	Principal Function(s)/Value(s)	Comments
Groundwater Recharge/Discharge					
Floodflow Alteration					
Fish and Shellfish Habitat					
Sediment/Toxicant Retention					
Nutrient Removal					
Production Export					
Sediment/Shoreline Stabilization					
Wildlife Habitat					
Recreation					
Educational Scientific Value					
Uniqueness/Heritage					
Visual Quality/Aesthetics					
ES Endangered Species Habitat					
Other					

Notes:

* Refer to back up list of numbered considerations.

Source: (U.S. Army Corps of Engineers 1995)

Appendix A

Wetland evaluation supporting documentation and reproducible forms.

Below is an example list of considerations that was used for a New Hampshire highway project. Considerations are flexible, based on best professional judgement and interdisciplinary team consensus. This example provides a comprehensive base, however, and may only need slight modifications for use in other projects.

GROUNDWATER RECHARGE/DISCHARGE— This function considers the potential for a wetland to serve as a groundwater recharge and/or discharge area. It refers to the fundamental interaction between wetlands and aquifers, regardless of the size or importance of either.

CONSIDERATIONS/QUALIFIERS

1. Public or private wells occur downstream of the wetland.
2. Potential exists for public or private wells downstream of the wetland.
3. Wetland is underlain by stratified drift.
4. Gravel or sandy soils present in/or adjacent to the wetland.
5. Fragipan does not occur in the wetland.
6. Fragipan, impervious soils, or bedrock, does occur in the wetland.
7. Wetland is associated with a perennial or intermittent watercourse.
8. Signs of groundwater recharge are present or piezometer data demonstrates recharge.
9. Wetland is associated with a watercourse, but lacks a defined outlet or contains a constricted outlet.
10. Wetland contains only an outlet.
11. Groundwater quality of stratified drift aquifer within or downstream of wetland meets drinking water standards.
12. Quality of water associated with the wetland is high.
13. Signs of groundwater discharge are present (e.g. springs).
14. Water temperature suggests it is a discharge site.
15. Wetland shows signs of variable water levels.
16. Gravel or sandy soils present in or adjacent to wetland.
17. Piezometer data demonstrates discharge.
18. Other

FLOODFLOW ALTERATION (Storage & Desynchronization) — This function considers the effectiveness of the wetland in reducing flood damage by water retention for prolonged periods following precipitation events and the gradual release of floodwaters. It adds to the stability of the wetland ecological system or its buffering characteristics and provides social or economic value relative to erosion and/or flood prone areas.

Source: (U.S. Army Corps of Engineers 1995)

Wetland Evaluation Technique (WET)

Source: (Adamus et al. 1987)

4.4.3 Floodflow Alteration

A number of quantitative methods are available for determining the floodflow alteration capacity of AA along a channel. Qualitative methods for determining floodflow alteration capacity have been presented by Reppert et al. (1979) and Wolverton (1980). Few of these quantitative or qualitative methods specifically examine the contribution of the wetland portion of the AA to floodflow alteration.

Definition - For purposes of WET, floodflow alteration occurs in those areas where surface water is stored or its velocity is attenuated to a greater degree than typically occurs in terrestrial environments. No judgment is made as to the value of such flow alteration, in fact, there may be situations in which reduction of flow velocity causes increased flooding due to flow synchronization.

1. Floodflow Alteration Effectiveness

Rationale (HIGH) - There are five types of AA's that most clearly are effective for altering floodflows. These include AA's which : (a) have regulated outflows (reservoirs, dams), (b) have outflows that are measured as being less than inflows, (c) have neither an outlet nor an inlet, (d) expand their surface area by at least 25 percent for 20 days of the year and are larger than 5 acres, or (e) are larger than 200 acres and are either in a precipitation deficit region or (if flowing water is present) are at least 70% covered with juxtaposed woody vegetation. Additionally, they must not be tidal. Thus, the simple presence of vegetation which adds to channel roughness is considered insufficient to result in a rating of HIGH; the wet depression must remove (through evapotranspiration) or store water as well as create a lag (desynchronized) effect.

Rationale (LOW) - Wetlands with LOW probabilities of altering floodflows are assumed to be those which have <u>all</u> the following characteristics: (a) the spatially dominant hydroperiod is "permanent," (b) the AA is less than 200 acres, (c) no potential for ponding of stormflows is apparent (e.g., fringe wetland or others with unconstricted outlets), (d) if precipitation is greater than evaporation, and the AA is smaller than 5 acres, and (e) if flow is present, channels are neither sinuous nor contain ample woody vegetation to intercept surface flows. Also, all tidal wetlands are rated LOW, as they are a buffer against floodflows only if mild storm surges occur at low tide.

General Sensitivity - Most western and prairie wetlands will be rated HIGH, as will large flowing wetlands elsewhere with extensive woody vegetation. LOW ratings will be assigned to most small, unconstricted, permanently flooded wetlands in the East, especially if they lack low-gradient channels and woody vegetation. The MODERATE rating will be the most common rating in many regions.

These ratings do not reflect the <u>quantity</u> (e.g., acre-feet) of flood storage--only the probability that storage or loss will occur or lag time will be measurably increased. The position of the wetland in the watershed and its position relative to floodable properties have been ignored in this portion of the key due to the difficulty of predicting whether increased lag time will synchronize or desynchronize floodflows at a particular point of interest.

Source: (Adamus et al. 1987)

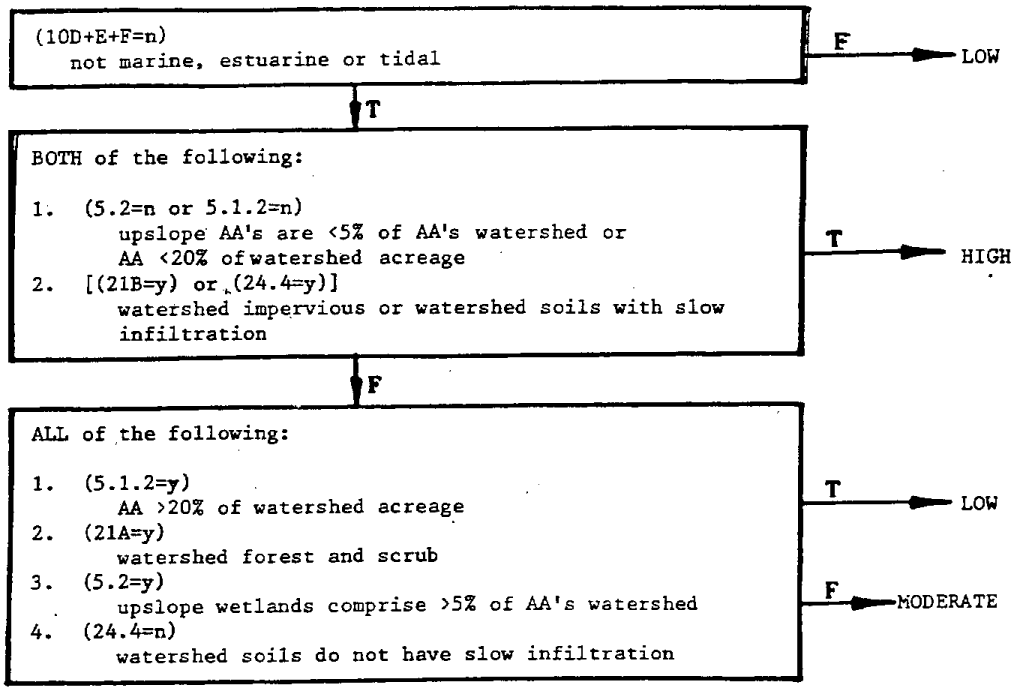
Evaluation Site: _____

EFFECTIVENESS/OPPORTUNITY EVALUATION – LEVEL 1 (OFFICE)

Q.#	WETLAND CONDITION $\overline{X}$	W	D	COMMENTS/ASSUMPTIONS
1.1	Y N			
1.2	Y N			
1.3	Y N			
2.1.1	Y N			
2.1.2	Y N			
2.1.3	Y N			
2.2.1	Y N I			
2.2.2	Y N I			
3.1	Y N			
3.2	Y N			
3.3	Y N			
4.1	Y N			
4.2A	Y N			
4.2B	Y N			
4.2C	Y N			
4.2D	Y N			
5.1.1		Y N		
5.1.2		Y N		
5.2		Y N		
6.1	Y N			
6.2	Y N			
7	Y N I			
8.1	Y N			
8.2	Y N			
8.3	Y N			
8.4	Y N			
9.1		Y N		
9.2		Y N I		
9.3		Y N I		
10A	Y N			
10B	Y N			
10C	Y N			
10D	Y N			
10E	Y N			
10F	Y N			

Source: (Adamus et al. 1987)

Floodflow Alteration Opportunity (FFAO) Key



-- End --

Source: (Adamus et al. 1987)

Wisconsin Rapid Assessment Methodology

(WI RAM)

Source: (Wisconsin Dept. of Natural Resources 1992)

FUNCTIONAL ASSESSMENT

The following assessment requires the evaluator to examine site conditions that provide evidence that a given functional value is present and to assess the significance of the wetland to perform those functions. Positive answers to questions indicate the presence of factors important for the function. The questions are not definitive and are only provided to guide the evaluation. After completing each section, the evaluator should consider the factors observed and use best professional judgement to rate the significance. The ratings should be recorded on page 1 of the assessment.

Special Features/ RED FLAGS

1. Y N Is the wetland in or adjacent to an area of special natural resource interest (NR 103.04, Wis. Adm. Code)? If so, check those that apply:

___a. Cold water community as defined in s. NR 102.04(3)(b), Wis. Adm. Code, (including trout streams, their tributaries, and trout lakes);
___b. Lakes Michigan and Superior and the Mississippi River;
___c. State or federal designated wild and scenic river;
___d. Designated state riverway;
___e. Designated state scenic urban waterway;
___f. Environmentally sensitive area or environmental corridor identified in an area-wide water quality management plan, special area management plan, special wetland inventory study, or an advanced delineation and identification study;
___g. Calcareous fen;
___h. State park, forest, trail or recreation area;
___i. State and federal fish and wildlife refuges and fish and wildlife management areas;
___j. State or federal designated wilderness area;
___k. Designated or dedicated state natural area;
___l. Wild rice water listed in ch. NR 19.09, Wis. Adm. Code;
___m. Surface water identified as an outstanding or exceptional resource water in ch. NR 102, Wis. Adm. Code.

2. Y N According to the Natural Heritage Inventory (Bureau of Endangered Resources) or direct observations, are there any rare, endangered, or threatened plant or animal species in, near, or using the wetland or adjacent lands? If so, list the species of concern:

3. Y N Is the project located in an area that requires a State Coastal Zone Management Plan consistency determination?

Source: (Wisconsin Dept. of Natural Resources 1992)

Floral Diversity

1. Y N Does the wetland support a variety of native plant species (i.e. not a monotypic stand of cattail or giant reed grass and/or not dominated by exotic species such as reed canary grass, brome grass, buckthorn, purple loosestrife, etc.)?

2. Y N Is the wetland plant community regionally scarce or rare?

Wildlife and Fishery Habitat

1. List any species observed, evidenced (e.g. tracks, scat, nest/burrow, calls), or expected to utilize the wetland:

2. Y N Does the wetland contain a number of diverse vegetative cover types and a high degree of interspersion of those vegetation types?

3. Y N Is the estimated ratio of open water to cover between 30 and 70 percent? What is the estimated ratio? _____%

4. Y N Does the surrounding upland habitat likely support a variety of animal species?

5. Y N Is the wetland part of or associated with a wildlife corridor or designated environmental corridor?

6. Y N Is the surrounding habitat and/or the wetland itself a large tract of undeveloped land important for wildlife that require large home ranges (e.g. bear, woodland passerines)?

7. Y N Is the surrounding habitat and/or the wetland itself a relatively large tract of undeveloped land within an urbanized environment that is important for wildlife?

8. Y N Are there other wetland areas near the subject wetland that may be important to wildlife?

9. Y N Is the wetland contiguous with a permanent waterbody or periodically inundated for sufficient periods of time to provide spawning/nursery habitat for fish?

10. Y N Can the wetland provide significant food base for fish and wildlife (e.g. insects, crustaceans, voles, forage fish, amphibians, reptiles, shrews, wild rice, wild celery, duckweed, pondweeds, watermeal, bulrushes, bur reeds, arrowhead, smartweeds, millets...)?

11. Y N Is the wetland located in a priority watershed/township as identified in the Upper Mississippi and Great Lakes Joint Venture of the North American Waterfowl Management Plan?

12. Y N Is the wetland providing habitat that is scarce to the region?

Source: (Wisconsin Dept. of Natural Resources 1992)

Technique for the Functional Assessment of Nontidal Wetlands in the Coastal Plain of Virginia
(VIMS)

Source: (Bradshaw 1991)

Function: Flood storage and storm flow modification

This function addresses the storage of water in the wetland and/or the reduction of water velocity by the wetland so that downstream movement of water is impeded (Adamus et al., 1990). Many wetlands store flood water and later release it. In doing so, the magnitude of flooding downstream from the wetlands may be reduced.

