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INTERIM FUNCTIONAL ASSESSMENT MODEL FOR LAKE DAKOTA SAND PLAINS

Version 2.2

BY

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I. FUNCTIONAL PROFILE

Subclass Name: Depressional, Endo-saturated, Highly Permeable Substrate, Temporary and Seasonal Wetlands.

Reference Domain: Lake Dakota Sand Plain of North and South Dakota and nearby Deltaic Sand Plains in North Dakota.

Existing Classification:

National Wetlands Inventory—PEMA, PEMB, PEMC

Stewart & Kantrud -- Class II and Class III

Circular 39 -- Type 1 and 3

Climate:

Cool sub-humid, cold winters and hot summers, broad seasonal fluctuations in precipitation and temperature.

Geomorphic Setting: Closed depressions

Geologic Materials: Sandy glacial outwash plains and deltas associated with glacial lakes and rivers modified by wind. Drainage pattern not well defined, high water table, low hummocky sands with low relief (2-12 feet).

Soil Types:

Wetland Soils—Hamar, Venlo, Fossum and Rosewood. The discharge wetland soil in this group is likely Rosewood and in a few cases may be a Fossum soil. Venlo and Hamar are recharge wetlands. Fossum soil is most likely a flow-through wetland.

Associated Upland Soils—Hecla, Ulen, Aylmer and Bantry soils.

Hydrology

Water sources: Principally ground water with precipitation.

Water losses: Evapotranspiration. Hydro-period fluctuations with upward, downward and lateral movement of water.

Hydrodynamics: Mainly lateral with some vertical fluctuations within the wetland

Hydrologic Functions: Dominated by moderating groundwater flow.

What are the most common alterations that may impact hydrology? Irrigation, land leveling, tiling, filling, tillage, ditches, dugouts.

Vegetative communities(NWI or other classification schemes) Range Sites: Subirrigated, Wet Meadow, Wetland

Fully functional ecosystem characterized by: Tall and mixed grass, warm season herbaceous vegetation on uplands with native herbaceous vegetation in wetlands.

Somewhat impaired ecosystem characterized by: Cool season introduced vegetation/ overgrazed eroding soils.

Critically impaired ecosystem characterized by intensive cultivation: Potatoes, carrots, onions and watermelon production.

Vegetative Red Flags (T&E): Orchids(western prairie fringe) on temporary wetland fringe.

Noxious plants/ invaders: Leafy Spurge, Canada Thistle

Existing vegetative classification other (not NWI): Low Prairie zone, Wet Meadow zone, and Shallow Marsh zone.

Habitat: What kind of "critters" rely on this subclass for part or all of their life cycles: shore birds, waterfowl, amphibians, reptiles and some mammals.

Any Threatened and Endangered species—

Live here: American Burying Beetle - South Dakota

Pass through: Bald eagle, peregrine falcon, whooping crane

Rely on: none

Does this subclass exist in a complex

with similar wetlands: YES

with other types of wetlands: YES Semi-permanent.

Is ecosystem fragmentation an issue: YES

Biogeochemical Functions: Removal of elements and compounds, nutrient cycling, particulate retention.

What common impacts might impair biogeochemical functions:

1. **Lowering of groundwater level by irrigation**
2. **Tile drainage**
3. **Filling of low areas**
4. **Application of fertilizer**
5. **Removal of native vegetation from wetland and upland**
6. **Dugouts**
7. **Surface ditches**

II. Model Explanation

INTERIM FUNCTIONAL ASSESSMENT MODEL FOR TEMPORARY AND SEASONAL WETLANDS ON THE SANDY OUTWASH PLAINS OF GLACIAL LAKE DAKOTA

Notes: This Interim sandy outwash plain HGM Model is patterned after the Northern Prairie Pothole Model by Lee, L.C. et al (1997). Many of the definitions, logic, rationale, functions, and variables have been taken from the model, however, not all of the functions and variables have been included in this interim model.

The Prairie Pothole Resource Technical Team wishes to thank Dave Dewald, NRCS State Biologist, Bismarck ND and Hal Weiser, NRCS, Area Resource Soil Scientist, Jamestown, ND for their help with consultation, review and assistance with sections of this model.

1.0 MAINTAIN CHARACTERISTIC HYDROLOGY

DEFINITION: The capacity of the wetland to regulate the outflow and/or the inflow and the ability of the wetland to provide storage of water.

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

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

Discussion of Function:

A combination of the geological material and the regional water balance in the sand prairie leads to moderation of ground water flow within the depressions. The principal water sources for the sand prairie depressional wetlands are from groundwater and precipitation, and the principal water loss is through evapotranspiration. These hydro-dynamics produce an inter- and intra-annual cycle of ground water exposure and water storage above and below the edge of the temporary wetlands. This cycle supports the diverse plant and animal habitats as well as biogeochemical processes. These sand plain depressional wetlands sustain the hydrological cycle. The hydrological dynamics of the Prairie Pothole Region are addressed by Stewart and Kantrud (1972), Winter (1989) and Kantrud et al. (1989).

1.0 INDEX OF FUNCTION: Maintain Characteristic Hydrology

$=\{Vhydalt * [(Vsource + Vupuse + Vsed)/3 + ((Vsorpt + Vpore)/2) + Vwetuse)/2]/2\}^{1/2}$

Discussion of Variables:

The variables associated with the performance of this function focus on land use and on the physical integrity of soil conditions. Human activities at nearby lower elevations and above or within the wetland affect the rate of ground water movement and quantity of surface and subsurface water entering and leaving the wetland. V_{upuse}, V_{wetuse}, and V_{source} are used to describe potential alterations of water flow to the wetlands. Land use activities also affect erosion and sediment import into the wetlands by water and wind. An increased sediment load will decrease the wetland's capacity to expose water and trap water to be routed to the groundwater. The degree of sedimentation is captured by the V_{sed} variable. Undisturbed soil conditions within the wetland are closely related to ground water movement and water storage, through the ability of the soil to transmit and hold water interstitially. This soil condition is described in the V_{sorpt} and V_{pore} variable. Finally, the elevation of surface or subsurface outlets inside and outside of the wetland temporary zone boundary and fill placed in the wetland impacts surface water elevations and, therefore, the ability of the depression to capture and expose groundwater. The V_{hydalt} variable reflects this aspect of the function.

1.0 MAINTAIN CHARACTERISTIC HYDROLOGY		
Model Variable	**Measurement or Condition**	**Index**
V_{hydalt} Hydrology Alterations **Definition: Presence of a constructed subsurface and/or surface outlet affecting the wetland or fill affecting the depth of the wetland.** **Logic: The depth of fill or changes in depth of the subsurface or surface drain and distance from the wetland impacts wetland groundwater surface elevation.**	**Surface drain or subsurface drain has no effect on wetland. Surface drain or subsurface drain is > 500 feet from the wetland edge and less than 3 feet below the wetland bottom elevation. If surface drain is present and within 500 feet of wetland, it is at or above the top of the temporary zone in elevation. No fill in wetland.**	**1.0**
	Surface drain or subsurface drain 150 to 500 feet from outside wetland edge and greater than 3 feet below wetland bottom elevation. **-OR-** **Surface outlet invert lowered to remove some static storage.** **-OR-** **Wetland filled to reduce some static storage.** **Wetland still ponds water.**	**0.5**
	Surface drain or subsurface drain within 150 feet of wetland edge removing all static water and drain is greater than 3 feet below wetland elevation bottom. **-OR-** **If large wetland, tile spacing is greater than 300 feet or ineffectively removing saturated conditions.** **-OR-** **Surface outlet lowered to remove all static storage.** **-OR-** **Site filled to the top of the temporary zone with some saturation remaining in wetland.** **Wetland meets saturation criteria only.**	**0.1**
	Surface outlet below bottom of wetland, and subsurface drain 3 feet or greater below wetland bottom elevation with spacing less than 300 feet in all parts within the wetland. **-OR-** **Wetland filled eliminating saturated conditions in the wetland.**	**0.0**

1.0 MAINTAIN CHARACTERISTIC HYDROLOGY		
Model Variable	**Measurement or Condition**	**Index**
V_{source}: Source Area of Flow to Wetland **DEFINITION: The area surrounding a wetland that defines the catchment and groundwater flow area to the wetland.** **LOGIC: Altering surface flow patterns within watershed and ground water flow area will impact ground water elevation within the basin.**	**Alteration of upland watershed source area by surface alterations (e.g., ditches, roads, terraces, irrigation) does not impact wetland, and no subsurface alterations (e.g., tile drains, ditches, irrigation).**	**1.0**
	Surface alterations of upland watershed source area impacts overland flow into wetland (e.g., ditches, roads, terraces, irrigation, etc.), however, no subsurface alterations(e.g., tile drains, irrigation).	**0.75**
	Upland watershed source area is changed to alter the dominant surface and subsurface flow path of water to the wetland(e.g., draining or irrigation return or draw-down). **-AND-** **Alteration does not change the NWI classification.**	**0.50**
	Upland watershed source area is changed to alter the dominant surface and subsurface flow path of water to the wetland (e.g., draining or irrigation return or draw-down). **-AND-** **Alteration does change the NWI classification.**	**0.1**
	Upland watershed source area extremely altered such that almost all water flow to wetland eliminated (e.g., urbanization).	**0.0**

1.0 MAINTAIN CHARACTERISTIC HYDROLOGY		
Model Variable	**Measurement or Condition**	**Index**
V_{upuse}: Upland Land Use **Definition: Dominant land use or condition of the upland watershed that contributes to the wetland.** **Logic: Upland land use impacts the evapotranspiration process that influences the quantity and quality of groundwater flow to the wetland. Upland land use also controls sediment delivery to the wetland which affects water storage capacity.**	**Native prairie managed to allow adequate plant recovery time between vegetation removal.**	**1.0**
	Dominated by non-native perennial species with fair management or better. **- OR -** **Native species managed under season long grazing** **- OR -** **Perennially idle grassland cover** **- OR -** **Permanent Hayland**	**0.75**
	Native or non-native species heavily over-grazed, some bare ground, low plant vigor **- OR -** **No-till continuous high-residue crop** **- OR -** **Minimum till high-residue crops in a grass/legume rotation**	**0.5**
	Native or non-native species heavily over-grazed, high amounts of bare ground, low plant vigor, and evidence of soil erosion **- OR -** **No-till row crop, minimum till small grain**	**0.25**
	Row crop or conventional tillage small grain	**0.1**
	Urban, semi-pervious, or impervious surface. (this condition will result in maximum overland flow; a high rate of delivery to wetland) If best management practices employed, the impact may be somewhat less.	**0.0**

1.0 MAINTAIN CHARACTERISTIC HYDROLOGY		
Model Variable	**Measurement or Condition**	**Index**
V_{sed}: Sediment Delivered to Wetland **DEFINITION: Extent of sediment delivered to wetland from human disturbance sources, including agriculture.** **LOGIC: The amount of sediment in the basin impacts the capacity of the wetland to moderate groundwater flow and store water.**	**No evidence of sediment delivery to wetland.**	**1.0**
	Representative sediment depth -- **in temporary zone – <4 inches** **in seasonal zone -- <2 inches**	**0.75**
	Representative sediment depth -- **in temporary zone – 4 to <6 inches** **in seasonal zone -- 2 to <7 inches**	**0.50**
	Representative sediment depth -- **in temporary zone – 6 to <10 inches** **in seasonal zone -- 7 to <12 inches**	**0.25**
	Representative sediment depth -- **in temporary zone – =>10 inches** **in seasonal zone -- =>12 inches** **-OR-** **Wetland filled but some basin remains** **-OR-** **A vegetation zone change (i.e., Shallow Marsh to Wet Meadow)**	**0.1**
	Basin filled and landscape depression is not evident from surface features.	**0.0**

1.0 MAINTAIN CHARACTERISTIC HYDROLOGY		
Model Variable	**Measurement or Condition**	**Index**
V_{sorpt}: Soil Sorptive Properties **DEFINITION: The ability of the upper part of the soil to retain and move elements and compounds.** **LOGIC: In sandy soils, organic matter content helps moderate the flow of water in the A horizon.**	**Organic Matter is >4.0% (Measurement)** ***Indicators*: The mineral soil in all parts of the A horizon within 6 inches of the surface has a value of 2 or 3 and chroma of 0.** **-OR-** **Value of 2 and chroma of 1 -AND- nearly all sand grains visible to naked eye are coated with organic matter in all parts of the A horizon within 6 inches of the surface and lacks a darker-colored A horizon immediately or contiguously below 6 inches .** **-OR-** **Site has no evidence of drainage or excessive vegetation removal.**	**1.0**
	Organic Matter is 1.5 to =<4.0% (Measurement) ***Indicators*: The mineral soil in parts of the upper 6 inches or A horizon has a value of >2 to 3 and chroma of 1, or value of 2 and chroma of 2.** **-OR-** **Value of 2 and chroma of 1 in parts of the A horizon within 6 inches of the surface -AND- Some individual grains of sand are not coated with organic matter, salt and pepper effect is visible.** **-OR-** **Site has been partially drained and/or there is evidence of intermittent or past cropping or excessive vegetation removal.**	**0.5**
	Organic Matter is <1.5% (Measurement) ***Indicators*: The mineral soil in the upper 6 inches or A horizon has a value of >3 to 4 and chroma of 1or 2** **-OR-** **Most individual grains of sand are not coated with organic matter in the A horizon within 6 inches of the surface.** **-OR-** **Site has been "effectively" drained and frequently cropped.**	**0.1**
	Wetland soil has been replaced by upland fill, asphalt, concrete, etc.	**0.0**

1.0 MAINTAIN CHARACTERISTIC HYDROLOGY		
Model Variable	**Measurement or Condition**	**Index**
V_{pore}: Soil Porosity **DEFINITION: The ability of the soil to allow movement of liquids, gases, etc. into, and through, the upper part of the soil. As indicated by the physical integrity of the upper part of the soil. This includes the number and continuity of pores, the type, grade, and size of soil structure, and the soils rupture resistance.** **LOGIC: Saturated hydraulic conductivity is related to pores in the soil. Reduced hydraulic conductivity impacts moderation of ground water flow.** **Note: Direct Measurement of V_{pore} is Soil Infiltration/Permeability measurements in the upper 12 inches of the soil. No standards set at this time.**	***Secondary Measure* - The upper (12") soil horizons have compound structure, i.e. the A1 has wk to moderate subangular blocky parting to moderate granular structure. The A2 has weak fine and medium subangular blocky parting to moderate granular structure.** **Many very fine and fine, continuous pores.** **Rupture resistance is very friable.** ***Indicator* - No evidence of an Ap within hydric soil boundary.**	**1.0**
	***Secondary Measure* - Fine to medium subangular blocky parting to granular structure.** **Common very fine and fine, continuous and discontinuous pores.** **Rupture resistance is friable** ***Indicator* - Ap horizon is present. Wetland is partially tilled or restored (cropland) < 20 years**	**0.5**
	***Secondary Measure* - Few very fine and fine discontinuous pores. Massive or coarse subangular blocky or coarse platy structure (coarse, cloddy)** **-OR-** **Plow pan evidenced by roots growing horizontally along pan. Rupture resistance is friable to firm for LFS and firm for FSL** ***Indicator* - Ap horizon present. Wetland is tilled throughout most years.**	**0.1**
	The substrate is a non-porous medium, i.e., asphalt, concrete, etc.	**0.0**

1.0 MAINTAIN CHARACTERISTIC HYDROLOGY		
Model Variable	**Measurement or Condition**	**Index**
V_{wetuse}: Wetland Land Use **DEFINITION: Dominant land use and condition of the wetland.** **LOGIC: Land use in the wetland affects soil pore space and vegetation-/evapo-transpiration relationships that influence characteristic hydrology.**	**No adverse impacts in the wetland, such as compaction, suppression of vegetation, or ruts resulting from activities such as tillage, grazing overuse, or untimely haying.**	**1.0**
	Adverse impacts are present but slight, such as: **Grazing use of seasonal wetland is excessive in temporary zone and proper in seasonal zone** **- OR -** **Temporary wetland plants exhibit overuse.** **- OR -** **Haying has been untimely or excessive, causing ruts, compaction, or reduced stand vigor.**	**0.75**
	Adverse impacts are moderate, such as: **Grazing use of seasonal wetland is excessive in temporary & seasonal zones** **- OR -** **Temporary wetland is heavily overused.** **- OR -** **Seasonal wetland with frequently tilled temporary zone and seasonal zone is mostly perennial vegetation properly managed or idle.** **- OR -** **Temporary wetland is seldom tilled; idle > 3 years out of 4.**	**0.50**
	Adverse impacts are severe, such as: **Temporary zone is tilled most years and seasonal zone is cultivated occasionally, or a temporary wetland is tilled most years but has significant vegetative growth.**	**0.25**
	Adverse impacts are extreme such as feedlot, stockpond dominating the wetland, or wetland is mostly filled.	**0.1**
	Wetland is impervious: (i.e. pavement or asphalt) Restoration is not practical.	**0.0**

2.0 REMOVAL, CONVERSION AND RELEASE OF ELEMENTS AND COMPOUNDS

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

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

Effects Off-Site: Removal of elements and compounds and nutrient cycling on site decreases probability of export to aquatic ecosystems down-gradient and consequent nutrient loading.