There are many factors and characteristics which determine the extent and existence of flood storage and flood flow modification by a wetland. Characteristics which enhance a wetland's **opportunity** to store floodwater and modify flood peaks are primarily watershed characteristics which increase the quantity and velocity of water entering the wetland:

- watersheds receiving frequent, intense rainstorms
- large watershed area
- steep slopes in watershed
- smooth land cover
- soils or land cover of slow or low permeability
- lack of upstream storage for flood water (e.g., channelized streams; no ponds or wetlands upstream of the wetland of interest)

A wetland's **effectiveness** at flood storage and flow modification depends on its capacity relative to the volume of inflow and its ability to hold water and reduce flow velocity. Characteristics which enhance a wetland's effectiveness in flood storage and flow modification:

- wetlands large relative to watershed
- wetlands not permanently flooded
- outlet from wetland constricted
- channel sinuosity within wetland is great
- wetland vegetation density is great (# stems/acre)
- stems of wetland plants are rigid

Methods for assessing the flood storage/flood flow modification function of wetlands range from a simplistic ratio of the area of the wetland to the area of the wetland's watershed (Reppert et al., 1979; Ammann et al., 1991) to complex computer simulation modeling of flood flows through wetlands (Kittelson, 1988; Ogawa and Male, 1986). An alternative approach is used by the WET methods (Adamus et al., 1987, 1990), which identify characteristics of wetlands and their watersheds which enhance or detract from the wetland's opportunity and ability to perform the function, and use these characteristics to produce a probability rating (High, Moderate, Low) for the wetland's opportunity and effectiveness at performing the function.

For the present study, a modification of the method of Simon et al. (1987) will be used as part of the evaluation of the flood storage and storm flow modification function of wetlands. This method is attractive because it provides a quantitative, volumetric measure of the flood storage capacity, rather than simply a qualitative High/Moderate/Low rating of the function as with the WET methods. Although the modeling methods (e.g., Kittelson, 1988; Ogawa and Male, 1986) would provide a more complete picture of the flood control function, those methods were determined to be inappropriate for the current level of effort. The Simon method strikes a balance be-

Source: (Bradshaw 1991)

tween the complex modeling methods and the more simplistic area ratio methods used by Connecticut (Ammann et al., 1986, 1991) and Reppert et al. (1979).

The Simon method (Simon et al., 1987) involves calculation of the volume of runoff from the watershed, based on a 2 year, 24 hour rainfall, and the land use characteristics and soil hydrologic group classification of the watershed soils. This runoff volume is then compared to the holding capacity of the wetland, which is calculated by multiplying wetland area by wetland flood storage depth. Simon et al. (1987) contend that any wetlands which have the capacity to store more than 25% of the runoff delivered from the watershed "perform a significant flood storage function."

The U.S. Department of Agriculture Soil Conservation Service (SCS) has not completed soil surveys for several of the counties in which our study was conducted. In the soil surveys that were available, some soils were not classified with respect to soil hydrologic group. Due to this lack of information, this portion of the Simon method was eliminated, and runoff calculations were based only on rainfall and land use.

The Simon method does not consider the effects on runoff conveyance of wetlands in the watershed other than the wetland of interest. The modification of the Simon method used in this study divides a wetland's watershed into two sub-watersheds: the **upstream sub-watershed** which discharges to the wetland of interest through other wetlands, and the **primary sub-watershed** which discharges directly into the wetland of interest. Runoff volume from each sub-watershed is calculated separately. Factors were generated by the SCS for adjusting discharge volume where runoff is conveyed through wetlands prior to reaching the design point in peak discharge calculations (USDA-SCS, 1986). These adjustment factors are based on the ratio of wetland to upland in the watershed, and are applied in this study to the runoff volume from the upstream sub-watershed.

The following procedure is the modification of the Simon method used for the present study:

Step 1. Delineate the following areas:

a. the wetland of interest (this should include the entire contiguous area studied which is similar in terms of vegetation structure and density)

b. the entire watershed of the wetland of interest (i.e., all uplands and wetlands which drain into the wetland of interest)

c. other wetlands occurring in this watershed (=**upstream wetlands**)

d. the portion of the watershed which discharges directly to the wetland of interest, without passing through other wetlands first (=**primary sub-watershed**)

The upstream sub-watershed is that portion of the watershed, <u>including wetlands</u>, which discharges runoff to the wetland of interest through other wetlands (the upstream wetlands). The entire watershed of the wetland of interest = upstream sub-watershed + primary sub-watershed.

Source: (Bradshaw 1991)

Step 2. Determine acreages of the wetland of interest, the primary sub-watershed, the upstream wetlands, and the upstream sub-watershed.

Area measurements will generally be made from USGS topographic maps with area dot grids or from digitizing these areas on a computerized geographic information system (GIS). For use in evaluation of other functions, calculate the following sub-watershed area weighting factors:

upstream sub-watershed area weighting factor

$$= \frac{\text{area of upstream sub–watershed}}{(\text{area of upstream sub–watershed} + \text{area of primary sub–watershed})}$$

primary sub-watershed area weighting factor

$$= \frac{\text{area of primary sub–watershed}}{(\text{area of upstream sub–watershed} + \text{area of primary sub–watershed})}$$

Step 3. Classify land use in the sub-watersheds. Land use will be determined using aerial photographs and field surveys. Proportions of land area within each land use will be assessed in 5% increments. Determine composite runoff curve numbers (RCN) for each of the two sub-watersheds using land use proportions and the following:

composite RCN= 55F + 70R + 81A + 92C + 80L

where:

F = proportion of sub-watershed in Forested or "natural" condition
R = proportion of sub-watershed in Residential land (houses/acre)
A = proportion of sub-watershed in Agricultural land (pasture and crops)
C = proportion of sub-watershed in Commercial/industrial/urban land
L = proportion of sub-watershed in Lakes or permanently flooded wetlands

(RCN's for each land use type were modified from Simon et al. (1987) and Kittelson (1988).)

Step 4. Find average runoff for each of the sub-watersheds, using:

If composite RCN $\geq$35, then average runoff= $$\frac{(3.5 - 0.2 \times \left(\frac{1000}{RCN} - 10\right))^2}{3.5 + 0.8 \times \left(\frac{1000}{RCN} - 10\right)}$$

If composite RCN <35, then average runoff = 0.001 inches.

This assumes a 2 year, 24 hour rainfall of 3.5 inches for the study area (Virginia Division of Soil and Water Conservation, 1980).

Source: (Bradshaw 1991)

Step 5. Multiply the average runoff from the upstream sub-watershed by the appropriate adjustment factor (USDA-SCS, 1986) to obtain adjusted average runoff:

% of upstream sub-watershed that is comprised of wetlands:	adjustment factor:
0.2	0.94
0.5	0.88
1.0	0.83
2.0	0.78
2.5	0.73
3.3	0.69
5.0	0.65
6.7	0.62
10.0	0.58
20.0	0.53
25.0	0.50

Step 6. Multiply average runoff (inches) for each sub-watershed by the area of the sub-watershed (acres) to get subtotal runoff figures (acre-inches). (For the upstream sub-watershed, use the adjusted average runoff calculated in Step 5.)

Step 7. Sum the two subtotal runoffs to get total runoff (acre-inches).

Step 8. Elevation range (inches) within wetland x 0.5 = wetland flood storage depth (inches). The elevation range is the difference in elevation between the open water/wetland boundary and the wetland/upland boundary. Where possible, we will use a hand-held level and stadia rod to determine the elevation change to the nearest tenth of a foot.

Step 9. Wetland acreage (acres) x storage depth (inches) = wetland storage (acre-inches).

Step 10. Wetland storage / total runoff = proportion of flood water stored in wetland.

The Simon method is strictly volumetric, and does not consider factors (such as watershed slope) affecting the delivery of water to the wetland. Also, this method does not consider potential damage downstream from the wetland. The Simon method, as modified, provides a measure of both the opportunity a wetland has to perform the flood storage function (i.e., runoff volume) and the wetland's effectiveness at flood storage (i.e., flood storage volume). Two additional factors will be assessed in evaluating this function. The average watershed slope will be estimated either from soil surveys or from USGS topographic maps. This provides an additional measure of the opportunity a wetland has to perform the flood storage function. Finally, a qualitative assessment of the wetland's ability to retain/detain storm water will provide an additional measure of the wetland's effectiveness at this function. A summary of factors to be assessed in determining the flood storage and flood flow modification function and the hydrologic portion of other functions follows.

Source: (Bradshaw 1991)

Factor 1: Proportion of 2 year, 24 hour storm volume stored in wetland (modification of Simon et al., 1987).

High: >25%
Low: ≤25%

(Simon et al. (1987) suggest the 25% threshold. Further refinement of ranking of this quantitative measure will occur following data collection.)

Factor 2: Watershed slope (%, obtained from USDA-SCS soil surveys or from USGS topo maps) (Ammann et al., 1986, 1991).

High: >8%
Moderate: 3-8%
Low: <3%

(The 3% and 8% thresholds are suggested by Ammann et al. (1986; 1991).)

Factor 3: Retention/detention of storm water within wetland (in part, Adamus et al., 1990).

High: detention time likely to be great due to significant constriction at outlet, very sinuous channels within the wetland, ponding within the wetland, high vegetation density within the wetland (stems/acre), and/or the wetland plants have rigid stems

Moderate: detention time likely to be intermediate

Low: detention time likely to be short due to lack of constriction at the wetland outlet, channelized flow through the wetland, low vegetation density within the wetland, and/or lack of vegetation with rigid stems.

In order to lessen the subjectivity of ranking this factor, priority will be given to the physical characteristics affecting retention/detention (i.e., outlet constriction, channel sinuosity, and ponding), and secondarily to the vegetation characteristics. Generally, we will consider forested wetlands to be of low stem density, scrub-shrub and non-persistent emergent wetlands to be of moderate density, and persistent emergent wetlands to be of high stem density. Actual field assessment may alter these guidelines. Woody species and some emergents will be considered to have rigid stems; other emergents will be considered to have non-rigid stems.

Overall ranking of flood storage and storm flow modification function:

A wetland will be rated as having a HIGH probability of performing the flood storage/flood flow modification function if either Factor 1 or Factor 3 is HIGH. A wetland will be rated as having a LOW probability of performing this function if Factor 3 and at least one of the other factors is rated LOW. All other wetlands will be rated MODERATE.

Source: (Bradshaw 1991)

Flood storage and flood flow modification

Calculation of Factor 1:

Step 1. Delineate the wetland of interest, its entire watershed, and other wetlands within that watershed, using USGS topo maps. Sub-divide these areas as follows:

Wetland of interest = entire contiguous area studied which is similar in vegetation structure and density.

Primary sub-watershed = that portion of the wetland of interest's watershed which discharges directly into the wetland of interest without passing through other wetlands first.

Upstream sub-watershed = that portion of the wetland of interest's watershed which discharges to the wetland of interest through other wetlands (this includes the upstream wetlands).

Upstream wetlands = wetlands in the upstream sub-watershed.

Step 2. Determine acreages:

Wetland of interest _____ acres (X1)
Primary sub-watershed _____ acres (X2)
Upstream sub-watershed (including upstream wetlands) _____ acres (X3)
Upstream wetlands _____ acres (X4)

Calculate (for use in assessment of water quality functions):

upstream sub-watershed area weighting factor

$$= \frac{X3}{(X2 + X3)} = _____ \text{ (X5)}$$

primary sub-watershed area weighting factor

$$= \frac{X2}{(X2 + X3)} = _____ \text{ (X6)}$$

Step 3. Determine the elevation range within the wetland of interest. The elevation range is the difference in elevation between the open water/wetland boundary and the wetland/upland boundary.

Elevation range = _____ inches (X7)

Source: (Bradshaw 1991)

Step 4. Classify land use in each sub-watershed.

Proportion of sub-watershed in each land use (Range of values = 0 to 1. Estimate to the nearest 0.05. The sum of each column = 1.0):

Sub-watershed Primary	Sub-watershed Upstream	Land use
Fp=	Fu=	Forested/"natural"
Ap=	Au=	Agricultural (pasture & crop land)
Rp=	Ru=	Residential (< 4 houses/acre)
Cp=	Cu=	Commercial/Industrial/Urban land
Lp= 0	Lu=	Lakes or permanently flooded wetlands
1.0	1.0	= Sum

Determine composite runoff curve numbers (RCN) for each sub-watershed, using land proportions and the following equations:

upstream sub-watershed composite RCN

$$= (55 \times Fu) + (81 \times Au) + (70 \times Ru) + (92 \times Cu) + (80 \times Lu)$$

$$= (55 \times ____) + (81 \times ____) + (70 \times ____) + (92 \times ____) + (80 \times ____) = _____ \quad (X8)$$

primary sub-watershed composite RCN

$$= (55 \times Fp) + (81 \times Ap) + (70 \times Rp) + (92 \times Cp) + (80 \times Lp)$$

$$= (55 \times ____) + (81 \times ____) + (70 \times ____) + (92 \times ____) + (80 \times ____) = _____ \quad (X9)$$

Step 5. Find average runoff for each of the sub-watersheds:

If composite RCN ≥ 35, then average runoff= $\dfrac{\left(3.5 - 0.2 \times \left(\dfrac{1000}{RCN} - 10\right)\right)^2}{3.5 + 0.8 \times \left(\dfrac{1000}{RCN} - 10\right)}$

If composite RCN < 35, then average runoff = 0.001 inches.

This assumes a 2 year, 24 hour rainfall of 3.5 inches for the study area (Virginia Division of Soil and Water Conservation, 1980).

Source: (Bradshaw 1991)

upstream sub-watershed average runoff =

$$\frac{(3.5 - 0.2 \times \left(\frac{1000}{X8} - 10\right))^2}{3.5 + 0.8 \times \left(\frac{1000}{X8} - 10\right)} = _____ \text{ (X10)}$$

primary sub-watershed average runoff =

$$\frac{(3.5 - 0.2 \times \left(\frac{1000}{X9} - 10\right))^2}{3.5 + 0.8 \times \left(\frac{1000}{X9} - 10\right)} = _____ \text{ (X11)}$$

Step 6. Multiply the average runoff from the upstream sub-watershed (X10) by the appropriate adjustment factor (USDA-SCS, 1986) to obtain adjusted average runoff:

% of upstream sub-watershed that is comprised of wetlands:	adjustment factor:
0.2	0.94
0.5	0.88
1.0	0.83
2.0	0.78
2.5	0.73
3.3	0.69
5.0	0.65
6.7	0.62
10.0	0.58
20.0	0.53
25.0	0.50

adjusted average runoff for upstream sub-watershed

= X10 x adjustment factor = _____ inches (X12)

Step 7. Multiply average runoff (inches) for each sub-watershed by the area of the sub-watershed (acres) to get subtotal runoff figures (acre-inches).

primary sub-watershed total runoff = X11 x X2 = _____ acre-inches (X13)
upstream sub-watershed total runoff = X12 x X3 = _____ acre-inches (X14)

Step 8. Sum the two subtotal runoffs to get total runoff (acre-inches).

total runoff = X13 + X14 = _____ acre-inches (X15)

Source: (Bradshaw 1991)

Step 9. Determine flood storage depth in the wetland of interest (assumed to be half the elevation range within the wetland).

wetland flood storage depth = X7 x 0.5 = _____ inches (X16)

Step 10. Determine wetland storage capacity.

Wetland acreage (acres) x storage depth (inches) = wetland storage (acre-inches).

X1 x X16 = _____ acre-inches (X17)

Step 11. Determine proportion of flood water stored in wetland.

$\frac{\text{Wetland storage}}{\text{total runoff}}$ = proportion of flood water stored in wetland

$\frac{X17}{X15}$ = _____ (range of values = 0 to 1)

Source: (Bradshaw 1991)

Factor 1 calculation worksheet—flood storage and flood flow modification

Step 1. Delineation.

Step 2. Wetland of interest = _____ acres (X1)
Primary sub-watershed = _____ acres (X2)
Upstream sub-watershed (including upstream wetlands) = _____ (X3)
Upstream wetlands = _____ (X4)

$$\frac{X3}{(X2 + X3)} = _____ \text{ (X5)} \qquad \frac{X2}{(X2 + X3)} = _____ \text{ (X6)}$$

Step 3. Elevation range = _____ inches (X7)

Step 4.
upstream sub-watershed composite RCN
= (55 x Fu) + (81 x Au) + (70 x Ru) + (92 x Cu) + (80 x Lu)
= (55 x ____)+(81 x ____)+(70 x ____)+(92 x ____)+(80 x ____) = _____ (X8)

primary sub-watershed composite RCN
= (55 x Fp) + (81 x Ap) + (70 x Rp) + (92 x Cp) + (80 x Lp)
= (55 x ____)+(81 x ____)+(70 x ____)+(92 x ____)+(80 x ____) = _____ (X9)

Step 5.
upstream sub-watershed average runoff =

$$\frac{(3.5 - 0.2 \times \left(\frac{1000}{X8} - 10\right))^2}{3.5 + 0.8 \times \left(\frac{1000}{X8} - 10\right)} = _____ \text{ (X10)}$$

primary sub-watershed average runoff =

$$\frac{(3.5 - 0.2 \times \left(\frac{1000}{X9} - 10\right))^2}{3.5 + 0.8 \times \left(\frac{1000}{X9} - 10\right)} = _____ \text{ (X11)}$$

Step 6. X10 x adjustment factor = _____ inches (X12)

Step 7. X11 x X2 = _____ acre-inches (X13)

X12 x X3 = _____ acre-inches (X14)

Step 8. X13 + X14 = _____ acre-inches (X15)

Step 9. X7 x 0.5 = _____ inches (X16)

Source: (Bradshaw 1991)

Step 10. X1 x X16 = _____ acre-inches (X17)

Step 11. $\frac{X17}{X15}$ = _____ (range of values = 0 to 1)

Source: (Bradshaw 1991)

Flood storage and flood flow modification

Factor ratings

Factor 1: Proportion of 2 year, 24 hour storm volume stored in wetland

___High: >25%
___Low: ≤25%

Factor 2: Watershed slope

___High: >8%
___Moderate: 3-8%
___Low: <3%

Factor 3: Retention/detention of storm water within wetland (priority: physical characteristics; secondary: vegetation characteristics

___High: detention time likely to be great due to significant constriction at outlet, very sinuous channels within the wetland, ponding within wetland, high vegetation density within the wetland (stems/acre), and/or the wetland plants have rigid stems

___Moderate: detention time likely to be intermediate

___Low: detention time likely to be short due to lack of constriction at the wetland outlet, channelized flow through the wetland, low vegetation density within the wetland, and/or lack of vegetation with rigid stems.

Interpretation Key

1. Are either Factor 1 or Factor 3 HIGH?

Y—HIGH
N—go to 2.

2. Is Factor 3 MODERATE?

Y—MODERATE
N—go to 3

3. Are at least 2 of the 3 Factors MODERATE or HIGH?

Y—MODERATE
N—LOW

Source: (Bradshaw 1991)

VIMS Nontidal Wetlands Functional Assessment Method—Summary Sheet

Flood storage and flood flow alteration

Factor 1: H L
Factor 2: H M L Overall: H M L
Factor 3: H M L

Nutrient retention and transformation

Factor 1: H M L
Factor 2: H M L
Factor 3: H M L Overall: H M L
Factor 4: H M L
Factor 5: H L
Factor 6: H M L

Sediment/toxicant retention

Factor 1: H M L
Factor 2: H M L Overall:
Factor 3: H M L Sediment trapping: H M L
Factor 4: H M L Toxicant trapping: H M L
Factor 5: H M L
Factor 6: H M L
Factor 7: H L
Factor 8: H M L

Sediment stabilization

Factor 1: H L
Factor 2: H L
Factor 3: H L Overall: H M L
Factor 4: H M L

Wildlife habitat

Factor 1: H M L
Factor 2: H M L
Factor 3: H M L Overall: H M L
Factor 4: H M L
Factor 5: H M L

Aquatic habitat

Factor 1: H L
Factor 2: H L
Factor 3: H M L Overall: H M L
Factor 4: H M L
Factor 5: H L

Public use

Factor 1: H M L

Other factors

Factor 1: H M L
Factor 2: H M L

Source: (Bradshaw 1991)

Guidance for Rating the Values of Wetlands in North Carolina
(NC Guidance)

Source: (North Carolina Dept. of Environmental and Natural Resources 1995)

WETLAND RATING WORKSHEET Fourth Version

Project Name _____ Nearest Road _____
County _____ Wetland Area _____ acres Wetland Width _____ feet
Name of evaluator _____ Date _____

Wetland Location	Adjacent land use (within 1/2 mile upstream, upslope, or radius)
___ on pond or lake ___ on perennial stream ___ on intermittent stream ___ within interstream divide ___ other _____	___ forested/natural vegetation ____ % ___ agriculture, urban/suburban ____ % ___ impervious surface ____ %
	Dominant vegetation
Soil series _____	(1) _____
___ predominantly organic - humus, muck, or peat ___ predominantly mineral - non-sandy ___ predominantly sandy	(2) _____ (3) _____
Hydraulic factors	**Flooding and wetness**
___ steep topography ___ ditched or channelized ___ total wetland width ≥100 feet	___ semipermanently to permanently flooded or inundated ___ seasonally flooded or inundated ___ intermittanly flooded or temporary surface water ___ no evidence of flooding or surface water

Wetland type (select one)*

___ Bottomland hardwood forest
___ Headwater forest
___ Swamp forest
___ Wet flat
___ Pocosin
___ Bog forest
___ Pine savanna
___ Freshwater marsh
___ Bog/fen
___ Ephemeral wetland
___ Carolina Bay
___ Other _____

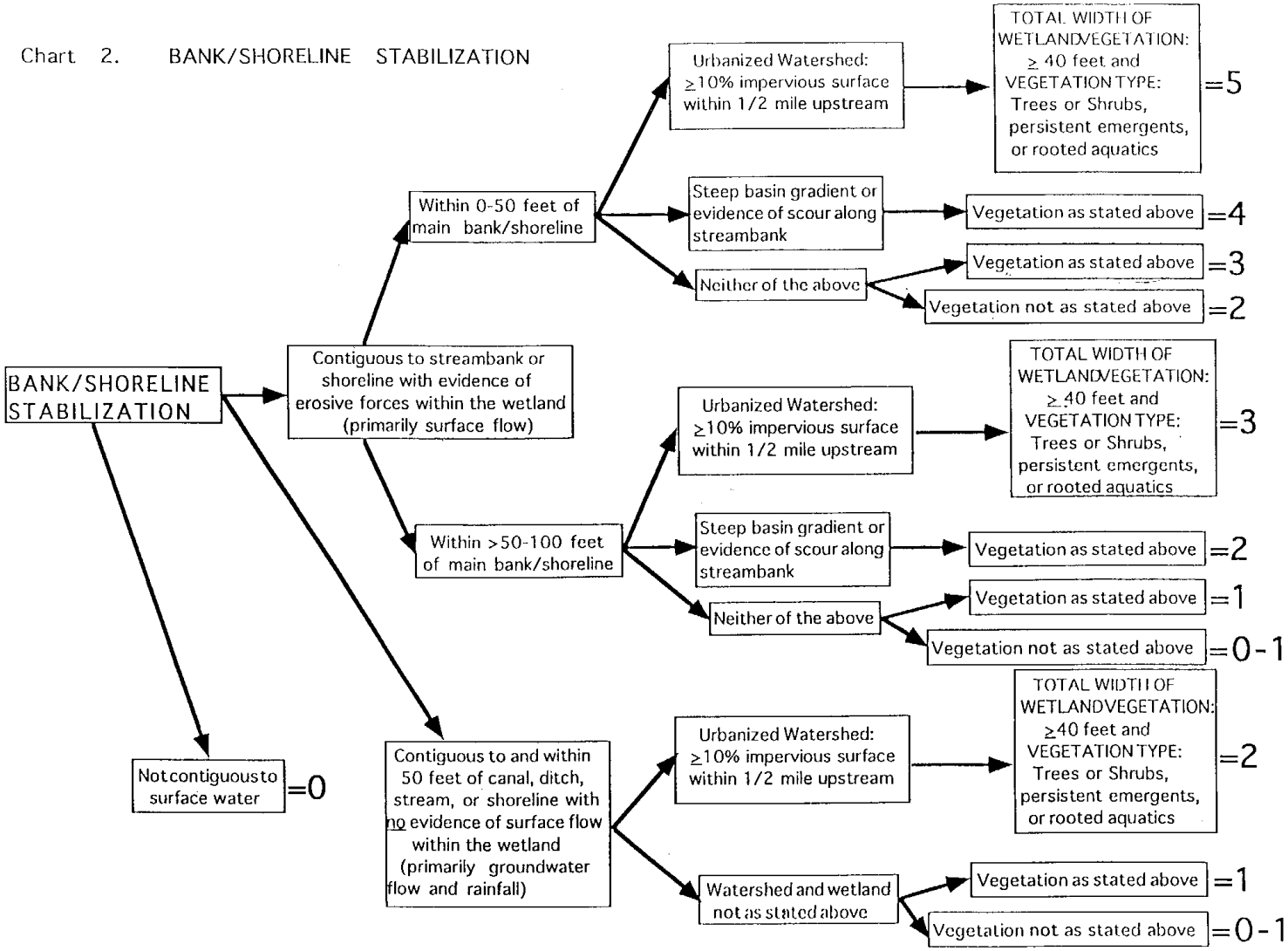
*the rating system cannot be applied to salt or brackish marshes or stream channels

			weight		Wetland Rating
R	Water storage	_____	x 4.00 =		
A	Bank/Shoreline stabilization	_____	x 4.00 =		
T	Pollutant removal	_____*	x 5.00 =		
I	Wildlife habitat	_____	x 2.00 =		
N	Aquatic life value	_____	x 4.00 =		
G	Recreation/Education	_____	x 1.00 =		