Discussion of Function

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

2.0 INDEX OF FUNCTION: Removal, Conversion and Release of Elements and Compounds

=[Vsorpt + Vpore + Vpcover + Vdetritus +(Vsource + Vhydalt)/2 + (Vwetuse + Vsed + Vbuffer + Vupuse)/4]/6

Discussion of Variables

The variables within this function reflect land use, abiotic, and biotic components. Land use activities impact the magnitude of elements and compounds entering the system and the natural cycling and removal processes of the elements and compounds. Land use is reflected by upland land use, wetland land use, and sediment delivery variables. (V_{upuse}, V_{wetuse}, and V_{sed} respectively). In addition, the condition, continuity, and width of a buffer around the wetland influences the amount of sediment and soluble elements and compounds delivered to the wetland. The impact of a buffer is reflected by the V_{buffer} variable.

Biotic components of the wetland ecosystem cycle and retain elements and compounds through biomass accumulation and litter production. Elements and compounds are recycled annually through decay and decomposition, however Neely and Baker (1989) report decay rates for some emergent plants in the Prairie Pothole region to be greater than one year indicating removal. These decomposition rates facilitate both cycling on an annual basis and removal on a longer than one year basis within the wetland. Biotic components consist of the plant and detritus variables (V_{pcover} and $V_{detritus}$,) respectively.

The abiotic components assist reduction and oxidation processes that biogeochemically cycle and remove elements and compounds. Abiotic components are represented by the soil integrity (V_{sorpt} and V_{pore}), and amount/presence of water represented by the (V_{hydalt} and V_{source}) variables.

2.0 REMOVAL, CONVERSION AND RELEASE OF ELEMENTS AND COMPOUNDS		
Model Variable	**Measurement or Condition**	**Index**
V_{sorpt}: Soil Sorptive Properties **DEFINITION: The ability of the upper part of the soil to retain and move elements and compounds.** **LOGIC: In sandy soils organic matter content affects the sorptive capacity of soils to hold elements and compounds for release, removal, and conversion.**	**Organic Matter is >4.0% (Measurement)** ***Indicators*: The mineral soil in all parts of the A horizon within 6 inches of the surface has a value of 2 or 3 and chroma of 0.** **-OR-** **Value of 2 and chroma of 1 -AND- nearly all sand grains visible to naked eye are coated with organic matter in all parts of the A horizon within 6 inches of the surface and lacks a darker-colored A horizon immediately or contiguously below 6 inches .** **-OR-** **Site has no evidence of drainage or excessive vegetation removal.**	**1.0**
	Organic Matter is 1.5 to =<4.0% (Measurement) ***Indicators*: The mineral soil in parts of the upper 6 inches or A horizon has a value of >2 to 3 and chroma of 1, or value of 2 and chroma of 2.** **-OR-** **Value of 2 and chroma of 1 in parts of the A horizon within 6 inches of the surface -AND- Some individual grains of sand are not coated with organic matter, salt and pepper effect is visible.** **-OR-** **Site has been partially drained and/or there is evidence of intermittent or past cropping or excessive vegetation removal.**	**0.5**
	Organic Matter is <1.5% (Measurement) ***Indicators*: The mineral soil in the upper 6 inches or A horizon has a value of >3 to 4 and chroma of 1or 2** **-OR-** **Most individual grains of sand are not coated with organic matter in the A horizon within 6 inches of the surface.** **-OR-** **Site has been "effectively" drained and frequently cropped.**	**0.1**
	Wetland soil has been replaced by upland fill, asphalt, concrete, etc.	**0.0**

2.0 REMOVAL, CONVERSION AND RELEASE OF ELEMENTS AND COMPOUNDS		
Model Variable	**Measurement or Condition**	**Index**
V_{pore}: Soil Porosity **DEFINITION: The ability of the soil to allow movement of liquids, gases, etc. into, and through, the upper part of the soil. As indicated by the physical integrity of the upper part of the soil. This includes the number and continuity of pores, the type, grade, and size of soil structure, and the soils rupture resistance.** **LOGIC: Soil pores provide surface area for soil water contact and, therefore, increased surface area for microbial activity.** **Note: Direct Measurement of V_{pore} is Soil Infiltration/Permeability measurements in the upper 12 inches of the soil. No standards set at this time.**	***Secondary Measure* - The upper (12") soil horizons have compound structure, i.e. the A1 has wk to moderate subangular blocky parting to moderate granular structure. The A2 has weak fine and medium subangular blocky parting to moderate granular structure.** **Many very fine and fine, continuous pores.** **Rupture resistance is very friable.** ***Indicator* - No evidence of an Ap within hydric soil boundary.** ***Secondary Measure* - Fine to medium subangular blocky parting to granular structure.**	**1.0**
	Common very fine and fine, continuous and discontinuous pores. **Rupture resistance is friable** ***Indicator* - Ap horizon is present. Wetland is partially tilled or restored (cropland) < 20 years**	**0.5**
	***Secondary Measure* - Few very fine and fine discontinuous pores. Massive or coarse subangular blocky or coarse platy structure (coarse, cloddy)** **-OR-** **Plow pan evidenced by roots growing horizontally along pan. Rupture resistance is friable to firm for LFS and firm for FSL** ***Indicator* - Ap horizon present. Wetland is tilled throughout most years.**	**0.1**
	The substrate is a non-porous medium, i.e., asphalt, concrete, etc.	**0.0**

2.0 REMOVAL, CONVERSION AND RELEASE OF ELEMENTS AND COMPOUNDS							
Model Variable	**Measurement or Condition**	**Index**					
V_{pcover} Vegetation Density **DEFINITION: Typical inter- and intra-seasonal amount of woody and herbaceous plants growing in all vegetation zones of the wetlands.** **LOGIC: Living plant biomass cycles nutrients through (1) soil and water nutrient uptake, (2) biomass accumulation, and (3) litter production.** **(*Note: Use Oct/1 values until May/1 of the next year.)**	**90 -125% vegetative cover**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**
	65 to 90% OR >125% vegetative cover	**1.0**	**1.0**	**1.0**	**0.75**	**0.75**	**0.75**
	40 to 65% vegetative cover	**1.0**	**1.0**	**0.5**	**0.5**	**0.5**	**0.5**
	15 to 40% vegetative cover	**1.0**	**0.5**	**0.25**	**0.25**	**0.25**	**0.25**
	1 to 15% vegetative cover	**0.5**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**
	0% unvegetated	**0**	**0**	**0**	**0**	**0**	**0**
	% Cover / Month/Day	**May/1**	**June/1**	**July/1**	**Aug/1**	**Sept/1**	**Oct/1 ***

2.0 REMOVAL, CONVERSION AND RELEASE OF ELEMENTS AND COMPOUNDS		
Model Variable	**Measurement or Condition**	**Index**
$V_{detritus}$: Detritus **DEFINITION: The typical inter and intra-seasonal amount of dead plant material in several stages of decomposition.** **LOGIC: Provides an energy source and increased surface area for microbial processing of nutrients.**	**Temporary Zone - 0.75 to 2.5 inches** **Seasonal Zone --- 2.25 to 6.25 inches**	**1.0**
	Temporary Zone - 0.5 to 0.75 inch -OR- >2.5 inches **Seasonal Zone --- 1.5 to 2.25 inches -OR- >6.25 inches**	**0.75**
	Temporary Zone - 0.25 to 0.5 inch **Seasonal Zone --- 0.75 to 1.5 inches**	**0.5**
	Temporary Zone - 0.1 to 0.25 inch **Seasonal Zone --- 0.25 to 0.75 inch**	**0.25**
	Temporary Zone - >0 to 0.1 inch **Seasonal Zone --- >0 to 0.25 inch**	**0.1**
	Litter absent	**0.0**

2.0 REMOVAL, CONVERSION AND RELEASE OF ELEMENTS AND COMPOUNDS		
Model Variable	**Measurement or Condition**	**Index**
V_{source}: Source Area of Flow to Wetland **DEFINITION: The area surrounding a wetland that defines the catchment and groundwater flow area to the wetland.** **LOGIC: Altering drainage patterns within watershed and ground water flow area will impact ground water elevation within the basin that impacts characteristic removal, conversion, and release of elements and compounds.**	**Alteration of upland watershed source area by surface alterations (e.g., ditches, roads, terraces, irrigation)does not impact wetland, and no subsurface alterations (e.g., tile drains, ditches, irrigation).**	**1.0**
	Surface alterations of upland watershed source area impacts overland flow into wetland (e.g., ditches, roads, terraces, irrigation, etc.), however , no subsurface alterations(e.g., tile drains, irrigation).	**0.75**
	Upland watershed source area is changed to alter the dominant surface and subsurface flow path of water to the wetland(e.g., draining or irrigation return or draw-down). **-AND-** **Alteration does not change the NWI classification.**	**0.50**
	Upland watershed source area is changed to alter the dominant surface and subsurface flow path of water to the wetland(e.g., draining or irrigation return or draw-down). **-AND-** **Alteration does change the NWI classification.**	**0.1**
	Upland watershed source area extremely altered such that almost all water flow to wetland eliminated (e.g., urbanization).	**0.0**

2.0 REMOVAL, CONVERSION AND RELEASE OF ELEMENTS AND COMPOUNDS		
Model Variable	**Measurement or Condition**	**Index**
V_{hydalt} Hydrology Alterations **Definition: Presence of a constructed subsurface and/or surface outlet affecting the wetland or fill affecting the depth of the wetland.** **Logic: Surface outlet, subsurface drain or fill impacts ground water surface elevations and maintenance of saturated anaerobic conditions throughout the wetland. Additionally, outlets provide vectors for the transport of elements and compounds to off-site aquatic systems.**	**Surface drain or subsurface drain has no effect on wetland. Surface drain or subsurface drain is > 500 feet from the wetland edge and less than 3 feet below the wetland bottom elevation. If surface drain is present and within 500 feet of wetland, it is at or above the top of the temporary zone in elevation. No fill in wetland.**	**1.0**
	Surface drain or subsurface drain 150 to 500 feet from outside wetland edge and greater than 3 feet below wetland bottom elevation. **-OR-** **Surface outlet invert lowered to remove some static storage.** **-OR-** **Wetland filled to reduce some static storage.** **Wetland still ponds water.**	**0.5**
	Surface drain or subsurface drain within 150 feet of wetland edge removing all static water and drain is greater than 3 feet below wetland elevation bottom. **-OR-** **If large wetland, tile spacing is greater than 300 feet or ineffectively removing saturated conditions.** **-OR-** **Surface outlet lowered to remove all static storage.** **-OR-** **Site filled to the top of the temporary zone with some saturation remaining in wetland.** **Wetland meets saturation criteria only.**	**0.1**
	Surface outlet below bottom of wetland, and subsurface drain 3 feet or greater below wetland bottom elevation with spacing less than 300 feet in all parts within the wetland. **-OR-** **Wetland filled, eliminating saturated conditions in the wetland.**	**0.0**

2.0 REMOVAL, CONVERSION AND RELEASE OF ELEMENTS AND COMPOUNDS		
Model Variable	**Measurement or Condition**	**Index**
V_{wetuse}: Wetland Land Use **DEFINITION: Dominant land use and condition of the wetland.** **LOGIC: Land use in the wetland affects soil organic matter content, vegetation, and detrital biomass that results in characteristic removal, conversion, and release of elements and compounds.**	**No adverse impacts in the wetland, such as compaction, suppression of vegetation, or ruts resulting from activities such as tillage, grazing overuse , or untimely haying.**	**1.0**
	Adverse impacts are present but slight, such as: **Grazing use of seasonal wetland is excessive in temporary zone and proper in seasonal zone** **- OR -** **Temporary wetland plants exhibit overuse.** **- OR -** **Haying has been untimely or excessive, causing ruts, compaction, or reduced stand vigor.**	**0.75**
	Adverse impacts are moderate, such as: **Grazing use of seasonal wetland is excessive in temporary & seasonal zones** **- OR -** **Temporary wetland is heavily overused.** **- OR -** **Seasonal wetland with frequently tilled temporary zone and seasonal zone is mostly perennial vegetation properly managed or idle.** **- OR -** **Temporary wetland is seldom tilled; idle > 3 years out of 4.**	**0.50**
	Adverse impacts are severe, such as: **Temporary zone is tilled most years and seasonal zone is cultivated occasionally, or a temporary wetland is tilled most years but has significant vegetative growth.**	**0.25**
	Adverse impacts are extreme such as feedlot, stockpond dominating the wetland, or wetland is mostly filled.	**0.1**
	Wetland is impervious: (i.e. pavement or asphalt) Restoration is not practical.	**0.0**

2.0 REMOVAL, AND RELEASE OF ELEMENTS AND COMPOUNDS

Model Variable	Measurement or Condition	Index
V_{sed}: Sediment Delivered to Wetland **DEFINITION: Extent of sediment delivered to wetland from human disturbance sources, including agriculture.** **LOGIC: The amount of sediment in the basin impacts the capacity of the wetland to maintain saturated anaerobic conditions throughout the wetland.**	**No evidence of sediment delivery to wetland.**	**1.0**
	Representative sediment depth -- **in temporary zone – <4 inches** **in seasonal zone -- <2 inches**	**0.75**
	Representative sediment depth -- **in temporary zone – 4 to <6 inches** **in seasonal zone -- 2 to <7 inches**	**0.50**
	Representative sediment depth -- **in temporary zone – 6 to <10 inches** **in seasonal zone -- 7 to <12 inches**	**0.25**
	Representative sediment depth -- **in temporary zone – =>10 inches** **in seasonal zone -- =>12 inches** **-OR-** **Wetland filled but some basin remains** **-OR-** **A vegetation zone change (ie Shallow Marsh to Wet Meadow)**	**0.1**
	Basin filled and landscape depression is not evident from surface features.	**0.0**

2.0 REMOVAL, CONVERSION AND RELEASE OF ELEMENTS AND COMPOUNDS								
Model Variable	**Measurement or Condition**	**Index**						
V_{buffer}: Buffer Zone **DEFINITION: Land use condition and average width of the buffer zone adjacent to the wetland.** **LOGIC: The width and condition of an intact buffer influences the spreading of surface and subsurface flow and increases water contact time in the buffer which helps limit direct inputs of particulate and dissolved elements and compounds.** **Buffer Area = Average buffer width X % continuity**	**Vigorous Well managed grassland OR idle grassland**	**0**	**0.2**	**0.3**	**0.5**	**0.7**	**0.9**	**1.0**
	Hayland OR average managed grassland where height is reduced	**0**	**0.1**	**0.2**	**0.4**	**0.6**	**0.7**	**0.8**
	Over-utilized OR poorly managed grassland No litter	**0**	**0**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**
	Alfalfa/Grass	**0**	**0.1**	**0.1**	**0.2**	**0.3**	**0.3**	**0.4**
	Alfalfa only	**0**	**0**	**0.1**	**0.1**	**0.1**	**0.2**	**0.2**
	Buffer Condition / Buffer Area	**0 to 3**	**3 to 10**	**10 to 20**	**20 to 30**	**30 to 40**	**40 to 47**	**47 to 50**

2.0 REMOVAL, CONVERSION AND RELEASE OF ELEMENTS AND COMPOUNDS		
Model Variable	**Measurement or Condition**	**Index**
V_{upuse}: Upland Land Use **Definition: Dominant land use or condition of the upland watershed that contributes to the wetland.** **Logic: Upland land use impacts infiltration, the evapotranspiration process and the potential availability of elements and compounds that influence the quantity and quality of groundwater flow to the wetland.**	**Native prairie managed to allow adequate plant recovery time between vegetation removal.**	**1.0**
	Dominated by non-native perennial species with fair management or better. **- OR -** **Native species managed under season long grazing** **- OR -** **Perennially idle grassland cover** **- OR -** **Permanent Hayland**	**0.75**
	Native or non-native species heavily over-grazed, some bare ground, low plant vigor **- OR -** **No-till continuous high-residue crop** **- OR -** **Minimum till high-residue crops in a grass/legume rotation**	**0.5**
	Native or non-native species heavily over-grazed, high amounts of bare ground, low plant vigor, and evidence of soil erosion **- OR -** **No-till row crop, minimum till small grain**	**0.25**
	Row crop or conventional tillage small grain	**0.1**
	Urban, semi-pervious, or impervious surface.(this condition will result in maximum overland flow; a high rate of delivery to wetland) If best management practices employed, the impact may be somewhat less.	**0.0**

3.0 RETENTION OF PARTICULATES

DEFINITION: Deposition and retention of inorganic and organic particulates from the water column, primarily through physical processes.

Effects On-Site: Sediment deposition in Sand Plain Depressions is a natural geologic process that is maintained over thousands of years. Natural rates of accumulation are slow. The presence of sediments and the processes that follow result in characteristic soils, hydrology, and geochemistry.

Effects Off-Site: Reduces potential export of particulates to down-gradient wetland and aquatic ecosystems and groundwater systems.

Discussion of Function

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

3.0 INDEX OF FUNCTION: Retention of Particulates

IF CLOSED DEPRESSION*1:

= (1.0*2 +Vupuse + Vsed + Vbuffer)/4

IF NON-CLOSED DEPRESSION:

= (Vhydalt + Vwetuse + Vupuse + Vsed + Vbuffer)/5

***1 – Closed depression is one with no artificial surface water outlet (i.e. surface drain, tile inlet or pump**

***2 – The 1.0 in the closed depression formula addresses hydrology(surface outlet variable). If the 1.0 "no outlet" factor is not included, a non-closed depression may show a higher function than an analogous closed depression.**

Discussion of Variables

The variables associated with the performance of this function focus primarily on components of the system that affect the physical processes of particulate removal and sedimentation. Particulate removal is dependent upon an undisturbed water column. The variable (V_{hydalt}) captures the presence/absence of an outlet and the extent of impact it has on the water level. The variable (V_{wetuse}) captures the extent of disturbance that may resuspend particulate matter within the water column. Sedimentation is represented by direct evidence (V_{sed}), or by indirect evidence of potential sources via land use activities (V_{upuse}). For example, Adomaitis et al. (1967) found that an aeolian mixture of snow and soil from surrounding fields without vegetation yielded nearly twice as much sediment as that deposited into native prairie. In addition, the condition, continuity, and width of a buffer around the wetland influences the amount of particulates delivered to the wetland. The impact of a buffer is reflected by the (V_{buffer}) variable.

3.0 RETENTION OF PARTICULATES		
Model Variable	**Measurement or Condition**	**Index**
V_{upuse}: Upland Land Use **Definition: Dominant land use or condition of the upland watershed that contributes to the wetland.** **Logic: None to moderate disturbance of the prairie yields the least particulates delivered to the wetland by water and/or wind.**	**Native prairie managed to allow adequate plant recovery time between vegetation removal.**	**1.0**
	Dominated by non-native perennial species with fair management or better. **- OR -** **Native species managed under season long grazing** **- OR -** **Perennially idle grassland cover** **- OR -** **Permanent Hayland**	**0.75**
	Native or non-native species heavily over-grazed, some bare ground, low plant vigor **- OR -** **No-till continuous high-residue crop** **- OR -** **Minimum till high-residue crops in a grass/legume rotation**	**0.5**
	Native or non-native species heavily over-grazed, high amounts of bare ground, low plant vigor, and evidence of soil erosion **- OR -** **No-till row crop, minimum till small grain**	**0.25**
	Row crop or conventional tillage small grain	**0.1**
	Urban, semi-pervious, or impervious surface.(this condition will result in maximum overland flow; a high rate of delivery to wetland) If best management practices employed, the impact may be somewhat less.	**0.0**

3.0 RETENTION OF PARTICULATES		
Model Variable	**Measurement or Condition**	**Index**
V_{sed}: Sediment Delivered to Wetland **DEFINITION: Extent of sediment delivered to wetland from human disturbance sources, including agriculture.** **LOGIC: The amount of sediment in the basin affects the capacity of the wetland to retain particulates.**	**No evidence of sediment delivery to wetland.**	**1.0**
	Representative sediment depth -- **in temporary zone – <4 inches** **in seasonal zone -- <2 inches**	**0.75**
	Representative sediment depth -- **in temporary zone – 4 to <6 inches** **in seasonal zone -- 2 to <7 inches**	**0.50**
	Representative sediment depth -- **in temporary zone – 6 to <10 inches** **in seasonal zone -- 7 to <12 inches**	**0.25**
	Representative sediment depth -- **in temporary zone – =>10 inches** **in seasonal zone -- =>12 inches** **-OR-** **Wetland filled but some basin remains** **-OR-** **A vegetation zone change(ie Shallow Marsh to Wet Meadow)**	**0.1**
	Basin filled and landscape depression is not evident from surface features.	**0.0**

3.0 RETENTION OF PARTICULATES

Model Variable	Measurement or Condition	Index						
V_{buffer}: Buffer Zone DEFINITION: Land use condition and average width of the buffer zone adjacent to the wetland. LOGIC: The width and condition of an intact buffer influences the spreading of surface and subsurface flow and increases water contact time in the buffer which helps to limit direct inputs of particulates. Buffer Area = Average buffer width X % continuity	Vigorous Well managed grassland OR idle grassland	0	0.2	0.3	0.5	0.7	0.9	1.0
	Hayland OR average managed grassland where height is reduced	0	0.1	0.2	0.4	0.6	0.7	0.8
	Over-utilized OR poorly managed grassland No litter	0	0	0.2	0.3	0.4	0.5	0.6
	Alfalfa/Grass	0	0.1	0.1	0.2	0.3	0.3	0.4
	Alfalfa only	0	0	0.1	0.1	0.1	0.2	0.2
	Buffer Condition / Buffer Area	0 to 3	3 to 10	10 to 20	20 to 30	30 to 40	40 to 47	47 to 50

3.0 RETENTION OF PARTICULATES

Model Variable	Measurement or Condition	Index
V_{hydalt} **Hydrology Alterations** **Definition: Presence of a constructed subsurface and/or surface outlet affecting the wetland or fill affecting the depth of the wetland.** **Logic: If an outlet is present, changes in outlet elevation and amount of fill can affect the degree to which particulates will be retained or exported.**	**Surface drain or subsurface drain has no effect on wetland. Surface drain or subsurface drain is > 500 feet from the wetland edge and less than 3 feet below the wetland bottom elevation. If surface drain is present and within 500 feet of wetland, it is at or above the top of the temporary zone in elevation. No fill in wetland.**	**1.0**
	Surface drain or subsurface drain 150 to 500 feet from outside wetland edge and greater than 3 feet below wetland bottom elevation. **-OR-** **Surface outlet invert lowered to remove some static storage.** **-OR-** **Wetland filled to reduce some static storage. Wetland still ponds water.**	**0.5**
	Surface drain or subsurface drain within 150 feet of wetland edge removing all static water and drain is greater than 3 feet below wetland elevation bottom. **-OR-** **If large wetland, tile spacing is greater than 300 feet or ineffectively removing saturated conditions.** **-OR-** **Surface outlet lowered to remove all static storage.** **-OR-** **Site filled to the top of the temporary zone with some saturation remaining in wetland.**	**0.1**
	Wetland meets saturation criteria only. **Surface outlet below bottom of wetland, and subsurface drain 3 feet or greater below wetland bottom elevation with spacing less than 300 feet in all parts within the wetland.** **-OR-** **Wetland filled eliminating saturated conditions in the wetland.**	**0.0**

3.0 RETENTION OF PARTICULATES

Model Variable	Measurement or Condition	Index
V_{wetuse}: Wetland Land Use DEFINITION: Dominant land use and condition of the wetland. LOGIC: If an outlet is present, wetland land use determines the degree to which particulates are retained or exported due to roughness and anchoring of soil by roots and plant cover.	No adverse impacts in the wetland, such as compaction, suppression of vegetation, or ruts resulting from activities such as tillage, grazing overuse , or untimely haying.	1.0
	Adverse impacts are present but slight, such as: Grazing use of seasonal wetland is excessive in temporary zone and proper in seasonal zone - OR - Temporary wetland plants exhibit overuse. - OR - Haying has been untimely or excessive, causing ruts, compaction, or reduced stand vigor.	0.75
	Adverse impacts are moderate, such as: Grazing use of seasonal wetland is excessive in temporary & seasonal zones - OR - Temporary wetland is heavily overused. - OR - Seasonal wetland with frequently tilled temporary zone and seasonal zone is mostly perennial vegetation properly managed or idle. - OR - Temporary wetland is seldom tilled; idle > 3 years out of 4.	0.50
	Adverse impacts are severe, such as: Temporary zone is tilled most years and seasonal zone is cultivated occasionally, or a temporary wetland is tilled most years but has significant vegetative growth.	0.25
	Adverse impacts are extreme such as feedlot, stockpond dominating the wetland, or wetland is mostly filled.	0.1
	Wetland is impervious: (i.e., pavement or asphalt) Restoration is not practical.	0.0

4.0 MAINTENANCE OF CHARACTERISTIC PLANT COMMUNITY

DEFINITION: Characteristic plant communities are not dominated by exotic or nuisance species. Vegetation is maintained by mechanisms such as seed dispersal , seed banks, and vegetative propagation which respond to variations in hydrology and disturbances such as fire and herbivores. The emphasis is on the temporal dynamics and structure of the plant community as revealed by species composition and abundance.

Effects On-Site: Creates microclimatic conditions that support the life histories of plants and animals. Converts solar radiation and carbon dioxide into complex organic carbon that provides energy to drive food webs . Provides habitat for feeding, and cover for nesting, resting refuge, escape, and breeding for resident and migratory animals.

Effects Off-Site: Provides a source of vegetative propagules for adjacent ecosystems which assists in revegetation following drought or disturbance and provides for gene flow between populations. Provides habitat for animals from adjacent ecosystems and for migrating birds (waterfowl, waders, etc.).

Discussion of Function:

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

The vegetation in the prairie pothole temporary (wet meadow) and seasonal (shallow marsh) wetlands changes both inter- and intra-annually due to regional climatic cycles and its effect on local hydrological regime (Weller 1987, Kantrud 1989, Kantrud et al. 1989). Variable precipitation and evapotranspiration commonly lead to years of extended drought or above normal moisture. Cyclic vegetation patterns arise from these climatic conditions. Much of the variability is explained by Stewart and Kantrud (1972).

4.0 INDEX OF FUNCTION: Maintain Characteristic Plant Community

={Vwetuse + Vpratio +[Vsorpt + Vpcover + Vdetritus +(Vsed + Vhydalt)/2]/4}/3

Discussion of Variables:

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

Plant community characteristics alter with various types of perturbation. The ratio of native to non-native plant species (V_{pratio}) indicates the health of a plant community. A healthy plant community is comprised of a high percentage of native non-invasive plants. As a system becomes perturbed, invasive native and non-native species out-compete sensitive native species. Plant abundance, as measured by percent cover (V_{pcover}), captures the ability of the system to remain self-sustaining. Detritus ($V_{detritus}$) maintains thermal regulation of rhizomes and propagules, and is essential for nutrient cycling. Organic matter in the sandy soil (V_{sorpt}) holds nutrients and increases water supplying capacity for plant growth.

The elements of a healthy plant community may be compromised by anthropogenic activities. Land use within the wetland (V_{sed}, V_{wetuse}) directly impacts plant communities by burying or disrupting detritus, seed banks, rhizomes, etc. Finally, hydrophytic plants are directly affected by water level and soil moisture regime which may be affected by the presence of an outlet. The presence and degree of impact of an outlet and source area is reflected in the (V_{hydalt}) variable.