*Add 1 point if in sensitive watershed and >10% nonpoint disturbance within 1/2 mile upstream, upslope, or radius

Source: (North Carolina Dept. of Environmental and Natural Resources 1995)

Chart 2. BANK/SHORELINE STABILIZATION



Source: (North Carolina Dept. of Environmental and Natural Resources 1995)

Maryland Department of the Environment Method for the Assessment of Wetland Function (MDE)

Source: (Fugro East 1995)

WETLAND INVENTORY DATA

Project Name: _____ Date: _____

Land Number: _____ Investigators: _____

Cowardin Class: _____ Area: _____

_____ Area: _____

_____ Area: _____

_____ Total Area: _____

Hydrogeomorphic Class

- ☐ Depressional
- ☐ Slope
- ☐ Lacustrine Fringe
- ☐ Riverine
- ☐ Mosaic

Dominant Vegetation Type Palustrine

- ☐ **Aquatic Bed**
  - ☐ Algal
  - ☐ Aquatic Moss
  - ☐ Rooted Vascular
  - ☐ Floating Vascular
  - ☐ Unknown Submergent
  - ☐ Unknown Surface
- ☐ **Emergent**
  - ☐ Persistent
  - ☐ Nonpersistent
- ☐ **Open Water**
- ☐ **Shrub/Scrub**
  - ☐ Broad-leaved Deciduous
  - ☐ Needle-leaved Deciduous
  - ☐ Broad-leaved Evergreen
  - ☐ Needle-leaved Evergreen
  - ☐ Dead
- ☐ **Forested**
  - ☐ Broad-leaved Deciduous
  - ☐ Needle-leaved Deciduous
  - ☐ Broad-leaved Evergreen
  - ☐ Needle-leaved Evergreen
  - ☐ Dead

Water Regime

- ☐ Temporarily Flooded
- ☐ Saturated
- ☐ Seasonally Flooded
- ☐ Semi Permanently Flooded
- ☐ Intermittently Exposed
- ☐ Permanently Flooded
- ☐ Intermittently Flooded
- ☐ Artificially Flooded

Source: (Fugro East 1995)

LANDSCAPE VARIABLES

Size
- ☐ > 100 acres
- ☐ 10 - 100 acres
- ☐ < 10 acres

Wetland Juxtaposition
- ☐ Connected upstream and downstream
- ☐ Only connected above
- ☐ Only connected below
- ☐ Other wetlands nearby but not connected
- ☐ Wetland isolated

Watershed Land Use
- ☐ > 90% of two or more non-urban cover types
- ☐ 50-90% of one or more; >90% of non-urban cover type
- ☐ < 50% of one or more of non-urban cover types

Regional Scarcity of Wetland Vegetation Type
- ☐ Not scarce
- ☐ Scarce

Wetland's Land Use
- ☐ High intensity
- ☐ Moderate intensity
- ☐ Low intensity

Topographic Position of Wetland in the Watershed
- ☐ Isolated
- ☐ Headwater (order 1 & 2)
- ☐ Lower reach (order 3 and above)

Is the Wetland a Fragment of a Once Larger and Complete Wetland?
- ☐ Yes
- ☐ No

HYDROLOGIC VARIABLES

Surface Water Level Fluctuation of Wetland
- ☐ High
- ☐ No fluctuation
- ☐ Low

Surface Hydrologic Water Connection
- ☐ Not connected
- ☐ Connected to an intermittent stream
- ☐ Connected to a perennial stream or river
- ☐ Connected to a lake

Nested Piezometer Data
- ☐ Recharge condition
- ☐ Horizontal flow
- ☐ Discharge condition

Relationship of Wetland's Substrate to Regional Potentiometric Surface
- ☐ Piezometric surface above wetland substrate
- ☐ Piezometric surface below wetland substrate

Water Regime
- ☐ Wet regimes
- ☐ Dry regimes

Water Chemistry
- ☐ Fresh < 800 μ Mos

pH
- ☐ Acid < 5.5
- ☐ Circumneutral 5.5 - 7.4
- ☐ Alkaline > 7.4

Surficial Geologic Deposit Under Wetland
- ☐ Low permeability deposits
- ☐ High permeability deposits

Basin Topographic Gradient
- ☐ High gradient > 2%
- ☐ Low gradient 2% or less

Degree of Outlet Restriction
- ☐ Restricted outlet
- ☐ Unrestricted outlet

Ratio of Wetland Area to Watershed Area
- ☐ Large > 10%
- ☐ Small 10% or less

Microrelief of Wetland
- ☐ Pronounced > 45 cm
- ☐ Well developed 15-45 cm
- ☐ Poorly developed < 15 cm

Does the Wetland Occur at the Base of a Steep Slope?
- ☐ Yes
- ☐ No

Is the Wetland Adjacent to or Part of a Critical Area of Special Concern?
- ☐ Yes
- ☐ No

Wetland Occurrence at Base of Steep Slope
- ☐ Does occur
- ☐ Does not occur

Source: (Fugro East 1995)

Evidence of Springs and Seeps
- ☐ No seeps or springs
- ☐ Seeps only
  - Perennial spring
  - ☐ Intermittent spring

Wet Regime Within a Drier Regime
- ☐ Yes
- ☐ No

Evidence of Sedimentation
- ☐ No evidence observed
- ☐ Sediment observed on Wetland Substrate
- ☐ Fluviquent soil present

Frequency of Overbank Flooding
- ☐ High 5 or less years
- ☐ Moderate 6 to 20 years
- ☐ Low > 20 years to 100 years

Potential for Overland Flows From Surrounding Upland
- ☐ High potential > 100 acres
- ☐ Low potential 100 or less

.t - Outlet Class
- ☐ No inlet - no outlet
- ☐ No inlet - intermittent outlet
- ☐ No inlet - perennial outlet
- ☐ Intermittent inlet - no outlet
- ☐ Intermittent inlet - intermittent outlet
- ☐ Intermittent inlet - perennial outlet
- ☐ Perennial inlet - no outlet
- ☐ Perennial inlet - intermittent outlet
- ☐ Perennial inlet - perennial outlet

Is the Wetland Associated With an Incised Stream Channel?
- ☐ Yes
- ☐ No

Does the Wetland Occur Downstream of an Urbanized Area?
- ☐ Yes
- ☐ No

Does the Stream Channel Within the Wetland Have Blockages Such as Debris, Dams?
- ☐ Yes
- No

Is the Wetland Ditched
- ☐ Yes
- ☐ No

Is the Wetland a Buffer for a Stream, River or Lake?
- ☐ Yes
- ☐ No

Is the Wetland Adjacent to a Water Body?
- ☐ Yes
- ☐ No

SOIL VARIABLES

Soil Type Histol
- ☐ Fibric
- ☐ Hemic
- ☐ Sapric

Mineral Hydric Soil
- ☐ Gravely
- ☐ Silty
- ☐ Sandy
- ☐ Clayey

VEGETATIVE VARIABLES

Dominant Wetland Type

Forested Wetland

Evergreen
- ☐ Needle-leaved

Deciduous
- ☐ Broad-leaved
- ☐ Needle-leaved

Scrub Shrub

Evergreen
- ☐ Needle-leaved

Deciduous
- ☐ Needle-leaved
- ☐ Broad-leaved

Emergent Wetland
- ☐ Persistent
- ☐ Non-persistent

Aquatic Bed
- ☐ No Vegetation

Number of Wetland Types
- ☐ >5
- ☐ 5
- ☐ 4
- ☐ 3
- ☐ 2
- ☐ 1
- ☐ No Vegetation

Source: (Fugro East 1995)

Number of Layers and Percent Cover
- ☐ Layer 1 submergents
- ☐ Layer 2 floating
- ☐ Layer 3 mosses and lichens
- ☐ Layer 4 short herbs (< 1m)
- ☐ Layer 5 tall herbs (≥ 1m)
- ☐ Layer 6 dwarf shrubs (< 0.5m)
- ☐ Layer 7 short shrubs (0.5-2m)
- ☐ Layer 8 talls shrubs (> 2-4m)
- ☐ Layer 9 saplings (> 4-5m)
- ☐ Layer 10 trees (≥ 6m)
- ☐ No Vegetation

Plant Species and Percent Cover by Layer
- ☐ 1 dominant species
- ☐ 2 codominant species
- ☐ 3 codominant species
- ☐ No Vegetation

Cover Distribution
- ☐ Continuous cover
- ☐ Small scattered patches
- ☐ One or more large patches with portions of the site open
- ☐ Solitary, scattered stems

Dead Plant Material
- ☐ Abundant
- ☐ Moderately abundant
- ☐ Low abundance
- ☐ None

Interspersion of Vegetation Cover and Open Water
- ☐ Scattered cover
- ☐ Peripheral cover
- ☐ Complete cover
- ☐ Complete open water

Shoreline/Wetland Length Ratio
- ☐ Low (.67 and higher)
- ☐ Medium (.33 to .66)
- ☐ High (less than .33)

Wetland Edge Complexity
- ☐ High convoluted
- ☐ Low level of convolution

Is the Wetland Part of a Known Wildlife Corridor?
- ☐ Yes
- ☐ No

Adjacent to Known Upland Wildlife Habitat
- ☐ Adjacent
- ☐ Not Adjacent

Evenness Distribution
- ☐ Even distribution
- ☐ Moderately even distribution
- ☐ Highly uneven distribution
- ☐ No Vegetation

Vegetative Interspersion
- ☐ High
- ☐ Moderate
- ☐ Low

Number of Layers
- ☐ >5
- ☐ 5
- ☐ 4
- ☐ 3
- ☐ 2
- ☐ 1
- ☐ No Vegetation

Stream Sinuosity
- ☐ SL/WL > 0.67
- ☐ SL/WL 0.33 - 0.66
- ☐ SL/WL <0.33
- ☐ No Stream

Presence of Islands
- ☐ Present
- ☐ Absent

Stem Density
- ☐ High
- ☐ Moderate
- ☐ Low
- ☐ No Vegetation

Adjacent to Fish Habitat
- ☐ Andromous or Catadromous
- ☐ Cold water fish
- ☐ Warm water fish
- ☐ No fish present

Habitat for Listed Species
- ☐ No listed species
- ☐ Listed species present

Does the Wetland Occur Adjacent to a Relatively Undisturbed Upland Habitat?
- ☐ Yes
- ☐ No

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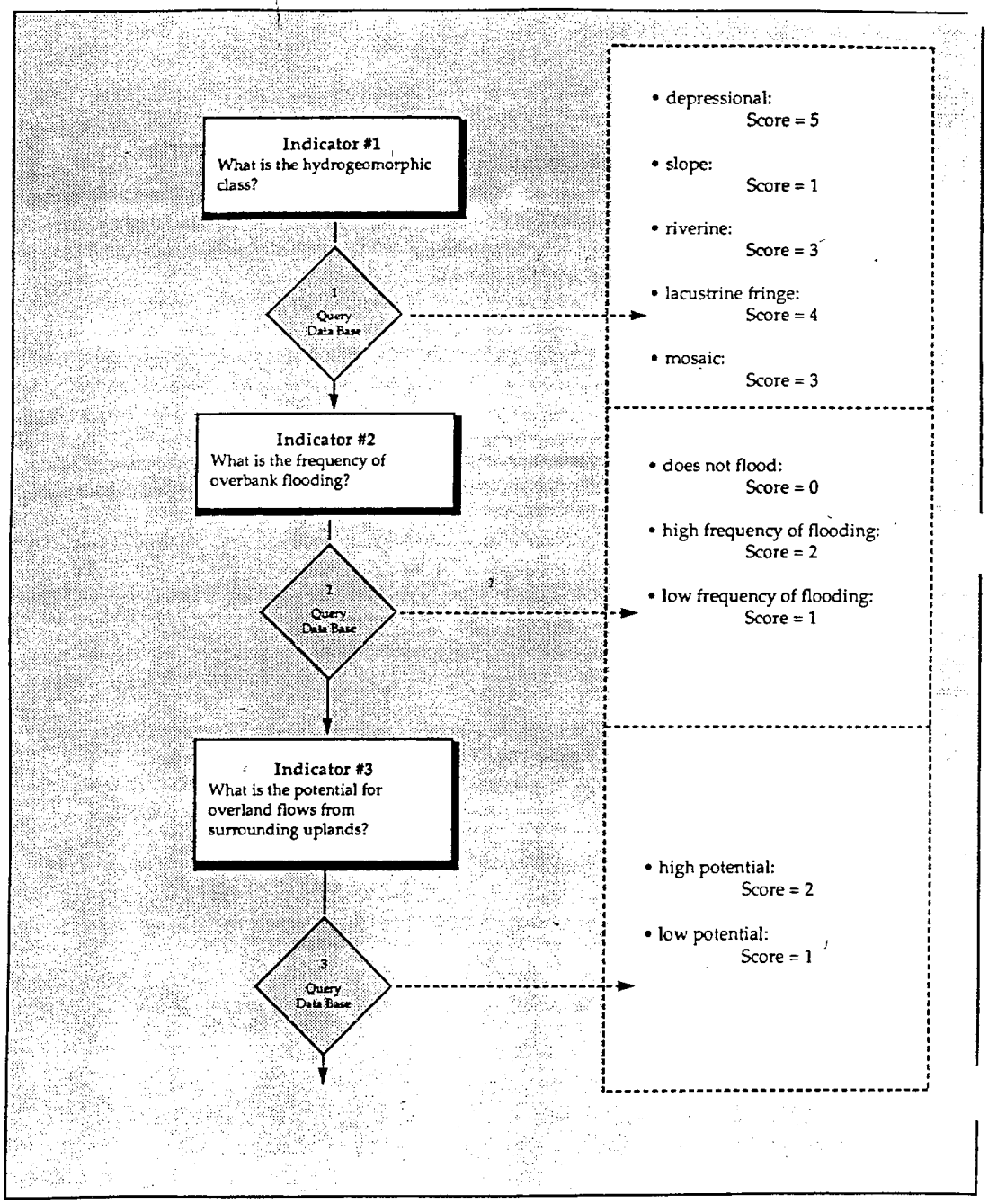
Source: (Fugro East 1995)