4.0 MAINTAIN CHARACTERISTIC PLANT COMMUNITY

Model Variable	Measurement or Condition	Index
V_{wetuse}: Wetland Land Use **DEFINITION: Dominant land use and condition of the wetland.** **LOGIC: Disturbance in the wetland can influence the maintenance of native plant populations.**	**No adverse impacts in the wetland, such as compaction, suppression of vegetation, or ruts resulting from activities such as tillage, grazing overuse , or untimely haying.**	**1.0**
	Adverse impacts are present but slight, such as: **Grazing use of seasonal wetland is excessive in temporary zone and proper in seasonal zone** **- OR -** **Temporary wetland plants exhibit overuse.** **- OR -** **Haying has been untimely or excessive, causing ruts, compaction, or reduced stand vigor.**	**0.75**
	Adverse impacts are moderate, such as: **Grazing use of seasonal wetland is excessive in temporary & seasonal zones** **- OR -** **Temporary wetland is heavily overused.** **- OR -** **Seasonal wetland with frequently tilled temporary zone and seasonal zone is mostly perennial vegetation properly managed or idle.** **- OR -** **Temporary wetland is seldom tilled; idle > 3 years out of 4.**	**0.50**
	Adverse impacts are severe, such as: **Temporary zone is tilled most years and seasonal zone is cultivated occasionally, or a temporary wetland is tilled most years but has significant vegetative growth.**	**0.25**
	Adverse impacts are extreme such as feedlot, stockpond dominating the wetland, or wetland is mostly filled.	**0.1**
	Wetland is impervious: (i.e. pavement or asphalt) Restoration is not practical.	**0.0**

4.0 MAINTAIN CHARACTERISTIC PLANT COMMUNITY

Model Variable	Measurement or Condition	Index
V_{pratio}: Ratio of Native to Non-native Plant Species **DEFINITION: The ratio of native to non-native plant species present in wetland zones (Wet Meadow, Seasonal) as indicated by the dominants, using the 50/20 rule, or by a more extensive species survey.** **Dominants are the most abundant species that immediately exceed 50% of the total dominance for a given stratum when the species are ranked in descending order of abundance and cumulatively totaled. Dominants also include any additional species comprising 20% or more of the total.** **LOGIC: The presence of a high ratio of non-invasive native to invasive native and non-native plant species indicates that disturbances which interrupt naturally occurring cycles and other vegetative dynamics are minimal.**	**All dominant species in the wetland are native, non-woody species.**	**1.0**
	Native, non-woody species comprise 75% to <100% of the dominants in one zone, and 75% to 100% in other zone if two are present. -OR- Dominants are 100% native in one zone and >50% to <75% in other zone.	**0.75**
	Native, non-woody species comprise 50% to <75% of the dominants in one zone, and 50% to <100% in other zone if two are present. **-OR-** **Native, non-woody species comprise 100% of the dominants in one zone and 25% to 50% in other zone.**	**0.5**
	Native, non-woody species comprise 25% to <50% of the %dominants in one zone, and 25% to <74% in other zone if two are present. **-OR-** **Native, non-woody species comprise 75% to <100% of the dominants in one zone and <25% in other zone.**	**0.25**
	Native, non-woody species comprise 0% to <25% of the dominants in one zone, and < 75% in second zone if two are present. **-OR-** **Lythrum salicaria (Purple Loosestrife) is among the dominant species.**	**0.1**
	Wetland is unvegetated.	**0.0**

4.0 MAINTAIN CHARACTERISTIC PLANT COMMUNITY		
Model Variable	**Measurement or Condition**	**Index**
V_{sorpt}: Soil Sorptive Properties **DEFINITION: The ability of the upper part of the soil to retain and move elements and compounds.** **LOGIC: In sandy soils, organic matter content increases water and plant nutrient holding capacity.**	**Organic Matter is >4.0% (Measurement)** ***Indicators*: The mineral soil in all parts of the A horizon within 6 inches of the surface has a value of 2 or 3 and chroma of 0.** **-OR-** **Value of 2 and chroma of 1 -AND- nearly all sand grains visible to naked eye are coated with organic matter in all parts of the A horizon within 6 inches of the surface and lacks a darker-colored A horizon immediately or contiguously below 6 inches .** **-OR-** **Site has no evidence of drainage or excessive vegetation removal.**	**1.0**
	Organic Matter is 1.5 to =<4.0% (Measurement) ***Indicators*: The mineral soil in parts of the upper 6 inches or A horizon has a value of >2 to 3 and chroma of 1, or value of 2 and chroma of 2.** **-OR-** **Value of 2 and chroma of 1 in parts of the A horizon within 6 inches of the surface -AND- Some individual grains of sand are not coated with organic matter, salt and pepper effect is visible.** **-OR-** **Site has been partially drained and/or there is evidence of intermittent or past cropping or excessive vegetation removal.**	**0.5**
	Organic Matter is <1.5% (Measurement) ***Indicators*: The mineral soil in the upper 6 inches or A horizon has a value of >3 to 4 and chroma of 1or 2** **-OR-** **Most individual grains of sand are not coated with organic matter in the A horizon within 6 inches of the surface.** **-OR-** **Site has been "effectively" drained and frequently cropped.**	**0.1**
	Wetland soil has been replaced by upland fill, asphalt, concrete, etc.	**0.0**

4.0 MAINTAIN CHARACTERISTIC PLANT COMMUNITY

Model Variable	Measurement or Condition	Index					
V_{pcover} Vegetation Density DEFINITION: Typical inter- and intra-seasonal amount of woody and herbaceous plants growing in all vegetation zones of the wetland. LOGIC: Characteristic plant densities of native prairies influence a suite of plant community components: seed/rhizome source, nutrient cycling processes, micro-climate conditions, etc. (*Note: Use Oct/1 values until May/1 of the next year.)	90 -125% vegetative cover	1.0	1.0	1.0	1.0	1.0	1.0
	65 to 90% OR >125% vegetative cover	1.0	1.0	1.0	0.75	0.75	0.75
	40 to 65% vegetative cover	1.0	1.0	0.5	0.5	0.5	0.5
	15 to 40% vegetative cover	1.0	0.5	0.25	0.25	0.25	0.25
	1 to 15% vegetative cover	0.5	0.1	0.1	0.1	0.1	0.1
	0% unvegetated	0	0	0	0	0	0
	% Cover / Month/Day	May/1	June/1	July/1	Aug/1	Sept/1	Oct/1 *

4.0 MAINTAIN CHARACTERISTIC PLANT COMMUNITY		
Model Variable	**Measurement or Condition**	**Index**
$V_{detritus}$: Detritus **DEFINITION: The typical inter and intra-seasonal amount of dead plant material in several stages of decomposition.** **LOGIC: Detrital biomass impacts nutrient cycling processes and disturbance regime (e.g., fire) and thereby influences plant assemblages. Detrital cover buffers soil temperature which affects propagule survival.**	**Temporary Zone - .75 to 2.5 inches** **Seasonal Zone --- 2.25 to 6.25 inches**	**1.0**
	Temporary Zone - .5 to .75 inch -OR- >2.5inches **Seasonal Zone --- 1.5 to 2.25 inches -OR- >6.25 inches**	**0.75**
	Temporary Zone - .25 to .5 inches **Seasonal Zone --- .75 to 1.5 inches**	**0.5**
	Temporary Zone - .1 to .25 inches **Seasonal Zone --- .25 to .75 inches**	**0.25**
	Temporary Zone - >0 to .1 inches **Seasonal Zone --- >0 to .25 inches**	**0.1**
	Litter absent	**0.0**

4.0 MAINTAIN CHARACTERISTIC PLANT COMMUNITY		
Model Variable	**Measurement or Condition**	**Index**
V_{sed}: Sediment Delivered to Wetland **DEFINITION: Extent of sediment delivered to wetland from human disturbance sources, including agriculture.** **LOGIC: Land use and erodibility characteristics of the soil affect the potential for sediment delivery to the wetland. The amount of sediment delivered to the basin impacts the capacity of the wetland to maintain native plant populations.**	**No evidence of sediment delivery to wetland.**	**1.0**
	Representative sediment depth -- **in temporary zone – <4 inches** **in seasonal zone -- <2 inches**	**0.75**
	Representative sediment depth -- **in temporary zone – 4 to <6 inches** **in seasonal zone -- 2 to <7 inches**	**0.50**
	Representative sediment depth -- **in temporary zone – 6 to <10 inches** **in seasonal zone -- 7 to <12 inches**	**0.25**
	Representative sediment depth -- **in temporary zone – =>10 inches** **in seasonal zone -- =>12 inches** **-OR-** **Wetland filled but some basin remains** **-OR-** **A vegetation zone change(ie Shallow Marsh to Wet Meadow)**	**0.1**
	Basin filled and landscape depression is not evident from surface features.	**0.0**

4.0 MAINTAIN CHARACTERISTIC PLANT COMMUNITY		
Model Variable	**Measurement or Condition**	**Index**
V_{hydalt} Hydrology Alterations **Definition: Presence of a constructed subsurface and/or surface outlet affecting the wetland or fill affecting the depth of the wetland.** **Logic: Surface outlet, subsurface drain or fill impacts ground water surface elevations, and thereby controls the assemblage of aquatic-/nonaquatic vegetation.**	**Surface drain or subsurface drain has no effect on wetland. Surface drain or subsurface drain is > 500 feet from the wetland edge and less than 3 feet below the wetland bottom elevation. If surface drain is present and within 500 feet of wetland, it is at or above the top of the temporary zone in elevation. No fill in wetland.**	**1.0**
	Surface drain or subsurface drain 150 to 500 feet from outside wetland edge and greater than 3 feet below wetland bottom elevation. **-OR-** **Surface outlet invert lowered to remove some static storage.** **-OR-** **Wetland filled to reduce some static storage.** **Wetland still ponds water.**	**0.5**
	Surface drain or subsurface drain within 150 feet of wetland edge removing all static water and drain is greater than 3 feet below wetland elevation bottom. **-OR-** **If large wetland, tile spacing is greater than 300 feet or ineffectively removing saturated conditions.** **-OR-** **Surface outlet lowered to remove all static storage.** **-OR-** **Site filled to the top of the temporary zone with some saturation remaining in wetland.** **Wetland meets saturation criteria only.**	**0.1**
	Surface outlet below bottom of wetland, and subsurface drain 3 feet or greater below wetland bottom elevation with spacing less than 300 feet in all parts within the wetland. **-OR-** **Wetland filled eliminating saturated conditions in the wetland.**	**0.0**

5.0 MAINTENANCE OF HABITAT STRUCTURE WITHIN WETLAND

DEFINITION: Soil, vegetation, and other aspects of the ecosystem structure within a wetland are required by animals for feeding, cover, and reproduction.

Effects On-Site: Habitat provides potential feeding, cover, and reproductive sites for resident and migratory fauna.

Effects Off-Site: Provides feeding, cover, and reproductive sites for resident and migratory fauna and contributes to the matrix or complex that animals require during life cycles.

Discussion of Function:

This function indicates the suitability of vegetation structure, microtopography, and hydrologic conditions for sustaining animal populations. Habitat components (1) provide potential feeding, resting, and nesting sites for vertebrates and invertebrates ; (2) regulate and moderate fluctuations in temperature; and (3) provide habitat heterogeneity to support a diverse assemblage of organisms. Since structure is an important habitat component for resident and nonresident animals, communities possessing a greater structural complexity often are more diverse and species rich. If intensive studies of wildlife and animal communities are needed and justified, the Habitat Evaluation Procedure (HEP) should be used (U.S. Fish and Wildlife Service 1980).

5.0 INDEX OF FUNCTION: Maintenance of Habitat Structure Within the Wetland

=[Vpcover + Vpratio + Vbuffer + Vdetritus +(Vupuse + Vwetuse + Vsed + Vhydalt)/4]/5

Discussion of Variables:

Faunal habitat requirements are areas for resting, nesting, feeding, and shelter from predation and thermal stress. The integrity of the system's vegetation components, which supply the bulk of the faunal habitat requirements, is captured by the following variables: ($V_{pratio,}$ V_{pcover}) and $V_{detritus}$). Land use reflects the ability of the wetland to sustain the habitat conditions and is captured by the (V_{upuse}, V_{wetuse}, V_{sed}, and V_{hydalt}) variables. Finally, many animals nest or feed in the buffer zone surrounding the wetland, therefore, buffer integrity is measured. Buffer integrity is reflected by the buffer variable (V_{buffer}).

5.0 MAINTENANCE OF HABITAT STRUCTURE WITHIN WETLAND							
Model Variable	**Measurement or Condition**	**Index**					
V_{pcover} Vegetation Density **DEFINITION: Typical inter- and intra-seasonal amount of woody and herbaceous plants growing in all vegetation zones of the wetland.** **LOGIC: Characteristic plant densities of native prairie influence habitat components (e.g., resting, nesting, and food supply) to support resident and nonresident fauna.** **(*Note: Use Oct/1 values until May/1 of the next year.)**	**90 -125% vegetative cover**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**
	65 to 90% OR >125% vegetative cover	**1.0**	**1.0**	**1.0**	**0.75**	**0.75**	**0.75**
	40 to 65% vegetative cover	**1.0**	**1.0**	**0.5**	**0.5**	**0.5**	**0.5**
	15 to 40% vegetative cover	**1.0**	**0.5**	**0.25**	**0.25**	**0.25**	**0.25**
	1 to 15% vegetative cover	**0.5**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**
	0% unvegetated	**0**	**0**	**0**	**0**	**0**	**0**
	% Cover / Month/Day	**May/1**	**June/1**	**July/1**	**Aug/1**	**Sept/1**	**Oct/1 ***

5.0 MAINTENANCE OF HABITAT STRUCTURE WITHIN WETLAND		
Model Variable	**Measurement or Condition**	**Index**
V_{pratio}: Ratio of Native to Non-native Plant Species **DEFINITION: The ratio of native to non-native plant species present in wetland zones (Wet Meadow, Seasonal) as indicated by the dominants, using the 50/20 rule, or by a more extensive species survey.** **Dominants are the most abundant species that immediately exceed 50% of the total dominance for a given stratum when the species are ranked in descending order of abundance and cumulatively totaled. Dominants also include any additional species comprising 20% or more of the total.** **LOGIC: : The presence of a high ratio of non-invasive native to invasive native and non-native plant species provides seasonally diverse plant community and, thereby, year round resting, nesting, and food supply for resident and nonresident fauna.**	**All dominant species in the wetland are native, non-woody species.**	**1.0**
	Native, non-woody species comprise 75% to <100% of the dominants in one zone, and 75% to 100% in other zone if two are present. -OR- Dominants are 100% native in one zone and >50% to <75% in other zone.	**0.75**
	Native, non-woody species comprise 50% to <75% of the dominants in one zone, and 50% to <100% in other zone if two are present. **-OR-** **Native, non-woody species comprise 100% of the dominants in one zone and 25% to 50% in other zone.**	**0.5**
	Native, non-woody species comprise 25% to <50% of the %dominants in one zone, and 25% to <74% in other zone if two are present. **-OR-** **Native, non-woody species comprise 75% to <100% of the dominants in one zone and <25% in other zone.**	**0.25**
	Native, non-woody species comprise 0% to <25% of the dominants in one zone, and < 75% in second zone if two are present. **-OR-** **Lythrum salicaria (Purple Loosestrife) is among the dominant species.**	**0.1**
	Wetland is unvegetated.	**0.0**

5.0 MAINTENANCE OF HABITAT STRUCTURE WITHIN WETLAND								
Model Variable	**Measurement or Condition**	**Index**						
V_{buffer}: Buffer Zone **DEFINITION: Land use condition and average width of the buffer zone adjacent to the wetland.** **LOGIC: The condition and width of an intact wetland/upland ecotone influences the availability of food sources for aquatic fauna (e.g., terrestrial invertebrates and upland seeds for water fowl).** **Buffer Area = Average buffer width X % continuity**	**Vigorous Well managed grassland OR idle grassland**	**0**	**0.2**	**0.3**	**0.5**	**0.7**	**0.9**	**1.0**
	Hayland OR average managed grassland where height is reduced	**0**	**0.1**	**0.2**	**0.4**	**0.6**	**0.7**	**0.8**
	Over-utilized OR poorly managed grassland No litter	**0**	**0**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**
	Alfalfa/Grass	**0**	**0.1**	**0.1**	**0.2**	**0.3**	**0.3**	**0.4**
	Alfalfa only	**0**	**0**	**0.1**	**0.1**	**0.1**	**0.2**	**0.2**
	Buffer Condition / Buffer Area	**0 to 3**	**3 to 10**	**10 to 20**	**20 to 30**	**30 to 40**	**40 to 47**	**47 to 50**

5.0 MAINTENANCE OF HABITAT STRUCTURE WITHIN WETLAND		
Model Variable	**Measurement or Condition**	**Index**
$V_{detritus}$: Detritus **DEFINITION: The typical inter and intra-seasonal amount of dead plant material in several stages of decomposition.** **LOGIC: Characteristic detrital biomass within the wetland offers year round habitat components (e.g., resting, nesting, and food supply) that support characteristic numbers of non-resident and resident fauna especially invertebrates.**	**Temporary Zone - .75 to 2.5 inches** **Seasonal Zone --- 2.25 to 6.25 inches**	**1.0**
	Temporary Zone - .5 to .75 inch -OR- >2.5inches **Seasonal Zone --- 1.5 to 2.25 inches -OR- >6.25 inches**	**0.75**
	Temporary Zone - .25 to .5 inches **Seasonal Zone --- .75 to 1.5 inches**	**0.5**
	Temporary Zone - .1 to .25 inches **Seasonal Zone --- .25 to .75 inches**	**0.25**
	Temporary Zone - >0 to .1 inches **Seasonal Zone --- >0 to .25 inches**	**0.1**
	Litter absent	**0.0**

5.0 MAINTENANCE OF HABITAT STRUCTURE WITHIN WETLAND		
Model Variable	**Measurement or Condition**	**Index**
V_{upuse}: Upland Land Use **Definition: Dominant land use or condition of the upland watershed that contributes to the wetland.** **Logic: Upland land use affects species that are interdependent on both wetland and upland habitat.**	**Native prairie managed to allow adequate plant recovery time between vegetation removal.**	**1.0**
	Dominated by non-native perennial species with fair management or better. **- OR -** **Native species managed under season long grazing** **- OR -** **Perennially idle grassland cover** **- OR -** **Permanent Hayland**	**0.75**
	Native or non-native species heavily over-grazed, some bare ground, low plant vigor **- OR -** **No-till continuous high-residue crop** **- OR -** **Minimum till high-residue crops in a grass/legume rotation**	**0.5**
	Native or non-native species heavily over-grazed, high amounts of bare ground, low plant vigor, and evidence of soil erosion **- OR -** **No-till row crop, minimum till small grain**	**0.25**
	Row crop or conventional tillage small grain	**0.1**
	Urban, semi-pervious, or impervious surface.(this condition will result in maximum overland flow; a high rate of delivery to wetland) If best management practices employed, the impact may be somewhat less.	**0.0**

5.0 MAINTENANCE OF HABITAT STRUCTURE WITHIN WETLAND		
Model Variable	**Measurement or Condition**	**Index**
V_{wetuse}: Wetland Land Use **DEFINITION: Dominant land use and condition of the wetland.** **LOGIC: Land uses in the wetland affect habitat features directly through alteration of vegetation composition, horizontal and vertical structure, and native plant and invertebrate populations.**	**No adverse impacts in the wetland, such as compaction, suppression of vegetation, or ruts resulting from activities such as tillage, grazing overuse , or untimely haying.**	**1.0**
	Adverse impacts are present but slight, such as: **Grazing use of seasonal wetland is excessive in temporary zone and proper in seasonal zone** **- OR -** **Temporary wetland plants exhibit overuse.** **- OR -** **Haying has been untimely or excessive, causing ruts, compaction, or reduced stand vigor.**	**0.75**
	Adverse impacts are moderate, such as: **Grazing use of seasonal wetland is excessive in temporary & seasonal zones** **- OR -** **Temporary wetland is heavily overused.** **- OR -** **Seasonal wetland with frequently tilled temporary zone and seasonal zone is mostly perennial vegetation properly managed or idle.** **- OR -** **Temporary wetland is seldom tilled; idle > 3 years out of 4.**	**0.50**
	Adverse impacts are severe, such as: **Temporary zone is tilled most years and seasonal zone is cultivated occasionally, or a temporary wetland is tilled most years but has significant vegetative growth.**	**0.25**
	Adverse impacts are extreme such as feedlot, stockpond dominating the wetland, or wetland is mostly filled.	**0.1**
	Wetland is impervious: (i.e. pavement or asphalt) Restoration is not practical.	**0.0**

5.0 MAINTENANCE OF HABITAT STRUCTURE WITHIN WETLAND		
Model Variable	**Measurement or Condition**	**Index**
V_{sed}: Sediment Delivered to Wetland **DEFINITION: Extent of sediment delivered to wetland from human disturbance sources, including agriculture.** **LOGIC: Sediment delivered to the wetland affects the capacity of the wetland to maintain native faunal populations, especially invertebrates.**	**No evidence of sediment delivery to wetland.**	**1.0**
	Representative sediment depth -- **in temporary zone – <4 inches** **in seasonal zone -- <2 inches**	**0.75**
	Representative sediment depth -- **in temporary zone – 4 to <6 inches** **in seasonal zone -- 2 to <7 inches**	**0.50**
	Representative sediment depth -- **in temporary zone – 6 to <10 inches** **in seasonal zone -- 7 to <12 inches**	**0.25**
	Representative sediment depth -- **in temporary zone – =>10 inches** **in seasonal zone -- =>12 inches** **-OR-** **Wetland filled but some basin remains** **-OR-** **A vegetation zone change(ie Shallow Marsh to Wet Meadow)**	**0.1**
	Basin filled and landscape depression is not evident from surface features.	**0.0**

5.0 MAINTENANCE OF HABITAT STRUCTURE WITHIN WETLAND		
Model Variable	**Measurement or Condition**	**Index**
V_{hydalt} Hydrology Alterations **Definition: Presence of a constructed subsurface and/or surface outlet affecting the wetland or fill affecting the depth of the wetland.** **Logic: Surface outlet, subsurface drain or fill impacts ground water surface elevations, thereby impacting the performance of water storage and maintenance of aquatic-habitat conditions throughout the wetland.**	**Surface drain or subsurface drain has no effect on wetland. Surface drain or subsurface drain is > 500 feet from the wetland edge and less than 3 feet below the wetland bottom elevation. If surface drain is present and within 500 feet of wetland, it is at or above the top of the temporary zone in elevation. No fill in wetland.**	**1.0**
	Surface drain or subsurface drain 150 to 500 feet from outside wetland edge and greater than 3 feet below wetland bottom elevation. **-OR-** **Surface outlet invert lowered to remove some static storage. -OR-** **Wetland filled to reduce some static storage.** **Wetland still ponds water.**	**0.5**
	Surface drain or subsurface drain within 150 feet of wetland edge removing all static water and drain is greater than 3 feet below wetland elevation bottom. **-OR-** **If large wetland, tile spacing is greater than 300 feet or ineffectively removing saturated conditions.** **-OR-** **Surface outlet lowered to remove all static storage.** **-OR-** **Site filled to the top of the temporary zone with some saturation remaining in wetland.** **Wetland meets saturation criteria only.**	**0.1**
	Surface outlet below bottom of wetland, and subsurface drain 3 feet or greater below wetland bottom elevation with spacing less than 300 feet in all parts within the wetland. **-OR-** **Wetland filled eliminating saturated conditions in the wetland.**	**0.0**

6.0 MAINTENANCE OF HABITAT INTERSPERSION AND CONNECTIVITY AMONG WETLANDS

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

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

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

Discussion of Function:

Wetlands provide water and other life requirements for motile species that primarily exploit upland habitats. In addition, all vegetative strata in wetlands, from herbaceous layer to tree canopy, provide wildlife corridors (connections) between different wetland types, between uplands and wetlands, and between uplands(Sedell et al. 1990). Such connections between habitats help maintain higher animal and plant diversity across the landscape than would be the case if habitats were more isolated from one another (Brinson 1995).

6.0 INDEX OF FUNCTION: Maintenance of Habitat Interspersion and Connectivity among Wetlands

$$=\{[(Vupuse+(((Vwetuse+Vhydalt)/2)+Vbuffer)/2)/2]*[(Vwbasin+Vwpairs)/2]\}^{1/2}$$

Discussion of Variables:

Uninterrupted corridors are critical for movement of animals within and between wetlands. The integrity of these corridors may be disturbed through human-induced perturbations both within and around the assessment area. The extent of these perturbations is represented by the variables (V_{upuse}, V_{wetuse}, and V_{hydalt}). (V_{upuse}) represents the land use within the watershed above the wetland, (V_{wetuse}) represents land-use within the wetland, and (V_{hydalt}) represents the maintenance of water level within the wetland and alterations which impact this maintenance. The buffer influences the cover and movement of organisms within and between wetlands. The buffer is represented by the (V_{buffer}) variable.

The V_{wbasin} and V_{wpairs} variables reflect the density, area, and pattern of different types of wetlands in the landscape, and their contribution to habitat. The frequency of distribution of wetland sizes within a radius of one mile relates to the animal guilds that use the wetlands is also included in this one variable.

Sand Plain depressional wetlands in the prairie pothole region are a dynamic, integrated system that provides habitat for migratory ducks and geese. If a wetland is accessible and provides a high quality food source, waterfowl will seek it out. Waterfowl dynamics as they are related to wetland types are explained in Gersib et al. (1989).

6.0 MAINTENANCE OF HABITAT INTERSPERSION AND CONNECTIVITY AMONG WETLANDS		
Model Variable	**Measurement or Condition**	**Index**
V_{upuse}: Upland Land Use **Definition: Dominant land use or condition of the upland watershed that contributes to the wetland.** **Logic: Upland land use affects species that are interdependent on both wetland and upland habitat.**	**Native prairie managed to allow adequate plant recovery time between vegetation removal.**	**1.0**
	Dominated by non-native perennial species with fair management or better. **- OR -** **Native species managed under season long grazing** **- OR -** **Perennially idle grassland cover** **- OR -** **Permanent Hayland**	**0.75**
	Native or non-native species heavily over-grazed, some bare ground, low plant vigor **- OR -** **No-till continuous high-residue crop** **- OR -** **Minimum till high-residue crops in a grass/legume rotation**	**0.5**
	Native or non-native species heavily over-grazed, high amounts of bare ground, low plant vigor, and evidence of soil erosion **- OR -** **No-till row crop, minimum till small grain**	**0.25**
	Row crop or conventional tillage small grain	**0.1**
	Urban, semi-pervious, or impervious surface.(this condition will result in maximum overland flow; a high rate of delivery to wetland) If best management practices employed, the impact may be somewhat less.	**0.0**

6.0 MAINTENANCE OF HABITAT INTERSPERSION AND CONNECTIVITY AMONG WETLANDS		
Model Variable	**Measurement or Condition**	**Index**
V_{wetuse}: Wetland Land Use **DEFINITION: Dominant land use and condition of the wetland.** **LOGIC: Land uses in the wetland affect habitat features directly through alteration of vegetation composition, horizontal and vertical structure, and native plant and invertebrate populations.**	**No adverse impacts in the wetland, such as compaction, suppression of vegetation, or ruts resulting from activities such as tillage, grazing overuse , or untimely haying.**	**1.0**
	Adverse impacts are present but slight, such as: **Grazing use of seasonal wetland is excessive in temporary zone and proper in seasonal zone** **- OR -** **Temporary wetland plants exhibit overuse.** **- OR -** **Haying has been untimely or excessive, causing ruts, compaction, or reduced stand vigor.**	**0.75**
	Adverse impacts are moderate, such as: **Grazing use of seasonal wetland is excessive in temporary & seasonal zones** **- OR -** **Temporary wetland is heavily overused.** **- OR -** **Seasonal wetland with frequently tilled temporary zone and seasonal zone is mostly perennial vegetation properly managed or idle.** **- OR -** **Temporary wetland is seldom tilled; idle > 3 years out of 4.**	**0.50**
	Adverse impacts are severe, such as: **Temporary zone is tilled most years and seasonal zone is cultivated occasionally, or a temporary wetland is tilled most years but has significant vegetative growth.**	**0.25**
	Adverse impacts are extreme such as feedlot, stockpond dominating the wetland, or wetland is mostly filled.	**0.1**
	Wetland is impervious: (i.e. pavement or asphalt) Restoration is not practical.	**0.0**

6.0 MAINTENANCE OF HABITAT INTERSPERSION AND CONNECTIVITY AMONG WETLANDS		
Model Variable	**Measurement or Condition**	**Index**
V_{hydalt} Hydrology Alterations **Definition: Presence of a constructed subsurface and/or surface outlet affecting the wetland or fill affecting the depth of the wetland.** **Logic: Surface outlet, subsurface drain or fill impacts ground water surface elevations, thereby impacting the performance of water storage and maintenance of aquatic-habitat conditions throughout the wetland.**	**Surface drain or subsurface drain has no effect on wetland. Surface drain or subsurface drain is > 500 feet from the wetland edge and less than 3 feet below the wetland bottom elevation. If surface drain is present and within 500 feet of wetland, it is at or above the top of the temporary zone in elevation. No fill in wetland.**	**1.0**
	Surface drain or subsurface drain 150 to 500 feet from outside wetland edge and greater than 3 feet below wetland bottom elevation. **-OR-** **Surface outlet invert lowered to remove some static storage.** **-OR-** **Wetland filled to reduce some static storage. Wetland still ponds water.**	**0.5**
	Surface drain or subsurface drain within 150 feet of wetland edge removing all static water and drain is greater than 3 feet below wetland elevation bottom. **-OR-** **If large wetland, tile spacing is greater than 300 feet or ineffectively removing saturated conditions.** **-OR-** **Surface outlet lowered to remove all static storage.** **-OR-** **Site filled to the top of the temporary zone with some saturation remaining in wetland.** **Wetland meets saturation criteria only.**	**0.1**
	Surface outlet below bottom of wetland, and subsurface drain 3 feet or greater below wetland bottom elevation with spacing less than 300 feet in all parts within the wetland. **-OR-** **Wetland filled eliminating saturated conditions in the wetland.**	**0.0**

6.0 MAINTENANCE OF HABITAT INTERSPERSION AND CONNECTIVITY AMONG WETLANDS								
Model Variable	**Measurement or Condition**	**Index**						
V_{buffer}: Buffer Zone **DEFINITION: Land use condition and average width of the buffer zone adjacent to the wetland.** **LOGIC: The condition and width of an intact wetland/upland ecotone influences the availability of food sources for aquatic fauna (e.g., terrestrial invertebrates and upland seeds for water fowl).** **Buffer Area = Average buffer width X % continuity**	**Vigorous Well managed grassland OR idle grassland**	**0**	**0.2**	**0.3**	**0.5**	**0.7**	**0.9**	**1.0**
	Hayland OR average managed grassland where height is reduced	**0**	**0.1**	**0.2**	**0.4**	**0.6**	**0.7**	**0.8**
	Over-utilized OR poorly managed grassland No litter	**0**	**0**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**
	Alfalfa/Grass	**0**	**0.1**	**0.1**	**0.2**	**0.3**	**0.3**	**0.4**
	Alfalfa only	**0**	**0**	**0.1**	**0.1**	**0.1**	**0.2**	**0.2**
	Buffer Condition / Buffer Area	**0 to 3**	**3 to 10**	**10 to 20**	**20 to 30**	**30 to 40**	**40 to 47**	**47 to 50**