FIGURE 22

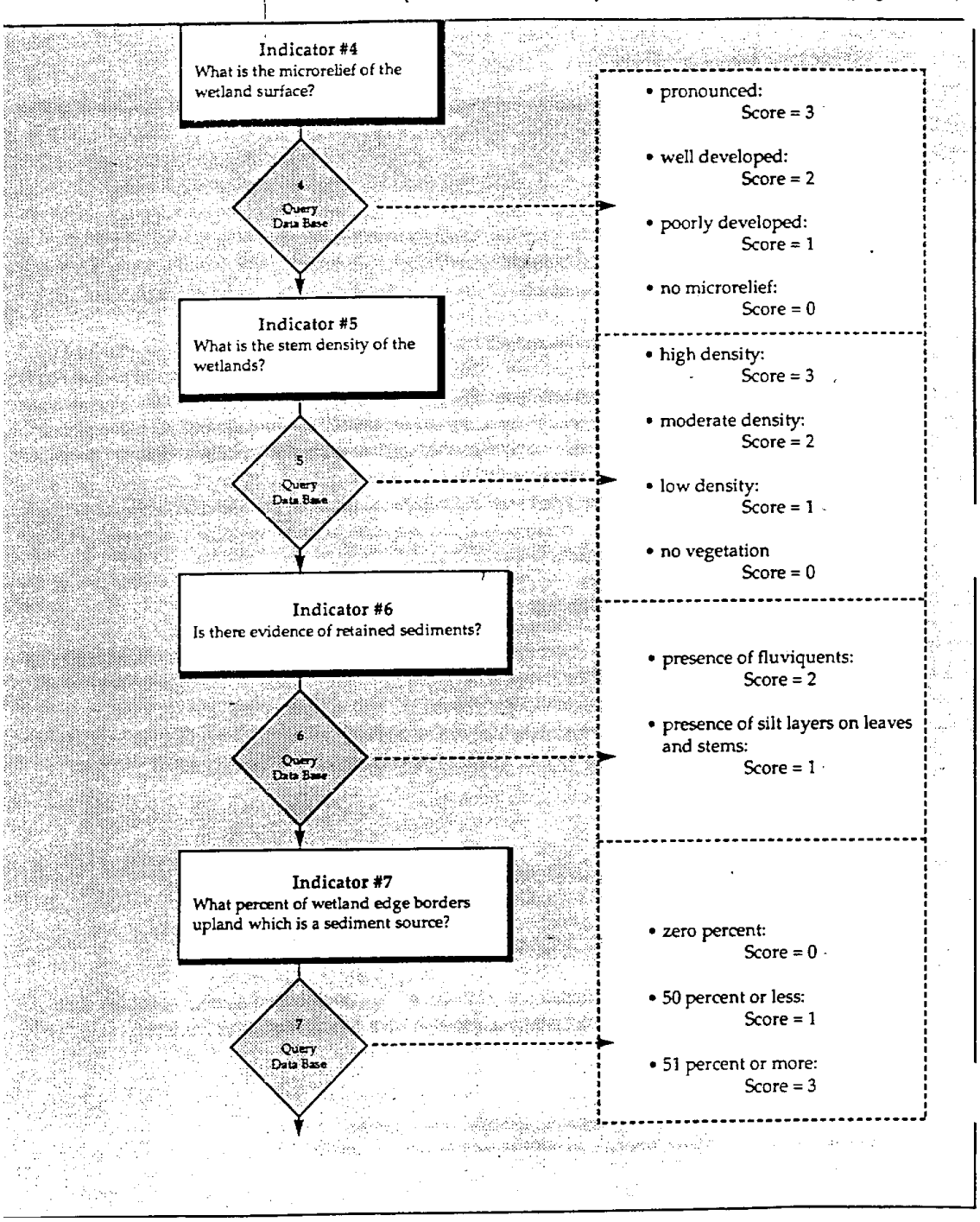
SEDIMENT STABILIZATION FUNCTION MODEL (FIELD METHOD)



Source: (Fugro East 1995)

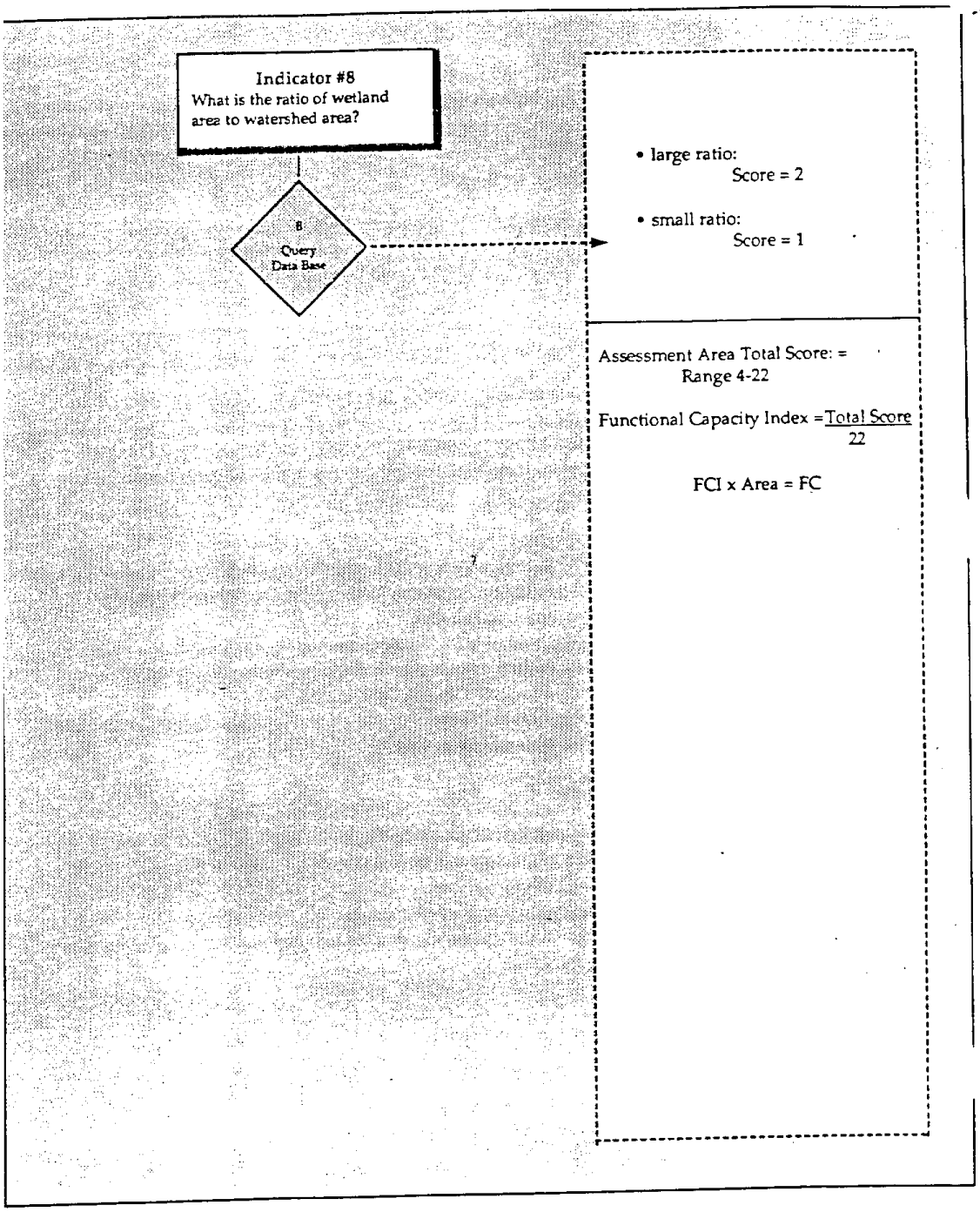
FIGURE 22

SEDIMENT STABILIZATION FUNCTION MODEL (FIELD METHOD)



Source: (Fugro East 1995)

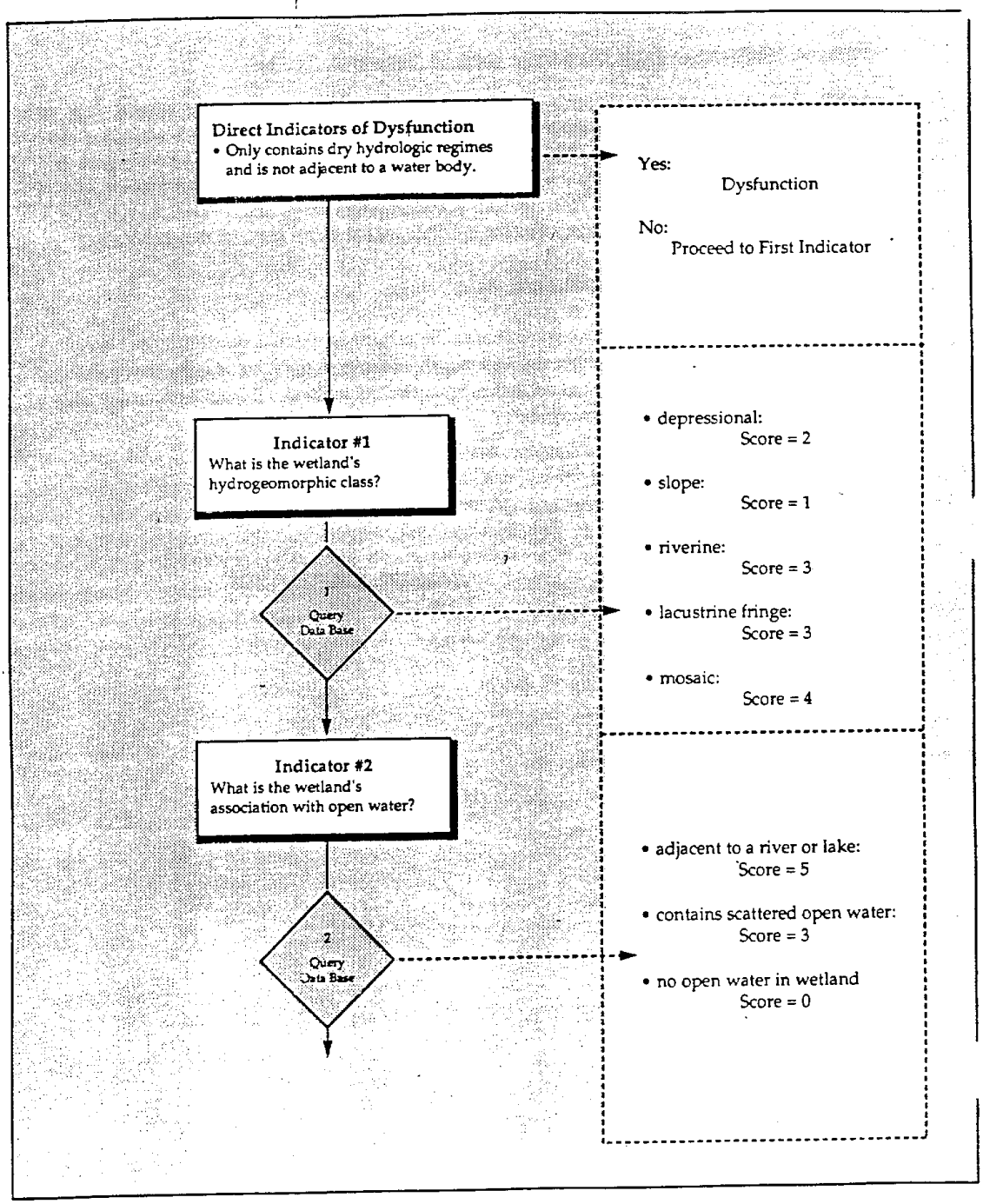
FIGURE 22
SEDIMENT STABILIZATION FUNCTION MODEL
(FIELD METHOD)



Source: (Fugro East 1995)

FIGURE 23

AQUATIC DIVERSITY/ABUNDANCE MODEL (FIELD METHOD) (page 1 of 6)



Source: (Fugro East 1995)

Soil Type

Soil type plays an important role in this function because of the chemical reactions that take place in the soil and at the soil, water, vegetation interface. Condition scores can vary from 3 for a type characterized by a high density of chemically reactive surfaces, such as a histosol (organic soil) or a mineral hydric soil with a high clay component, to a 1 for soil with a high proportion of sand. An intermediate condition would receive a score of 2.