6.0 MAINTENANCE OF HABITAT INTERSPERSION AND CONNECTIVITY AMONG WETLANDS		
Model Variable	**Measurement or Condition**	**Index**
Vwbasin **DEFINITION: The number of wetland basins on the landscape within a defined radius from the WAA. (Data reported at 1/4 mile scale).** **LOGIC: There is more perimeter in several small basins than one large basin of equal area. Edge is a key factor to the faunal guild.**	**5 or more wetland basins within ¼ mile radius from the center of assessment wetland. (1 mile radius 80 wetland basins)**	**1.0**
	4 wetland basins within ¼ mile radius from the center of assessment wetland. (1 mile radius 64 wetland basins)	**0.75**
	3 wetland basins within ¼ mile radius from the center of assessment wetland. (1 mile radius 48 wetland basins)	**0.5**
	2 wetland basins within ¼ mile radius from the center of assessment wetland. (1 mile radius 32 wetland basins)	**0.25**
	1 wetland basin within one mile radius from the center of assessment wetland.	**0.1**
	No other wetlands within 1 mile radius.	**0.0**

6.0 MAINTENANCE OF HABITAT INTERSPERSION AND CONNECTIVITY AMONG WETLANDS		
Model Variable	**Measurement or Condition**	**Index**
V_{wpairs} : Waterfowl breeding pairs distribution map. **DEFINITION: The relative ability of a wetland to provide niches for a variety of vertebrate species.** **LOGIC: Index values are based on State-wide Waterfowl Breeding Pairs Distribution Maps.[#1] The values are based on the Mallard Model, which is the best single tool available to measure habitat diversity and quality for the whole wildlife community in the Lake Dakota Sand Plain. Size, classification, and density of wetlands are factored in.**	**Duck breeding pairs per sq. mile >60**	**1.0**
	Duck breeding pairs per sq. mile 40 to 59.9	**0.75**
	Duck breeding pairs per sq. mile 20 to 39.9	**0.5**
	Duck breeding pairs per sq. mile 10 to 19.9	**0.25**
	Duck breeding pairs per sq. mile 0 to 9.9	**0.1**
	No standard exists for this value as any wetland will have value to the vertebrate guild.	**0.0**

#1 NOTE: ***(If Map is not available see Vwpairs variable in appendix 1 for substitutes.)***

Formulae for calculating functional capacity indeces:

1.0 INDEX OF FUNCTION: Maintain Characteristic Hydrology

$=\{Vhydalt * [(Vsource + Vupuse + Vsed)/3 + (((Vsorpt + Vpore)/2) + Vwetuse)/2]/2\}^{1/2}$

$=\{$_____ x [(_____ + _____ + ____)/3 + (((_____ + _____)/2)+_____)/2]/2$\}^{1/2}$

2.0 INDEX OF FUNCTION: Removal, Conversion and Release of Elements and Compounds

=[Vsorpt + Vpore + Vpcover + Vdetritus +(Vsource + Vhydalt)/2 + (Vwetuse + Vsed + Vbuffer + Vupuse)/4]/6

=[_____ + _____+ _____ + _____ + (_____ _+ _____)/2 + (_____ + ____ + _____ + _____)/4]/6

3.0 INDEX OF FUNCTION: Retention of Particulates

IF CLOSED DEPRESSION*1:

= (1.0*2 +Vupuse + Vsed + Vbuffer)/4

= (1.0 + _____ + _____ + _____)/4

IF NON-CLOSED DEPRESSION:

= (Vhydalt + Vwetuse + Vupuse + Vsed + Vbuffer)/5

= (_____ + _____ + _____ + ____ _ + _____)/5

***1 – Closed depression is one with no artificial surface water outlet (i.e. surface drain, tile inlet or pump**

***2 – The 1.0 in the closed depression formula addresses hydrology(surface outlet variable). If the 1.0 "no outlet" factor is not included, a non-closed depression may show a higher function than an analogous closed depression.**

4.0 INDEX OF FUNCTION: Maintain Characteristic Plant Community

={Vwetuse + Vpratio +[Vsorpt + Vpcover + Vdetritus +(Vsed + Vhydalt)/2]/4}/3

={ _____ + _____ + [_____ + _____ + _____ +(____ + _____)/2]/4}/3

5.0 INDEX OF FUNCTION: Maintenance of Habitat Structure Within the Wetland

=[Vpcover + Vpratio + Vbuffer + Vdetritus +(Vupuse + Vwetuse + Vsed + Vhydalt)/4]/5

=[_____ + _____ + _____ + _____ +(_____ + _____ + _____ + _____)/4]/5

6.0 INDEX OF FUNCTION: Maintenance of Habitat Interspersion and Connectivity among Wetlands

=$\{[(Vupuse+(((Vwetuse+Vhydalt)/2)+Vbuffer)/2)/2]*[(Vwbasin+Vwpairs)/2]\}^{1/2}$

=$\{[(\_\_\_\_\_+(((\_\_\_\_\_+\_\_\_\_\_)/2)+\_\_\_\_\_)/2)/2]*[(\_\_\_\_\_+\_\_\_\_\_)/2]\}^{1/2}$

III. Field Guide for Measurement of Indicators and Condition

A PROCEDURE FOR ASSESSMENT
ENDOSATURATED DEPRESSIONAL WETLANDS
LAKE DAKOTA SAND PLAIN

A. INTRODUCTION: This guide is meant to be user friendly and taken to the field to assess the functional capacity of wetlands on the Lake Dakota Sandy Outwash Plain and adjacent Sandy Outwash Plains in North Dakota. It is a tool to use to determine minimal effect and the mitigation requirements associated with the projected loss of a wetland or some of its function. This interim model is also a tool that can be used to evaluate wetland use and management alternatives in the conservation planning process.

Before using this field guide a person should become familiar with the preceding functional profile and model explanation parts of this interim model. Reviewing the preceding parts of this model will help determine if this interim model is applicable to the subclass of the wetland to be assessed. This model is intended to be user friendly.

The following sections in this Field Guide are: Guidelines for Assessing Wetland Function, Tools for Functional Assessment, Preferred Order of Assessing Variables and Detailed Instructions on Measurements of Indicators, and data recording procedures.(See Section IV, Appendix 1, Part B - Figure 1 and 2 for Scale of Assess ment and Observation of Variables)

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

B. GUIDELINES FOR ASSESSING WETLAND FUNCTIONS

OFFICE PREPARATION:

1. **Review the tools list and assure needed tools are available to do the assessment.**

2. **Prior to performing the office review, it is important to collect the documents and information that is relevant to the site. Pay particular attention to the land use of the assessment site noting any differences in land use within or surrounding the wetland.**

3. **Gather and record information on variables Vwpairs, Vwbasin, Vsource and Vhydalt in the office. Prepare the tools needed for the field assessment. Take recorded comments and data to the field with you.**

FIELD ASSESSMENT:

1. **Bound the Assessment Area in the Field by:**

   a. **Separate upland from wetland**
   b. **Separate HGM wetland subclasses on the project site into Wetland Assessment Areas(WAA)**
   c. **Separate disturbance regimes**

2. **Walk the perimeter of the wetland**

   a. **Look for buffer, outlet, source intercept, sediment delivery and verify variables assessed in the office.**
   b. **Verify bounding of Wetland Assessment Area(WAA).**
   c. **Look for representative areas to assess variables in temporary and seasonal zones.**
   d. **Visually determine zones and confirm when plant, soils and hydrology data is gathered.**

Guide to help in estimating % area of circular zones:

% Radial distance(center to edge)	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
center point→	**.--------)**	**--------)**	**--------)**	**--------)**	**--------)**	**--------)**	**---------)**	**---------)**	**--------)**	**--------)**
% Area within that radius	**1%**	**4%**	**9%**	**16%**	**25%**	**36%**	**49%**	**64%**	**81%**	**100%**

3. **Follow the steps for on-site measurement of indicators in the field as explained in the Preferred Order of Assessing Variables and the Detailed Instructions for Determination and Measurement of Indicators.**

4. **Score the variable index scores on worksheet Table A-1 along with measurements and comments.**

5. **Calculate Functional Capacity Index's(FCI's) using Table A-2 or computer program.**

6. **Check to insure you have all needed field data collected and recorded. Review the data collected to see if it makes sense and recheck data appearing questionable.**

TOOLS FOR FUNCTIONAL ASSESSMENT

OFFICE TOOLS:

USGS QUAD MAPS
NWI WETLAND MAPS
PHOTO MAPS OF WETLAND AND THE AREA WITHIN ONE MILE RADIUS
METHOD/TOOLS FOR ACREAGE CALCULATION
SOIL SURVEY
MAP SCALE

FIELD TOOLS:

INTERIM FUNCTIONAL ASSESSMENT MODEL LAKE DAKOTA SAND PLAINS
PHOTO MAP OF WETLAND AND LANDSCAPE
BASIC SURVEY EQUIPMENT; HAND, ABNEY OR TRANSIT LEVEL, ROD, SURVEY OR STADIA
PLANT IDENTIFICATION HANDBOOKS
CAMERA, FILM, TRIPOD, ETC.
SPADE, SOIL PROBE OR AUGER FOR SOILS WORK
HAND LENS
CLIPBOARD, PAPER, PEN-PENCIL
FIELD RECORDING SHEETS
SOIL SURVEY
SOILS FIELD KIT - SPATULA, ACID, MUNSELL COLOR BOOK, TAPE MEASURE, WATER BOTTLE, HYDRIC SOIL INDICATORS BOOK,
FLAGS - VARIOUS COLORS OR LATH AND FLAGGING TAPE
MARKING PENS (TO WRITE ON FLAGS)
100 FOOT CHAIN
ACREAGE SCALE/RULER
CALCULATOR WITH SQUARE ROOT CAPABILITY
TILE PROBE

OTHER CONSIDERATIONS:

NOTIFY OWNER/OPERATOR
INSECT REPELLENT
SUN SCREEN
WADERS, HIP-CHEST-IRRIGATION
BINOCULARS
GENERAL LAND USE KNOWLEDGE OF THE BASIN
M.A.R.S.H. PLANT ID PROGRAM IN A LAPTOP
GPS PLGR
BAGS AND CARDBOARD OR PLANT PRESS FOR PLANT COLLECTIONS
EDTA SOLUTION

D. PREFERRED ORDER OF ASSESSING VARIABLES

1. Vwpairs

Review Waterfowl Breeding Pairs Distribution Map and record the Density of Breeding Pairs indicated by the map. *(If Map is not available see Vwpairs variable in appendix 1 for substitutes.)*

2. Vwbasin

When approaching the wetland(s), examine area within 1320 feet(1/4 mile) radius, verify location of wetlands found in office review and a route to wetland basins noted as suspect. Formulate plans for an on-site check if needed (For larger wetlands a 1 mile radius may be needed to accurately assess the Vwbasin variable).

3. Vsource

Review USGS quad sheets of the area, noting the watershed. Observe and note drainage work (ditches, subsurface drains) in and outside of the wetland and within 1/4 mile of the wetland. Eyeball the subject wetland and note land use and any alterations such as drains or tile, watershed size and any source impacts such as roads, irrigation, etc. Also note any indicators of high water marks such as trash lines, detritus hanging in standing vegetation, sediment stains, etc.

4. Vsorpt

Using soil survey tools, locate wetland edge and wetland zones. Observe hydric indicators, soil color, organic matter levels, % unstained sand grains, evidence and effectiveness of drainage, and evidence and frequency of cropping.

5. Vpore

Using soil survey tools, locate wetland edge and wetland zones. Within the wetland look for an Ap horizon or other evidence of tillage, plow pan, and horizontally deflected roots. Observe soil structure, soil pores and rupture resistance,.

6. Vhydalt

Using survey equipment, establish the following elevations: Wetland bottom, natural threshold outlet, constructed outlet, any wetland zones, hydric line, high water. Estimate average depth. Observe and note drainage work (ditches, subsurface drains) in and outside of the wetland and within 500 feet of the wetland. Determine amount of fill in the wetland. Record any length, width or other measurements you feel are appropriate.

7. Vpcover - Vpratio

Survey plant populations; species and abundance, canopy, and note any noxious plants.

8. Vsed

Check sediment depth and record representative depths.

9. Vdetritus

Measure thickness of litter in both the temporary and seasonal zone if present. Variability will dictate the number of measurements to be taken to obtain a representative thickness. (Note; Range given in thickness of detritus accounts for the seasonal variation.)

10. Vbuffer

Observe the upland within 50 feet of the wetland. Use best professional judgment in determining average width and land use condition of the buffer.

11. Vupuse - Vwetuse

Observe and record the land use within the wetland and the dominant land uses within ¼ mile radius of the wetland perimeter. (Note; If wetland is divided by significantly different land uses, separate assessments may be needed – See Bounding)

E. DETAILED INSTRUCTIONS FOR DETERMINATION AND MEASUREMENT OF INDICATORS

Where and When to Measure: Vwpairs [#1]

This variable is most conveniently measured in the office using the Waterfowl Breeding Pairs Distribution Map. This data can be gathered at the same time as Vwbasin data. There will be no seasonal variability in this measurement. These maps are based upon work done by the U. S. Fish and Wildlife Service. It meshes the Mallard Model and the National Wetland Inventory, to predict how many breeding pairs of five major species of ducks would nest in a particular forty acre cell of land area. The predictions are based on many years of actual census data of the duck population. The density of breeding pairs is used as an indicator of habitat quality. In short, if the ducks like it, then rodents, other birds, and mammals will also be present. Breeding pairs "thunder storm" maps are currently available for the prairie pothole region of North and South Dakota. The maps for other states in the prairie pothole region are being, or will be, developed. The indexing was done using best professional judgment and applies to North Dakota. Indexing for other states should be done by local experts using their best professional judgment. The variable lacks sensitivity in that it does not count basins, nor is it able to detect instant change. This does not, however detract from its use. If a wetland is being assessed due to a planned alteration that requires mitigation, then mitigation should be performed in an area of the same or higher index score. It may take a policy decision to determine if mitigation will be basin for basin, function for function, in the same watershed, etc.

#1 NOTE: ***(If Map is not available see Vwpairs variable in appendix 1 for substitutes.)***

How and What to Measure:

The evaluator only needs to know the location of the wetland being assessed and have access to a U. S. Fish and Wildlife Service Waterfowl Breeding Pairs Distribution map. The location is found on the breeding pairs map and, using the color-coded index legend on the map, the number of breeding pairs predicted to use this location is noted.

What to Record:

Indicator:

The density of breeding pairs indicated by the map _____.

Model Variable	Measurement or Condition	Index
V_{wpairs} : Percentile land base waterfowl breeding pairs distribution map.[#1] **DEFINITION: The relative ability of a wetland to provide niches for a variety of vertebrate species.** **LOGIC** **#1 Note:** ***(If Map is not available see Vwpairs variable in appendix 1 for substitutes.)***	**Duck breeding pairs per sq. mile >60**	**1.0**
	Duck breeding pairs per sq. mile 40 to 59.9	**0.75**
	Duck breeding pairs per sq. mile 20 to 39.9	**0.5**
	Duck breeding pairs per sq. mile 10 to 19.9	**0.25**
	Duck breeding pairs per sq. mile 0 to 9.9	**0.1**
	No standard exists for this value as any wetland will have value to the vertebrate guild.	**0.0**

Where to Measure: Vwbasin

This variable accounts for the actual number count of wetland basins on the landscape within ¼ and 1 mile radius of the center of the assessed wetland.

When to Measure:

The data for this variable can be gathered in conjunction with the variable Vwpairs and initially is done in the office. Always verify results in the field.

What and How to Measure:

In the office, review the NWI and FSA wetland inventory maps and inscribe a circle scaled to ¼ mile radius from the center of the assessed wetland. Count the number of wetlands within or intercepted by the inscribed circle. Verify the number count in the field. (For larger wetlands a radius of 1 mile (2000.3 acres) may be needed to describe the Vwbasin variable). If a wetland is bisected by a road, count it as one wetland.

When approaching the site on the field review, verify location of wetlands found in office review of the area within the 1/4 mile radius(1320 feet). Formulate plans for an on-site check if needed.

What to Record:

Number of wetland basin(s) within ____ mile radius of the center of the assessed wetland _____.

Model Variable	Measurement or Condition	Index
Vwbasin **DEFINITION: The number of wetland basins on the landscape within a defined radius from the WAA. (Data reported at 1/4 mile scale).** **LOGIC:**	**5 or more wetland basins within ¼ mile radius from the center of assessment wetland. (1 mile radius 80 wetland basins)**	**1.0**
	4 wetland basins within ¼ mile radius from the center of assessment wetland. (1 mile radius 64 wetland basins)	**0.75**
	3 wetland basins within ¼ mile radius from the center of assessment wetland. (1 mile radius 48 wetland basins)	**0.5**
	2 wetland basins within ¼ mile radius from the center of assessment wetland. (1 mile radius 32 wetland basins)	**0.25**
	1 wetland basin within one mile radius from the center of assessment wetland.	**0.1**
	No other wetlands within 1 mile radius.	**0.0**

Where to measure: Vsource

This variable reflects the catchment area and the groundwater source area. Measurement of this variable will be from the wetland out to 1/4 mile from the wetland.

When to measure:

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

How and what to measure:

Review aerial photography, USGS quad sheets, scope and effect maps and NWI maps. Note and document any surface alterations (roads, surface ditches, terraces, etc.), Irrigation systems, and subsurface alterations (tile, wells, etc.) within a ¼ mile radius of the wetland. Note and document wetland subclass. From the USGS quad map, delineate the original catchment area.

NOTE: If the office review can determine that the catchment area has been altered, determine the amount of catchment area that has been structurally altered to prevent flow to the wetland. Also note areas added to the watershed due to road ditches or drainage.

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

WHAT TO RECORD:

Type and effect of surface alteration(s) _____

Type and effect of subsurface alteration(s) _____

Change in NWI wetland subclass(Yes or No) _____

Percent catchment area affected _____

Model Variable	Measurement or Condition	Index
V_{source}: Source Area of Flow to Wetland **DEFINITION: The area surrounding a wetland that defines the catchment and groundwater flow area to the wetland.** **LOGIC:**	**Alteration of upland watershed source area by surface alterations (e.g., ditches, roads, terraces, irrigation)does not impact wetland, and no subsurface alterations (e.g., tile drains, ditches, irrigation).**	**1.0**
	Surface alterations of upland watershed source area impacts overland flow into wetland (e.g., ditches, roads, terraces, irrigation, etc.), however , no subsurface alterations(e.g., tile drains, irrigation).	**0.75**
	Upland watershed source area is changed to alter the dominant surface and subsurface flow path of water to the wetland(e.g., draining or irrigation return or draw-down). **-AND-** **Alteration does not change the NWI classification.**	**0.50**
	Upland watershed source area is changed to alter the dominant surface and subsurface flow path of water to the wetland(e.g., draining or irrigation return or draw-down). **-AND-** **Alteration does change the NWI classification.**	**0.1**
	Upland watershed source area extremely altered such that almost all water flow to wetland eliminated (e.g., urbanization).	**0.0**

Where and When to measure: Vsorpt

The wetland will be scouted and the measurement recorded will be representative for the temporary or seasonal zone assessed in the wetland. The percent of each zone will be recorded. This information will then be used to calculate the index for all or the portion of the wetland that is needed for the assessment. These measurements can be recorded when checking for sediment or detritus thickness.

How and What to measure:

Upon examining the soils and the wetland basin, note the evidence and effectiveness of drainage (not drained, partially drained, and effectively drained), and evidence of cropping and frequency of cropping. An "effectively" drained wetland still exhibits some wetland character which does not interfere with cropping most years.

With the use of a spade(sharpshooter) take a vertical slice of soil to a depth of 16 inches. Examine in good sunlight. This should be done when the soil is moist and not when wet or dry. Wet soils glisten which interferes with reading colors and with estimating un-stained sand grains. If sampling site is under water the use of a soil probe (preferably one with a 1.5" diameter coring tube) could be used to obtain a sample.

Using the Munsell Soil Color Chart, examine the colors of the A horizon from the surface to 6 inches. Record the hue, chroma and value. (Note; check for Neutral Colors in the A horizon and note whether there is a darker-colored A horizon below and contiguous to the A in the upper 6 inches.)

By visual observation (without magnification) record the % of unstained sand grains (salt and pepper effect) in the A horizon from the surface to 6 inches. Soil should be in the moist to slightly dry condition.

List the hydric soil indicator used to identify the hydric soil if found in the Field Indicator of Hydric Soils Publication. If EDTA is used for determining the level of soil organic matter use the field method outlined by R.A. Bowman, USDA-ARS, Akron, CO.

WHAT TO RECORD:

Indicators:	Temporary Zone	Seasonal Zone
Evidence and effectiveness of drainage:	_____	_____
Evidence and frequency of cropping:	_____	_____
Soil Color:		
Hue:	_____	_____
Chroma:	_____ _____	_____
Value:	_____	_____
Darker A horizon contiguous (Yes or No) below 6 inches	_____	_____
Percent of unstained sand grains:	_____	_____
Measurement:		
Percent Organic Matter(EDTA Method):	_____	_____

Model Variable	Measurement or Condition	Index
V_{sorpt}: Soil Sorptive Properties **DEFINITION: The ability of the upper part of the soil to retain and move elements and compounds.** **LOGIC:**	**Organic Matter is >4.0% (Measurement)** ***Indicators*: The mineral soil in all parts of the A horizon within 6 inches of the surface has a value of 2 or 3 and chroma of 0.** **-OR-** **Value of 2 and chroma of 1 -AND- nearly all sand grains visible to naked eye are coated with organic matter in all parts of the A horizon within 6 inches of the surface and lacks a darker-colored A horizon immediately or contiguously below 6 inches .** **-OR-** **Site has no evidence of drainage or excessive vegetation removal.**	**1.0**
	Organic Matter is 1.5 to =<4.0% (Measurement) ***Indicators*: The mineral soil in parts of the upper 6 inches or A horizon has a value of >2 to 3 and chroma of 1, or value of 2 and chroma of 2.** **-OR-** **Value of 2 and chroma of 1 in parts of the A horizon within 6 inches of the surface -AND- Some individual grains of sand are not coated with organic matter, salt and pepper effect is visible.** **-OR-** **Site has been partially drained and/or there is evidence of intermittent or past cropping or excessive vegetation removal.**	**0.5**
	Organic Matter is <1.5% (Measurement) ***Indicators*: The mineral soil in the upper 6 inches or A horizon has a value of >3 to 4 and chroma of 1or 2** **-OR-** **Most individual grains of sand are not coated with organic matter in the A horizon within 6 inches of the surface.** **-OR-** **Site has been "effectively" drained and frequently cropped.**	**0.1**
	Wetland soil has been replaced by upland fill, asphalt, concrete, etc.	**0.0**

Where to measure: Vpore

The wetland will be scouted and the measurement recorded will be representative for the temporary or seasonal zone assessed in the wetland. This information will then be used to calculate the index for all or the portion of the wetland that is needed for the assessment.

When to measure:

These measurements can be taken anytime during the assessment, but for efficiency, could be performed in conjunction with the delineation procedure. These measurements can be recorded when checking for soil organic matter, sediment or detritus thickness.

How and what to measure:

In assessing this variable look for micro-topographical highs and lows in the wetland that may be associated with past evidence of tillage.

With the use of a spade(sharpshooter) take a vertical slice of soil to a depth of 16 inches. Examine in good sunlight. Apply a moderate thud to the back of the spade to help show the natural structure cleavage of the soil. Record presence or absence of an Ap horizon or evidence of past tillage.

Pay special notice to the 4 to 10 inch layer checking for a plow pan. Note, look for horizontal layer(s) in the 4 to 10 inch zone which could be a plow layer. Look for horizontal root growth as an indicator of a highly compacted layer (plow pan) Record findings.

Examine the slice and note the size, shape and grade (distinctness) of the soil peds in the A horizon. Note if the structure parts to medium and fine granular and the size of blocks. Record the size, grade, and type of structure for the A horizon. If sampling site is under water the use of a soil probe (preferably one with a 1.5" diameter coring tube) could be used to obtain a sample, however, coarser structure and grade of structure may not be evident.

Examine horizontal surfaces for tubular pores. Concentrate on the layer with the least amount of pores and the most compaction if an Ap is present. Count the number of very fine and fine pores in a square centimeter and the number of medium and coarse pore in a square decimeter and record. Also examine the pores to determine their continuity. Record the number of pores and their continuity. Note: Roots are a surrogate for pores.

To determine rupture resistance in the upper 16 inches of the soil, take a soil ped (about 1 inch cube) that has not been compressed or deformed in getting the slice and crush it between your forefinger and thumb, noting the strength needed to deform or rupture the ped. Note this estimation as very friable(very slight force), friable(slight force), firm(moderate force) or very firm(strong force). Then record the most resistant measurement found within the upper 16 inches. (Hint; If tilled this will probably be in a 4 inch thick layer found just below the tillage zone which may extend to 12 inches below the surface.)

WHAT TO RECORD: INDICATORS:

Evidence of past tillage: Temp Zone (yes or no)_____ Seas Zone (yes or no) _____

Ap horizon present: Temp Zone (yes or no)_____ Seas Zone (yes or no) _____

Plow pan with roots growing: Temp Zone (yes or no) ____ Seas Zone (yes or no) _____
horizontally along pan:

SECONDARY MEASUREMENTS:

Soil Structure:	**Temporary zone**	**Seasonal zone**
Size:	_____	_____
Type:	_____	_____
Grade:	_____	_____
Soil Pores:		
Number:	_____	_____
Continuity:	_____	_____
Rupture Resistance:	_____	_____

Model Variable	Measurement or Condition	Index
V_{pore}: Soil Porosity **DEFINITION: The ability of the soil to allow movement of liquids, gases, etc. into, and through, the upper part of the soil. As indicated by the physical integrity of the upper part of the soil. This includes the number and continuity of pores, the type, grade, and size of soil structure, and the soils rupture resistance.** **LOGIC:** **Note: Direct Measurement of V_{pore} is Soil Infiltration/Permeability measurements in the upper 12 inches of the soil. No standards set at this time.**	***Secondary Measure* - The upper (12") soil horizons have compound structure, i.e. the A1 has wk to moderate subangular blocky parting to moderate granular structure. The A2 has weak fine and medium subangular blocky parting to moderate granular structure.** **Many very fine and fine, continuous pores.** **Rupture resistance is very friable.** ***Indicator* - No evidence of an Ap within hydric soil boundary.**	**1.0**
	***Secondary Measure* - Fine to medium subangular blocky parting to granular structure.** **Common very fine and fine, continuous and discontinuous pores.** **Rupture resistance is friable** ***Indicator* - Ap horizon is present. Wetland is partially tilled or restored (cropland) < 20 years**	**0.5**
	***Secondary Measure* - Few very fine and fine discontinuous pores. Massive or coarse subangular blocky or coarse platy structure (coarse, cloddy)** **-OR-** **Plow pan evidenced by roots growing horizontally along pan. Rupture resistance is friable to firm for LFS and firm for FSL** ***Indicator* - Ap horizon present. Wetland is tilled throughout most years.**	**0.1**
	The substrate is a non-porous medium, i.e., asphalt, concrete, etc.	**0.0**

Where and When to measure: Vhydalt

This variable will be measured from the bottom (lowest elevation) of the wetland out to five hundred feet from the wetland boundary. Elevation shots will be taken at the lowest elevation of the wetland, at the control section of the outlet (highest point of a natural outlet or a man made outlet), at the wetland boundary, and depth of drainage features in relation to wetland elevations.

These measurements can be taken at anytime during the assessment, but for efficiency, could be performed in conjunction with the delineation procedure. Distances to drainage features may be measured from aerial photography prior to going to the field.

How and what to measure:

Elevations and distances will be determined by approved surveying methods and equipment. Hydrology alterations are typically in the form of lateral removal of subsurface flow or saturation, surface water removal and / or fill placed in the wetland.

Preferred method:

Lateral Removal of Subsurface Flow

1. **Elevations of buried subsurface drainage features (tile) should be determined as follows:**
   - **a. Determine the tile size from scope & effect or local information.**
   - **b. Determine the shortest distance between the tile and the wetland.**
   - **c. Determine the depth the tile is below the ground surface with the tile probe.**
   - **d. Shoot the elevation at this location and subtract the depth to tile and the tile diameter from the ground elevation.**

2. **Elevations of surface drainage features (road ditches, etc.) should be determined as follows:**
   - **a. Determine the shortest distance between the surface drainage feature and the wetland.**
   - **b. Shoot the elevation of the lowest point in the surface drainage feature at this distance.**

Surface Water Removal

- **a. Shoot the elevation of the surface outlet (natural or man made).**
- **b. Shoot the elevation of the wetland bottom.**
- **c. Compare the two elevations to determine if site ponds water.**

Fill Placed in Wetland

- **a. Using the methods described in Vsed, determine if fill has been placed in the wetland by digging or probing in the wetland to determine if wetland has been filled.**

WHAT TO RECORD:

Distance to surface drainage feature _____ Depth of surface drainage feature _____

Distance to subsurface drainage feature _____ Depth of subsurface drainage feature _____

Diameter of subsurface drainage feature _____

Elevation of surface outlet _____

Elevation of wetland bottom _____

Depth of ponding _____ Depth of fill _____

Model Variable	Measurement or Condition	Index
V_{hydalt} Hydrology Alterations **Definition: Presence of a constructed subsurface and/or surface outlet affecting the wetland or fill affecting the depth of the wetland.** **Logic:**	**Surface drain or subsurface drain has no effect on wetland. Surface drain or subsurface drain is > 500 feet from the wetland edge and less than 3 feet below the wetland bottom elevation. If surface drain is present and within 500 feet of wetland, it is at or above the top of the temporary zone in elevation. No fill in wetland.**	**1.0**
	Surface drain or subsurface drain 150 to 500 feet from outside wetland edge and greater than 3 feet below wetland bottom elevation. **-OR-** **Surface outlet invert lowered to remove some static storage. -OR-** **Wetland filled to reduce some static storage.** **Wetland still ponds water.**	**0.5**
	Surface outlet or subsurface drain within 150 feet of wetland edge removing all static water and drain is greater than 3 feet below wetland elevation bottom. **-OR-** **If large wetland, tile spacing is greater than 300 feet or ineffectively removing saturated conditions.** **-OR-** **Site filled to the top of the temporary zone with some saturation remaining in wetland.** **Wetland meets saturation criteria only.**	**0.1**
	Surface outlet below bottom of wetland, and subsurface drain 3 feet or greater below wetland bottom elevation with spacing less than 300 feet in all parts within the wetland. **-OR-** **Wetland filled eliminating saturated conditions in the wetland.**	**0.0**

Where to measure Vpcover:

This variable will be measured within each wetland zone present (temporary and seasonal) and the findings will be recorded. The information will be used to assign an index score that is representative for the assessment area.

When to measure:

This variable is usually easiest to determine near the end of the growing season if vegetation is not altered. If possible, coordinate with the owner/operator to avoid assessing after tillage, fire, or other hindrances. During the assessment, Vpcover can be assessed concurrently with the Vpratio Variable.