Hydrogeomorphic Class

The geomorphology of the wetland basin controls the water flow vectors, hydrodynamics and interaction of water with wetland processes occurring in the wetland's water column regime, soil regime and vegetation regime.

Range of Conditions:

- **Depressional wetlands** predominating maximum water residency time, allowing for maximum interaction and are assigned a score of 4.
- **Riverine wetlands** are frequently inundated by overbank flooding and include certain vegetation, soils and natural valley flood storage conducive to processes which modify water quality. They are assigned a score of 3.
- **Mosaic wetlands**, because of their flatness, also induce interactions and are also assigned a score of 3.
- **Lacustrine fringe** wetlands generally flood less frequently and are assigned a score of 2.
- **Slope wetlands** retain and detain water less than other hydrogeomorphic classes and are assigned a score of 1.

Source: (Fugro East 1995)

Hydrogeomorphic Class

The wetland's geomorphology has a major influence on the hydrodynamics of the water which passes through the wetland.

Range of Conditions:

- **Depressional wetlands**, because of their shape and general lack of flow through hydrology and outlets, perform sediment stabilization by trapping the sediment within their basin and are assigned a score of 5.
- **Lacustrine fringe** wetlands are predominantly nearly flat and their surface is controlled by the adjacent lake's water plain. They are predominately densely vegetated and serve as excellent sediment traps and are assigned a score of 4.
- **Riverine wetlands** are associated with flood plains, where they are periodically inundated with flood water which typically contains sediment. The riverine wetland vegetation creates roughness which slows water allowing for sedimentation to occur. Floodplains are also areas where the hydrology is dynamic and flood water may erode sediment and prevent stabilization. Therefore, riverine wetlands are given a score of 3.
- **Mosaic wetlands** are generally broad flat wetlands containing riverine, lacustrine fringe and depressional wetland subareas. They are assigned a score of 3.
- **Slope wetlands** do not store flood water and lack the sedimentation function of the other wetland types. They do offer roughness to through-flowing sediment rich water, which results in a limited sediment stabilization function, and they are assigned a score of 1.

Frequency of Overbank Flooding

Overbank flooding is the transport mechanism by which sediments from streams enter floodplain wetlands. This function primarily relates to riverine wetlands, but lacustrine fringe wetland receive flood water from the lake. Mosaic wetlands generally contain floodplains, and occasionally so do depressional wetlands. Those wetlands with a high frequency of overbank flooding are assigned a score of 2, those with low frequency a 1. Wetlands that do not flood are assigned a zero.

Range of Conditions:

High Frequency:	< 5 years
Moderate Frequency:	6 to 20 years
Low Frequency:	> 20 years to 100 years

Field Evidence of Flooding:

A. Direct Observation
B. Watermarks/Silt marks on tree trunks
C. Scouring
D. Debris Deposition

Potential of Overland Flows From Surrounding Uplands

Another source of sediment rich water to the wetland is runoff from the surrounding upland. Those upland areas surrounding the wetland which have a high potential are assigned a score of 2, those with a low potential a 1.

Range of Conditions:

High Potential:	> 100 acres of upland contributing to overland flow
Low Potential:	100 or less acres of upland contributing to overland flow

Source: (Fugro East 1995)

Microrelief of Wetland Surface

Microrelief adds to the roughness of the wetland surface, slowing down flood water and trapping sediment within the pools of the mound and pool microtopography. Pronounced microrelief performs this process the best and is assigned a score of 3, well developed a 2, and poorly developed a 1. No microrelief is assigned a zero.

Range of Conditions:

Pronounced:	> 45 cm
Well Developed:	15-45 cm
Poorly Developed:	<15 cm

Stem Density

Vegetation stems offer resistance to through-flowing flood waters carrying sediment and adds to the roughness of the wetland surface. This slows down water allowing sedimentation. Fine grained sediment is deposited downstream of dense vegetation. New vegetation holds the trapped sediment in place preventing erosion and resuspension of the sediment. High stem density is assigned a score of 3, low a 1.

Range of Conditions:	*Definitions:*
• **High**	**High Density:** Stem density in the form of woody or emergent vegetation that covers the entire wetland with little/no open water or bare ground surface present.
• **Low**	**Low Density:** Stem density in the form of woody or emergent vegetation that is sparsely distributed throughout the wetland due to large amounts of open water or bare ground surface.
• **Moderate**	**Moderate Density:** Stem density whose distribution pattern is between the low and high conditions.

Evidence of Retained Sediment

Silt covered leaves, silt rings on stems, and silt shadows downstream of stems and dense stands of vegetation indicate that sedimentation is occurring. These indicators are assigned a 1. Fluviquents are soils which form from numerous sedimentation events on floodplains. They not only illustrate that process occur in the wetland which induce sedimentation, but that the sediment accumulates over years to produce the fluviquent soil and the sediment is stabilized for the long-term. The presence of fluviquent soils is assigned a 2.

Source: (Fugro East 1995)

Percent of Wetland Edge Bordering Upland Sediment Source

Sediment may enter a wetland carried by runoff from adjacent upland. Some upland, such as agricultural land may be a sediment source. The wetland can trap this inflowing sediment. The amount of wetland edge bordering erodible upland influences how much sediment a wetland may trap. If 51 percent or more of the wetland edge borders erodible upland then a score of 3 is assigned. If 50 percent or less of the wetland edge borders erodible upland then a score of 1 is assigned. If none of the wetland edge borders erodible upland then a score of zero is assigned.

Ratio of Wetland Area to Watershed Area

The amount of sediment entering a wetland may be influenced by its watershed size. All other characteristics being equal, the larger the wetland, the more opportunity to trap sediment, and the larger the watershed, the more potential sediment enters the wetland. A large ratio is assigned a score of 2, a small ratio is assigned a score of 1.

Range of Conditions:

Large ratio: >10%

Small ratio: <10%

$$\text{Ratio} = \frac{\text{wetland area}}{\text{watershed area}} \times 100$$

Source: (Fugro East 1995)

Wetland Rapid Assessment Procedure
(WRAP)

Source: (Miller and Gunsalus 1999)

Wetland Rapid Assessment Procedure

☐ Existing Conditions ☑ Check one ☐ Proposed Conditions (WRAP)

Application Number	Project Name	Date	Evaluator	Wetland Type

Land Use	FLUCCS Code	Wetland Acreage
	Description:	

Wildlife Utilization (WU)	Wetland Canopy (O/S)	Wetland Ground Cover (GC)

Habitat Support / Buffer

Buffer type	(Score)	X (% of area)	=Sub Totals
			TOTAL

Field Hydrology (HYD)

WQ Input & Treatment (WQ)*

* The value of WQ is obtained by adding the TOTAL scores of Land use Category and Pretreatment category then dividing by 2

Land use Category (LU)

Land use Category	(Score)	X (% of area)	=Sub Totals
		(LU) TOTAL	

Pretreatment Category (PT)

Pretreatment Category	(Score)	X (% of area)	=Sub Totals
		(PT) TOTAL	

WRAP Score

Field Notes:

Wildlife Utilization (WU)

Wetland Canopy (O/S)

Wetland Ground Cover (GC)

Habitat Support / Buffer

Field Hydrology (HYD)

WQ Input & Treatment (WQ)

Source: (Miller and Gunsalus 1999)

2.2.2.2 WETLAND OVERSTORY/SHRUB CANOPY RATING INDEX

Objective

The wetland overstory/shrub canopy variable is a measure of the health and appropriateness of the wetland shrub and overstory canopy. The assessment of the canopy variable is objectively evaluated based on food resources, cover, nesting potential, and appropriateness of the vegetative community. The canopy stratum is evaluated based on the habitat type. This variable may not be applicable to freshwater marsh and wet prairie habitats where overstory/shrub canopy is typically not present (less than 20%). By definition, undesirable plant species include exotic and nuisance plant species.

Score

NO DESIRABLE WETLAND OVERSTORY/SHRUB CANOPY TREES PRESENT — 0

- No desirable wetland trees or shrub species.
- Negligible or little habitat support (i.e., roosting, nesting and foraging) from seedling trees (if present).
- Site subject to recent clear cutting with no evidence of native canopy plant regeneration.
- Greater than 75% undesirable plant species (including E&N species).

MINIMAL DESIRABLE WETLAND OVERSTORY/SHRUB CANOPY TREES PRESENT — 1

- Large amounts (approx.. 50%) of undesirable tree or shrub species.
- Wetland overstory/shrub canopy immature but some potential for habitat support.
- Minimal signs of natural recruitment of native canopy and shrub seedlings, or tree coppicing.
- Few snags, or if many present, it may be an indication of hydrology problems or environmental impacts.
- Disease or insect damage in live canopy trees.

MODERATE AMOUNT OF DESIRABLE WETLAND OVERSTORY/SHRUB CANOPY TREES PRESENT — 2

- Few (less than 25%) undesirable canopy trees/shrubs.
- Wetland overstory/shrub canopy is providing habitat support.
- Some evidence of natural recruitment of native canopy/shrub seedlings, or tree coppicing.
- Few snags or den trees.
- Healthy live canopy trees with minimal evidence of disease or insect damage.

ABUNDANT AMOUNT OF DESIRABLE WETLAND OVERSTORY/SHRUB CANOPY TREES PRESENT — 3

- No exotic and less than 10% invasive canopy/shrub species present.
- Good habitat support provided by wetland overstory/shrub canopy.
- Strong evidence of natural recruitment of native canopy and shrub seedlings.
- Few snags or den trees.
- Healthy live canopy trees with minimal evidence of disease or insect damage.

Source: (Miller and Gunsalus 1999)

Freshwater Mitigation Quality Assessment Procedure

(WMQA)

Source: (Balzano et al, 2002)

C. VEGETATION COMPOSITION/DIVERSITY –

C.1 OVERSTORY (TREE AND SHRUB) LAYER

Objective:

The vegetation composition/diversity - overstory layer variable evaluates the presence, health, and abundance of the wetland's tree and shrub layer 3 feet or more in height, where applicable. Desirable plant species are those plants that one would expect to see in a comparable undisturbed wetland and those that do not have a tendency to become invasive. Undesirable plant species are plant species that are not usually considered nuisance species, however may be indicative of other problems (i.e. - improper hydrology) and may dominate a particular stratum. Nuisance or invasive plant species have the potential to dominate plant communities (e.g. tree-of-heaven, multiflora rose, Russian olive). This variable is not applicable to emergent habitats where overstory layers are typically not present. In this case a score of NA (not applicable) should be noted on the field data sheets. (Note - Overstory trees >15' height, Shrub = >3-15' height).

Refer to Appendix A - list of plants defined by NJDEP to be "nuisance or invasive" species.

	Relative Score:
ABUNDANT AMOUNT OF DESIRABLE WETLAND OVERSTORY LAYER PRESENT	3

a. **Abundant** wetland overstory layer present (75-100% cover).
b. Wetland contains negligible nuisance or invasive trees and shrubs **(<1%).**
c. **Strong** evidence of natural recruitment of desirable tree and shrub seedlings.
d. **Abundant** signs of recent growth.
e. **Negligible** evidence of insect damage and/or herbivory.
f. **Negligible** signs of abnormal growth patterns, chlorosis, or other abnormalities.
g. **High** tree and shrub diversity.

MODERATE AMOUNT OF DESIRABLE WETLAND OVERSTORY LAYER PRESENT	2

h. **Moderate** wetland overstory layer present (50-74% cover).
i. Wetland contains minimal nuisance or invasive trees and shrubs **(1-10%)**.
j. **Moderate** evidence of natural recruitment of desirable tree and shrub seedlings.
k. **Moderate** signs of recent growth.
l. **Minimal** evidence of insect damage and/or herbivory.
m. **Minimal** signs of abnormal growth patterns, chlorosis, or other abnormalities.
n. **Moderate** tree and shrub diversity.

Source: (Balzano et al, 2002)

C. 1 OVERSTORY (TREE AND SHRUB) LAYER (continued)

	Relative Score:
LIMITED AMOUNT OF DESIRABLE WETLAND OVERSTORY LAYER PRESENT	1

o. **Minimal** wetland overstory layer present (25-49% cover).
p. Nuisance or invasive trees and shrubs are well-established **(>10-50%)**.
q. **Minimal** evidence of natural recruitment of desirable tree and shrub seedlings.
r. **Minimal** signs of recent growth.
s. **Moderate** evidence of insect damage and/or herbivory.
t. **Abundant** signs of abnormal growth patterns, chlorosis, or other abnormalities.
u. **Minimal** tree and shrub diversity.

UNDESIRABLE WETLAND OVERSTORY LAYER PRESENT	0

v. **Negligible** wetland overstory layer present (0-24% cover).
w. Wetland is dominated by nuisance or invasive trees and shrubs **(>50%)**.
x. **Negligible** signs of natural recruitment of desirable tree and shrub seedlings.
y. **Negligible** signs of recent growth.
z. **Strong** evidence of insect damage and/or herbivory.
aa. **Extensive** signs of abnormal growth patterns, chlorosis, or other abnormalities.
bb. **Negligible** tree and shrub diversity.

Source: (Balzano et al, 2002)

IV. Scoring Matrix - See introduction for instructions on how to apply these guidance field indicator lists. Letters for these field indicators correspond to Section III which should be used to assign a value based on the "best fit" method.

A. HYDROLOGY

Relative Score	Wetland Hydrology	Undesirable Plant Colonization	Plant Stress	Plant Mortality	Surface Inundation	Water Flow Channelization	Redoximorphic Features	Hydric Soils
3	a. adequate	b. negligible	c. no stress	d. negligible	e. abundant	f. negligible	g. distinct	h. strong
2	i. impaired	j. minimal	k. minimal	l. minimal	m. moderate	n. minimal	o. present	p. moderate
1	q. inadequate	r. moderate	s. moderate	t. moderate	u. minimal	v. moderate	w. minimal	x. minimal
0	y. limited	z. extensive	aa. severe	bb. extensive	cc. absent	dd. extensive	ee. absent	ff. negligible

B. SOILS

Relative Score	Topsoil	Erosion	Soil Compaction	Debris
3	a. >6"	b. negligible	c. negligible	d. negligible
2	e. 3-6"	f. minimal	g. minimal	h. minimal
1	i. present, up to 3"	j. moderate	k. moderate	l. moderate
0	m. absent	n. strong	o. strong	p. extensive

C.1 VEGETATION COMPOSITION/DIVERSITY - OVERSTORY (TREE AND SHRUB) LAYER

Relative Score	Plant Cover	Invasive Plants	Natural Recruitment	Plant Growth	Insects & Herbivory	Plant Stress	Diversity
3	a. abundant	b. <1%	c. strong	d. abundant	e. negligible	f. negligible	g. high
2	h. moderate	i. 1-10%	j. moderate	k. moderate	l. minimal	m. minimal	n. moderate
1	o. minimal	p. >10-50%	q. minimal	r. minimal	s. moderate	t. abundant	u. minimal
0	v. negligible	w. >50%	x. negligible	y. negligible	z. strong	aa. extensive	bb. negligible

C.2. VEGETATION COMPOSITION/DIVERSITY - GROUND COVER

Relative Score	Plant Cover	Invasive Plants	Natural Recruitment	Plant Growth	Insects & Herbivory	Plant Stress	Diversity
3	a. abundant	b. <1%	c. strong	d. abundant	e. negligible	f. negligible	g. high
2	h. moderate	i. 1-10%	j. moderate	k. moderate	l. minimal	m. minimal	n. moderate
1	o. minimal	p. >10-50%	q. minimal	r. minimal	s. moderate	t. abundant	u. minimal
0	v. negligible	w. >50%	x. negligible	y. negligible	z. strong	aa. extensive	bb. negligible

Source: (Balzano et al, 2002)

IV. Scoring Matrices (continued)

D. WILDLIFE SUITABILITY

Relative Score	Cover	Adjacent Resources	Human Impediments	Nest/Breeding Activity
3	a. abundant	b. abundant	c negligible	d. strong
2	e. adequate	f. available	g. minimal	h. moderate
1	i. limited	j. limited	k. moderate	l. minimal
0	m. inadequate	n. inadequate	o. extensive	p. inadequate

E. SITE CHARACTERISTICS

Relative Score	Maintenance	Edge:Area Ratio	Heterogeneity	Location	Size
3	a. stable	b. low	c. distinct	d. conducive	e. conducive
2	f. some	g. moderate	h. moderate	i. adequate	j. adequate
1	k. extensive	l. high	m. low	n. impedes	o. impedes
0	p. continuous	q. extreme	r. none	s. inadequate	t. inadequate

F.1. LANDSCAPE CHARACTERISTICS - ADJACENT BUFFER

Relative	Width	Invasive Species	Wildlife Suitability	Cover	Slope
3	a. ≥150.	b. <1%	c. predominantly	d. adequate	e. <10%
2	f. >50-<150 ft.	g. <50%	h. some	i. limited	j. 10-20%
1	k. ≤50 ft.	l. >50%	m. limited	n. inadequate	o. >20%
0	p. 0 ft.	q. not applicable	r. not available	s. not available	t. not available

F.2 LANDSCAPE CHARACTERISTICS - CONTIGUITY

Relative Score	Contiguity
3	a. 75-100%
2	b. 50-<75%
1	c. 25-<50%
0	d. <25%.

F.3 LANDSCAPE CHARACTERISTICS – LAND USE

Land Use (Score shown in parenthesis)	
a. undeveloped open space (3)	f. agriculture (1)
b. low density residential (2)	g. highway (0.5)
c. low intensity commercial (1.5)	h. industrial (0.5)
d. high-density residential (1)	i. high intensity commercial/industrial (0)
e. recreation/golf courses (1)	

Source: (Balzano et al, 2002)

Appendix D:

Operational Strengths and weaknesses of the functional assessment methods implemented in WMA 6

Operational strengths and weaknesses of the individual methods:

We provide points for strengths and weaknesses that we encountered for each method from the perspective of implementation and interpretation of the method. We also provide recommendations on how the methods may need to be further modified to be applicable in New Jersey, as well as revisions that we found would be useful from the perspective of increasing reliability between different evaluators and potentially across different wetland types.

Descriptive Approach

Strengths

- The indicators are straightforward, and the detail provided by listing all applicable indicators in the rationale column of the data sheet can be used to provide a detailed description of the wetland.
- The method is very flexible, allowing the evaluator to add or weight indicators as appropriate, thus allowing the method to be applied to any wetland type. This also allows the evaluator room for individual interpretation at unusual sites.
- The documentation for the method provides a good definition of the functions assessed in this method.
- The documentation provides a nice example of a graphical approach that can be used to summarize assessment information for many wetlands in the same geographic area, but this requires taking the evaluations from the field into the office and further refining the information. While this might be appropriate and informative for a larger spatial context, it could become burdensome for individual wetlands.

Weaknesses

- Due to the subjective and binary nature of evaluating wetlands with this method, it is particularly important that people who use this method have breadth and depth in wetland ecology and that it relies on team consensus rather than a single evaluator.
- The procedure lacks adequate guidelines to help the evaluator determine principal functions.
- The legwork required prior to fieldwork is time-consuming, as a great deal of data is required and some of it can be difficult to locate or unavailable.
- The lack of any sort of ranking method in the Descriptive Approach makes it difficult to compare a large number of wetlands and time-consuming to compare even a small number in a meaningful way.
- The method provides limited information regarding degree of wetland functioning, particularly compared to the other methods.
- Some of the indicators show positive functioning in the wetland, while others show a lack of functioning. The positive and negative indicators are not separated in the lists or data sheets. This is problematic, especially when one needs to sort through a long list of indicators that apply to each function.
- The method is not particularly rapid when the suggested indicators are used due to the long lists of indicators and extensive legwork. In addition, there is

considerable upfront time collecting the materials necessary to implement the method (Table 6).

Modifications for New Jersey:
We did not identify any modifications that would be required to increase the suitability of the Descriptive Approach to New Jersey wetlands. The documentation provides support for using a presence/absence method rather than rating the degree of functioning:

- Using ratings (high, moderate, low) can imply a more quantifiable database than actually exists.
- Numerical rankings are absolute and should be avoided unless data can support the analysis. In any case, arbitrary weightings should not be applied to functions, and dissimilar functions should not be ranked together.

Based on our experience with this method and binary (yes/no) responses, it is critically important that the methodology be clearly and concisely documented and the indicators be clearly defined, described and organized. Clear instructions on how principle functions are to be identified is necessary to ensure repeatability across different teams and wetlands.

Wetland Evaluation Technique (WET)

Strengths

- A glossary is provided, which helps clarify terminology used in the method.
- Instructions are detailed and complete.
- Figures are often provided to help clarify the methodology questions.
- Detailed information is provided for each function in the Effectiveness and Opportunity evaluations, including definition and description of the function, rationale for ratings, general sensitivities of the interpretation key and interpretation key to determine ratings.
- A computer program has been developed to determine the ratings for the Effectiveness and Opportunity evaluations, thereby eliminating the long, time-intensive interpretation keys, and possibly reducing the time required to complete a site evaluation.
- Detailed keys are provided to guide the delineation of the assessment area.
- A list of the indicators is provided in an appendix, along with information regarding which functions each indicator is used in.

Weaknesses

- The method is long and tedious. This prevents it from being particularly rapid. There are many detailed questions required for each assessment and the interpretation keys (especially for the effectiveness evaluation) are very long and tedious.
- The method requires a lot of information gathering prior to site visits.
- The social significance (Level 1) evaluation does not provide a rationale for ratings.

- The evaluator must determine if the service area is covered by more than 10% impervious surface. A consistent interpretation of landuse maps is necessary to ensure consistency between evaluators.

Modifications for New Jersey:

We did not identify any modifications that would be required to increase the suitability of WET to New Jersey wetlands.

Rapid Assessment Methodology for Evaluating Wetland Functional Values (WI RAM)

Strengths

- The method provides a list of special features or "red flags" that are not incorporated into the ratings for functions, but that are included on the summary sheet for consideration along with the ratings for each function. This allows evaluators to call attention to any unique or important features that may influence decisions about the wetland. However, these "red flags" are not until page 5 of the document and may not be adequately recognized by someone looking at the results. A more prominent place on or near the ratings results (which is on page 1) could help ensure that these special features are recognized if they are present.
- A place is given to describe any seasonality limitations of the wetland evaluation due to the time of year, and/or current hydrologic or climatologic conditions (i.e. drought, spring flood). This may help explain conditions that may affect ratings causing unusual or inconsistent results.
- The data sheet is clear and easy to understand.

Weaknesses

- This method provides few instructions or guidelines, which increases the subjectivity of the results and reduces the confidence of the evaluators in the ratings.
- The method provides a list of questions, primarily yes/no questions, for each wetland function, but does not provide guidelines for turning the answers to these questions into a rating (of low, medium, high, or exceptional) for the function. This leaves a great deal to the judgment of the evaluator and decreases the precision of the method.
- The Floral Diversity function has a list of only two questions. Evaluators had difficulty determining how to choose among four possible ratings (low, medium, high, and exceptional) based on the answers to only two questions and felt that more questions were needed.
- Usually an answer of yes for any given question indicated that the site was functioning in some way, but for a few questions, which were dispersed among the others, an answer of yes indicated a lack of functioning. This also made it difficult for evaluators to look through the list and determine an overall rating for the function. These questions should be reworded or separated to reduce confusion.

- Groundwater Discharge/Recharge would also benefit from an increase in the number of questions, as only three are listed. Additionally, the second and third questions are unclear and require definitions of terms or examples.
- Evaluators expressed lower than average confidence in the answers to yes/no questions, as the questions did not account for "gray areas" or unusual situations.
- No rationale is given in the documentation for the development of the method or the indicators used in determining the ratings.
- In general we had less confidence in the Floral Diversity and in the Groundwater Recharge/Discharge functions. Floral Diversity only had 2 questions that had the same answers for each wetland, yet the evaluators did not feel that all wetlands deserved the same rating, so best professional judgment was employed to make a rating decision. This can lead to greater differences between different evaluators. It was difficult to determine a rating of low, medium, high, or exceptional from such little input. The Groundwater Recharge/Discharge function only has 3 questions and evaluators were not clear on what specifically to look for in two of the three questions. It was also difficult to determine a rating for this function with so few questions.

Modification for New Jersey

Some information within the text should be modified to increase the suitability of WI RAM to New Jersey wetlands. This includes a list of wetland types in New Jersey, a list of critical habitats and species for New Jersey in the evaluation of red flags, locations of wetlands that are particularly sensitive or targeted for conservation, and reference to New Jersey Natural Heritage Program and the NJ Endangered and Nongame Species Landscape Project. The method should also be updated to incorporate New Jersey coastal laws (Wisconsin includes their coastal management laws) if it is used for this area. Wetland regulations that are specific to New Jersey should replace those specific for Wisconsin in the methodology.

Technique for the Functional Assessment of Nontidal Wetlands in the Coastal Plain of Virginia (VIMS)

Strengths

- The method documentation provides information regarding the method's purpose, wetland types for which its use is appropriate, and limitations of the method. It also provides good support for their choice of wetland type (i.e. why it is important to evaluate nontidal coastal plain wetlands in VA).
- A short literature review of wetland assessment methods is given that provides some background for the method's development.
- Method documentation provides good background information regarding each of the wetland functions, including definitions, characteristics that affect the effectiveness of a wetland to perform a function, review of how other assessment methods evaluate the function, rationale and references for selected indicators and for the rating thresholds, description of each indicator and its ratings, and rationale for the dichotomous key that is used to determine the overall rating for

the function. This level of detail facilitates future users if they find they need to modify the method.

- The questions are clear and straightforward. There are few questions with ambiguous wording or lack of instructions. In some cases, guidelines are given for questions to help reduce their subjectivity.
- There are separate data sheets for the office and the field. The separate data sheets helped evaluators to easily identify questions that needed to be answered in the office from those that required a field assessment.

Weaknesses

- No information is given regarding the qualifications, training, or the level of expertise the evaluators should possess.
- In two different locations within the manual, there are two sets of directions for determining the overall rating for each function: a written set and a dichotomous key. The written description is not explicit for some functions, using terms such as "most," and, if used instead of the dichotomous key, this description could lead to erroneous scoring if the inexplicit directions are interpreted differently than as laid out by the key.
- Likewise, there are multiple, overlapping data sheets, which can be awkward and confusing. This system should be simplified to decrease overlap and shorten the amount of time required to perform the method by decreasing the number of sheets that need to be filled out.
- The calculation for the proportion of a 2-year, 24-hour flood volume stored in the wetland did not work well for our wetland sites in WMA 6 (this indicator is used in the flood storage, nutrient retention, and sediment/toxicant trapping functions). The wetlands were located within large wetland complexes along the Passaic River. As such, the primary sub-watershed (which discharges directly into the wetland without the water passing through other wetlands first) was very small compared to the upstream sub-watershed (which discharges into the wetland with water traveling through other wetlands first). Because the majority of the runoff in the wetland's watershed is captured by other wetlands first during a storm event, the amount of runoff that reaches the wetland is low. However, because the wetlands are floodplains, they have a relatively high storage capacity. This combination of low amounts of runoff reaching the wetland and a high storage capacity resulted in numbers greater than 1 for the calculation for the proportion of a 2-year, 24-hour flood volume stored (more than 100% of the volume can be stored in the wetland). However, the method documentation states that this number should be a number between 0 and 1. This was not a problem in WMA 19 where less of the site's watershed was comprised of wetlands.

Modification for New Jersey

The calculation for the proportion of a 2-year, 24-hour flood volume stored in the wetland may not be applicable for floodplain wetlands, as it does not address overbank flooding from the river as a source of hydrology to the wetland during a storm event. Only surface runoff from the surrounding watershed is calculated into the final determination.

Guidance for Rating the Values of Wetlands in North Carolina (NC Guidance)

Strengths

- It is important that evaluators keep in mind that NC Guidance assesses a wetland's value to human society, and not specific wetland functioning, when comparing wetlands with different overall wetland rating scores.
- The method is straightforward and easy to apply in the field. Implementation required little gathering of data sources and little field preparation.
- A narrative description is included for each wetland function, which provides text for clarification on wording or the meaning of the flowcharts. The narrative description includes: function definition, rationale for the scoring criteria, why specific indicators were used and how they affect scoring of the function.
- Data sheets were clear and concise. Instructions are accompanied with flowcharts, which facilitate moving through the calculations to the final wetland score.
- The method explains how to follow flowcharts and what to do in cases where the flowchart is not applicable for a particular wetland.
- A glossary is included in the documentation for NC Guidance, which helps to clarify terminology used in the flowcharts for the method.
- The NC Guidance rating system was developed from a literature review of biological criteria (DEHNR 1993). An appendix is included in the method documentation that provides citations for the indicators that were chosen to evaluate each function. This information is useful if modifications to the method are desired.

Weaknesses

- Due to the rapidness of this method, less field and data input is required, which may reduce the accuracy of the scores.
- There is no justification for the weightings that are used for the different functions, so it is difficult to evaluate if they are appropriate or if they need to be adjusted for New Jersey. Errors made in determining the scores are amplified when they are multiplied by the weightings for each wetland function, especially for the Pollutant Removal wetland function due to its high weighting. This can potentially alter the overall Wetland Rating and reduce consistency among evaluators.
- Degree of microtopographic relief (water storage, pollutant removal). The evaluator must determine whether more than 50% of the wetland area consists of depressions greater than 10 inches, between 5 and 10 inches, or less than 5 inches. It can be difficult to accurately determine the size of depressions if they are over 50% of the wetland area in very large wetlands.
- Land use within the watershed (bank/shoreline stabilization). The evaluator must determine if there is greater than 10% impervious surface within ½ mile upstream from the wetland. There are no instructions on how to determine this number. Different evaluators using different methods to estimate the percent of impervious surface could lead to inconsistencies in the wetland evaluation.

- Flooding frequency (pollutant removal). The evaluator has to determine whether a 2nd or higher order stream floods seasonally or temporarily. This requires a working knowledge of the hydrology of the area. The distinction between these two flooding frequencies is important, since errors in selecting the correct flooding frequency can cause large discrepancies between ratings due to the high weighting of this function.

Modification for New Jersey

Some information within the text should be modified to increase the suitability of NC Guidance to New Jersey wetlands. For example, tables listing common plant species preferred by waterfowl or wildlife should be modified with plant species commonly used by waterfowl and wildlife in New Jersey. A list of rare plant species for New Jersey would substitute the current list for rare plants in North Carolina. In addition, some indicators were not clearly defined and could lead to inconsistencies in the ratings. These indicators were mainly within the water storage, bank/shoreline stabilization, and pollutant removal functions.

MDE:

Strengths

- MDE has the best overall description of the functions and the indicators of all the methods we tested. In particular, the information regarding inventory methods and the figures for each indicator helped to clarify what to look for in the office and in the field. As a result, evaluators were confident in their abilities to accurately evaluate the indicators for the method.
- The directions for applying the method are also clear and well explained. The method includes explicit guidelines on how to use the results to obtain a score for the wetland, thus reducing the number of judgment calls required to obtain a score. Detailed instructions and criteria are provided for the definition of assessment area boundaries, including figures and special cases (i.e., wetland mosaics).
- Two versions of the method are included: a field method and a desktop method, which does not require field work. The desktop method may be useful in some situations; however, the document itself warns that this method may not be as accurate as the field method. Thus, there are situations in which its use would not be appropriate.
- There are a large number of indicators that influence the score for each function. This makes the method both more comprehensive and less prone to large variations in scores due to errors in scoring individual indicators. The indicators are also weighted to allow more important factors to influence the score more heavily. The only indicator that may drastically affect scores if computed improperly is area, which has an inordinately large, multiplicative weighting on the final score.
- The document also includes a literature review and justification for choosing the functions and indicators that were included.

- Method documentation provides information regarding specific utilizations and limitations of the method.

Weaknesses

- Area has an inappropriately large effect on the overall score. The score for each of the six functions is multiplied by the area of the site prior to being summed, giving area an inordinately large effect on the overall score. In addition, using area as a multiplier causes the scores for the quality of site functionality to be lost in the measurement of quantity of functionality.
- The indicators are listed in different orders on the data sheets than they are in the text. This makes it difficult to look up information if questions arise concerning terminology, etc.
- There is no summary data sheet on which to calculate the overall site score.
- The definition of intermittent outlet was difficult to apply in floodplains wetlands such as the ones we evaluated in this study.
- Evaluators found it difficult to determine whether surficial geological deposits had high or low permeability.
- Nested piezometer data is listed as an indicator for the ground water discharge function, however this information is very time and labor intensive for a rapid assessment method, as it requires the installation of ground water monitoring wells. The method documentation states that this information is rarely available, but does not provide any guidelines as to how to adjust the scoring if this information is not available.

Modification for New Jersey

- Some information within the text needs modification to increase the suitability of MDE to New Jersey wetlands. For example, in the Aquatic Diversity function, some steps in determining the score for the function did not have appropriate choices for the wetlands examined in this study. Steps 3 and 5 do not include options appropriate for drier regimes, such as those found in floodplains. Step 17 in the Aquatic Diversity function, which deals with special areas of concern on the Chesapeake Bay, should be adjusted to account for special areas of concern in New Jersey or could be dropped and the maximum score for the function adjusted downward.
- Information is provided regarding Maryland GIS data layers that are available, including the name, relevance to the method, how to obtain it, and which are the most accurate. Equivalent information for New Jersey would be appropriate.

Freshwater Wetland Mitigation Quality Assessment Procedure (WMQA)

Strengths

- Scoring is flexible. Additional indicators may be included with those discussed in the manual, and the evaluator may assign greater weight to indicators that are more important at given sites. The evaluator may also assign scores in increments of 0.5 as deemed appropriate.

- The method was designed to assess the potential of mitigated wetland sites to function properly as wetlands. Results from relatively pristine, natural sites are high compared to those at most mitigation sites, demonstrating that the method successfully picks up functioning when it is present (Hatfield et al. 2003).
- The method is reasonably straightforward, making it easy to apply in the field.
- The method is also reasonably objective and relies less on professional judgment than do several of the other methods examined in this report.
- Evaluators found the method easy to apply and were confident in their abilities to accurately evaluate the indicators for each function.
- Method documentation provides background information regarding the development of the method and its purpose.
- A definition is provided for each wetland function, as well as a short discussion regarding the indicators for each function and what to look for in the field.

Weaknesses

- The method's writers assume that evaluators are experienced in wetland identification, delineation, and mitigation construction techniques, and that a pair of two evaluators will collaborate to score the wetland. This may not always be true or practical.
- Since the method was designed to measure the functional potential of mitigated sites, several indicators are designed specifically for mitigated sites and may be less appropriate for use with natural sites, including:
  - Soils: topsoil depth, erosion, or loss of topsoil (may not be appropriate for natural floodplain wetlands were erosion is natural) and evidence of soil compaction
  - Site Charateristics: degree of maintenance required to achieve and maintain wetland
- Soil erosion is expected in riverine, forested wetlands with overbank flow, yet WMQA scores sites with erosion lower for the soils function.
- The instructions for this method could use more detail and further definition of terms, both of which may decrease variability among evaluators.
- The same title "plant stress" is used for two separate indicators, one occurring in the hydrology function (where it refers to signs of improper hydration) and one in the vegetation function (where it refers to signs of improper nutrition). The use of separate terms would reduce confusion.
- It would also aid clarity if the hydrology indicator "undesirable plant colonization" were changed to something more specific, such as "transitional/upland plant succession," in order to avoid confusion with the vegetation function's "invasive plant colonization" indicator.

Modification for New Jersey

We did not identify any modifications that would be required to increase the suitability of WMQA to New Jersey wetlands.

Wetland Rapid Assessment Procedure (WRAP)

Strengths

- The method includes a glossary to ensure that all evaluators are interpreting terms in the same manner.
- The method includes several appendices, which detail information about different wetland types and which species or features you might expect to find there. This aids the evaluator in determining what he or she should look for.
- The questions are straightforward and the directions easy to follow, making the method easy to apply. This provided evaluators with higher confidence in their ability to accurately rate the wetlands.
- The method allows some leeway in rating sites, such as scoring in increments of 0.5, in order to account for situations that do not exactly fit the criterion listed within the method. This allows for intuitive ratings based on professional judgment, which lends flexibility to the method.
- The method is rapid compared to many of the other methods examined.
- When determining the effect of surrounding land uses, the method considers a wide range of land use types.
- The method is applicable to a range of different wetland types.

Weaknesses

- The description of how to calculate the score for the wetland buffer is confusing. The method documentation should state that the wetland buffer should be determined for the entire perimeter of the wetland, and as a result, that multiple buffer types are permitted for each wetland.
- Intended for use by regulatory professionals, the method relies on professional experience to aid in interpretation of field observations.
- The Wildlife Utilization function requires the evaluator to be familiar with the habitat requirements for all levels of the food chain. Furthermore, all wildlife habitat features may be difficult to identify within large wetlands.

Modification for New Jersey

Some information within the text should be modified to increase the suitability of WRAP to New Jersey wetlands. For example, the land use categories should be modified to reflect those found in New Jersey. One requirement for receiving a score of 3 for vegetative overstory cover and vegetative ground cover is that there be no exotic species present. It is difficult to find a wetland site in New Jersey with no exotic species. It may be appropriate to adjust the number of exotic species that one might expect to find at sites of different quality. Another requirement for a 3 under vegetative ground cover is that periodic burns should be present. This would not be appropriate for most New Jersey wetland types. Several appendices, which provide useful information, should be adjusted to reflect information appropriate to New Jersey.