How and what to measure:

The Vpcover evaluation needs to be based on the typical inter-seasonal and intra-seasonal conditions of the wetland. Wetlands that are covered with perennial vegetation are easy to rate. Wetlands that are cultivated intermittently may be more difficult to assess. Events such as fire, tillage, extended wet or dry periods, and abrupt changes in precipitation may culminate in a plant cover that is much more or much less than average for the site. In these cases, seek additional information and use best professional judgment. Additions of non-typical hydrology due to natural events that cause a shift in vegetation (emergent - submergent) should not penalize index scores. Document observations from aerial color slides and infra-red photography from the current and previous years, and the knowledge of reliable persons familiar with the site.

Preferred method:

1. **Flag the perimeter of the assessment area. Evaluate the plant cover on the entire assessment area, but not beyond it. Avoid being "thrown off" by tillage lines or other pseudo-boundaries.**

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

3. **Walk through the wetland in a zig-zag or cross-sectional pattern that will provide a representative view of the vegetation present on the entire wetland. Keep in mind that the outer points of a straight line transect through a wetland represent a greater proportion of its area. For example, the outer one-fourth of a transect represents 44% of a round wetland. The outer one-eighth of such a linear transect represents 23.4% of the total wetland area. Accurate determination of the proportion of different conditions on the outer portion of a wetland is essential for proper assessment.**

4. **If the wetland has been cultivated or otherwise disturbed in a manner that reduces vegetative growth, observe the amount of plant matter present on the surface. Using a spade, also check for plant residue and roots below the surface. Root mass is a good indicator of recent years' vegetative growth. Record observations for each vegetative zone present, (wet meadow and shallow marsh). A mental comparison of the assessment site and a comparable native site in excellent condition is helpful. Wet meadow can produce 4000# of forage per acre annually; shallow marsh can produce 7000# . These production levels require a vigorous sod.**

5. **Consider the temporal aspect of vegetative cover. While native wetlands in excellent condition "green up" quickly in spring and are usually covered with growing vegetation for most of the growing season, plant cover on cultivated sites is widely variable. Some wetlands are left idle for years at a time; others have a good crop cover most years; and some are intensively cultivated and compacted resulting in little growth anytime. Cultivated wetlands are often covered by species that are prone to drowning- an intra-seasonal consideration. Best professional judgment is critical for assigning the index score that represents the inter- and intra- seasonal average for the wetland. The proper index score may not correspond to the conditions observed at the time of assessment; written documentation for the decision is essential.**

Future measurement method:

1. **Growth curves for various management scenarios (crop use, Hayland, or grazing)**
2. **plotting the amounts of vegetation expected to be present on wet meadows and shallow marshes on a calendar time line, would be desirable for assessing Vpcover. No research of this type is known to exist at this time.**

WHAT TO RECORD ON THE FIELD DATA FORM:

% of wetland area covered with vegetation, including crops and upland invaders _____

Rationale for assigned index score, if different from chart indication; typical management or events, frequency, etc._____

Model Variable	Measurement or Condition	Index					
V_{pcover} Vegetation Density DEFINITION: Typical inter- and intra-seasonal amount of woody and herbaceous plants growing in all vegetation zones of the wetlands. LOGIC: (*Note: Use Oct/1 values until May/1 of the next year.)	90 -125% vegetative cover	1.0	1.0	1.0	1.0	1.0	1.0
	65 to 90% OR >125% vegetative cover	1.0	1.0	1.0	0.75	0.75	0.75
	40 to 65% vegetative cover	1.0	1.0	0.5	0.5	0.5	0.5
	15 to 40% vegetative cover	1.0	0.5	0.25	0.25	0.25	0.25
	1 to 15% vegetative cover	0.5	0.1	0.1	0.1	0.1	0.1
	0% unvegetated	0	0	0	0	0	0
	% Cover / Month/Day	May/1	June/1	July/1	Aug/1	Sept/1	Oct/1 *

Where to measure Vpratio:

This variable will be measured within each wetland zone present (temporary and seasonal) and the findings will be recorded. The information will be used to assign an index score that is representative for the assessment area.

When to measure:

These observations can be made at any time during the assessment. Observing and recording Vpcover and Vpratio data concurrently is suggested, for efficiency.

How and what to measure:

The Vpratio measurement needs to take into account the typical inter-seasonal and intra-seasonal conditions of the wetland. Wetlands that are covered with perennial vegetation are relatively easy to rate. Wetlands that are cultivated intermittently may be more difficult to assess. Events such as fire, tillage, extended wet or dry periods, and abrupt changes in precipitation can change the species composition on part or all of a wetland. In these cases, seek additional information and use best professional judgment. Document observations from aerial color slides and infra-red photography from the current and previous years, and the knowledge of reliable persons familiar with the site.

After extended high-water conditions, a draw-down phase may enable numerous early-succession species to germinate. This may result in a wetland having a very good native community to temporarily having a lower index score. A sound understanding of recent conditions and plant succession may justify assigning an index score that does not match the plant community found at the time of assessment. Documenting the rationale for such cases is essential.

Preferred method:

1. **Flag the perimeter of the assessment area. Evaluate the plant cover on the entire assessment area, but not beyond it. Avoid being thrown off by tillage lines or other pseudo-boundaries.**

2. **If the wetland has a seasonal zone, flag its boundary. Look at the wetland from a high point to identify areas with significantly different vegetation types. Determine the relative size of each such area by visual estimation or by measurement such as pacing, and record findings. Examine the plant cover on each portion individually. Then, a weighted index score can be assigned for the wetland.**

3. **Walk through each vegetative zone of the wetland in a zig-zag or cross-sectional pattern that will provide a representative view of the vegetation present. Keep in mind that the outer points of a straight line transect through a wetland represent a greater proportion of its area. For example, the outer one-fourth of a transect represents 44% of a round wetland. The outer one-eighth of a linear wetland represents 23.4% of the total wetland area. Accurate determination of the proportion of different conditions on the outer portion of a wetland is essential for proper assessment.**

4. **Considering the expected growth for the entire season, estimate the % of total vegetation mass that the dominant species will produce in each zone present, (wet meadow and shallow marsh). Keep in mind that warm-season species such as Prairie cordgrass and yellow foxtail are slow starters with rapid growth later. Growth measurement could be done by weighing clipped samples late in the growing season. At other times, the decision must be based on Best Professional Judgment, with knowledge of the growth capabilities of the each species. Record observations on a data sheet. After assigning % of total production to the dominants in each zone, look over the wetland again to mentally check if the assigned proportions are reasonable. Make adjustments if needed.**

5. **After determining which species comprise the dominants in each zone, classify them as native or non-native. Then assign the appropriate Vpratio index score. NOTE: While only the dominant species need to be evaluated for Vpratio, it is desirable to base the Vpratio measurement on an extensive species survey.**

What to record on the field data sheet:

% of the total vegetative cover comprised by each of the dominant species _____

% of vegetative cover, if any, that is Purple loosestrife _____

Any applicable comments on plant succession factors/rationale for the assigned Vpratio index score, if the decision may appear questionable_____

Model Variable	Measurement or Condition	Index
V_{pratio}: Ratio of Native to Non-native Plant Species **DEFINITION: The ratio of native to non-native plant species present in wetland zones (Wet Meadow, Seasonal) as indicated by the dominants, using the 50/20 rule, or by a more extensive species survey.** **Dominants are the most abundant species that immediately exceed 50% of the total dominance for a given stratum when the species are ranked in descending order of abundance and cumulatively totaled. Dominants also include any additional species comprising 20% or more of the total.** **LOGIC:**	**All dominant species in the wetland are native, non-woody species.**	**1.0**
	Native, non-woody species comprise 75% to <100% of the dominants in one zone, and 75% to 100% in other zone if two are present. -OR- Dominants are 100% native in one zone and >50% to <75% in other zone.	**0.75**
	Native, non-woody species comprise 50% to <75% of the dominants in one zone, and 50% to <100% in other zone if two are present. **-OR-** **Native, non-woody species comprise 100% of the dominants in one zone and 25% to 50% in other zone.**	**0.5**
	Native, non-woody species comprise 25% to <50% of the %dominants in one zone, and 25% to <74% in other zone if two are present. **-OR-** **Native, non-woody species comprise 75% to <100% of the dominants in one zone and <25% in other zone.**	**0.25**
	Native, non-woody species comprise 0% to <25% of the dominants in one zone, and < 75% in second zone if two are present. **-OR-** **Lythrum salicaria (Purple Loosestrife) is among the dominant species.**	**0.1**
	Wetland is unvegetated.	**0.0**

Where to measure: Vsed

A representative site will be selected by scouting and measurements will be made in both the temporary and seasonal zone of the wetland. The percent of each zone which makes up the wetland will be recorded. This information will then be used to calculate the index for all or the portion of the wetland that is needed for the assessment.

A good question to ask is where is the runoff coming from? Is most of the runoff coming from an ephemeral drain or a steep slope? Is there a buffer? Most likely, within the wetland the sediment will be deepest along the outer edge of the temporary zone. Wind-deposited sediment is probably thickest on the northwest, west and south sides of the wetland. Other important items to consider are land use differences if they exist in the catchment area. On oval-shaped wetlands with the thickest sediment, deltas can often be seen on aerial photos or colored slides, especially if active deltas are forming.

Soil observations along wetland edge can be used to estimate the amount of sediment delivered. Over-thickened A horizons are excellent evidence but must be calibrated to local reference standard A horizon thickness'. Another method of assessing this variable is predictively using a simplified USLE approach. (Slopes and Land Use).

When to measure:

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

How and what to measure:

With the use of a spade(sharpshooter) take a vertical slice of soil to a depth of 16 inches or greater if sediment is expected. Examine in good sunlight. If sampling site is under water the use of a soil probe (preferably one with a 1.5" diameter coring tube) could be used to obtain a sample. In cases where the texture is coarse sand or coarser in texture, a probe may not work and an auger can be used. Sediment usually is harder to detect in an auger sample.

Preferred method:

a. Use a color difference in the dark colored A horizon to indicate sediment. If a slightly lighter color is found over a darker A horizon, this is an indicator of sediment. The thickness can be recorded as sediment delivered to the wetland when and if mixing by tillage is weighted.

b. If the suspected sediment feels more gritty than the underlying material, this can be an indicator of sediment. In this case, fines were removed by wind or water and the coarser material was blown or washed into the wetland, making the sediment feel more gritty.

Alternative Method:

a. If the thickness of the A horizon is used to indicate the thickness of sediment delivered to the wetland, this should be measured in the temporary zone. Some soils such as Rosewood have Bk horizons or limy layers, which are light colored, making the A and Bk horizon boundary abrupt and easy to see. Typically, Rosewood soils on the sand plain have A horizons that are 5 to 8 inches in thickness. Measuring the depth of the darker colored material over the limy layer and subtracting from 8 inches would be a method of determining sediment thickness(The use of the 8 inch depth allows for natural sedimentation not accelerated by man-made actions in or around the wetland, and also allows for some range in A horizon thickness). This is an indirect way and will not work well if the natural lower boundary does not have a contrasting abrupt boundary, but is gradual and diffuse, as which usually happens in the seasonal zone.

WHAT TO RECORD:

Thickness of sediment in temporary zone _____

Thickness of sediment in seasonal zone _____

Model Variable	Measurement or Condition	Index
V_{sed}: Sediment Delivered to Wetland **DEFINITION: Extent of sediment delivered to wetland from human disturbance sources, including agriculture.** **LOGIC:**	**No evidence of sediment delivery to wetland.**	**1.0**
	Representative sediment depth -- **in temporary zone – <4 inches** **in seasonal zone -- <2 inches**	**0.75**
	Representative sediment depth -- **in temporary zone – 4 to <6 inches** **in seasonal zone -- 2 to <7 inches**	**0.50**
	Representative sediment depth -- **in temporary zone – 6 to <10 inches** **in seasonal zone -- 7 to <12 inches**	**0.25**
	Representative sediment depth -- **in temporary zone – =>10 inches** **in seasonal zone -- =>12 inches** **-OR-** **Wetland filled but some basin remains** **-OR-** **A vegetation zone change(ie Shallow Marsh to Wet Meadow)**	**0.1**
	Basin filled and landscape depression is not evident from surface features.	**0.0**

Where to measure: Vdetritus

A representative site will be selected by scouting and measurements will be made in both the temporary and seasonal zone of the wetland. The percent of each zone which makes up the wetland will be recorded. This information will then be used to calculate the index for all or the portion of the wetland that is needed for the assessment.

When to measure:

These measurements can be taken at anytime during the assessment, but for efficiency it could be performed in conjunction with the delineation procedure or in conjunction with collecting the Vsorpt and Vsed variable measurements.

How and what to measure:

Preferred method:

1. **The index finger can be used to measure the thickness of detritus (undecomposed brown litter or dead plant material) and the thickness noted on the finger can be measured with a ruler and recorded. A slippery or smooth feeling on your finger tip indicates you have gone through the detritus layer. If finger method fails, use of probe or spade is an alternative described below.**

2. **Care should be taken not to compact the detritus and not to measure the current year's growth. Previous years' growth is what to measure. If different land uses exist in the assessment area, a number of measurements need to be taken and averaged to assign the representative condition of the wetland.**

3. **Measurement will be recorded in both the temporary and seasonal zones. Range given in thickness of detritus accounts for the seasonal variation.**

Alternate method:

1. **With the use of a spade(sharpshooter) take out a plug of soil deep enough to penetrate beyond the detrital layer. Account for disturbance by compaction, measure and record depth in inches to nearest 1/10 inch.**

2. **If sampling site is under water the use of a soil probe instead of a spade (preferably one with a 1.5" diameter coring tube) could be used to obtain a sample. Compare the cored samples to the detrital mass in the wetland. Coarse or fibrous material may slide around the probe tip. If the core samples do not match the source area, then use other sampling techniques.**

WHAT TO RECORD:

Representative Thickness of detritus in the Temporary Zone _____.
Representative Thickness of detritus in the Seasonal Zone _____.

Model Variable	Measurement or Condition	Index
$V_{detritus}$: Detritus **DEFINITION: The typical inter and intra-seasonal amount of dead plant material in several stages of decomposition.** **LOGIC:**	**Temporary Zone - .75 to 2.5 inches** **Seasonal Zone --- 2.25 to 6.25 inches**	**1.0**
	Temporary Zone - .5 to .75 inch -OR- >2.5inches **Seasonal Zone --- 1.5 to 2.25 inches -OR- >6.25 inches**	**0.75**
	Temporary Zone - .25 to .5 inches **Seasonal Zone --- .75 to 1.5 inches**	**0.5**
	Temporary Zone - .1 to .25 inches **Seasonal Zone --- .25 to .75 inches**	**0.25**
	Temporary Zone - >0 to .1 inches **Seasonal Zone --- >0 to .25 inches**	**0.1**
	Litter absent	**0.0**

BUFFER EVALUATION

The buffer area of a wetland is technically part of the upland and not the wetland. The measurement of conditions which become the index score are very subjective as definitive research on buffers and wetlands is not readily available. The indexing is based on common sense, limited literature and best professional judgment. Buffers around wetlands are seldom contiguous, of the same land use, or of uniform width. This is why the evaluator is allowed latitude in making a best professional judgment in index scoring the Vbuffer variable.

WHERE TO MEASURE

This will be an onsite field measurement. Width measurement is outward from the jurisdictional (1987 COE Manual) edge.

WHAT AND HOW TO MEASURE

As buffers are seldom continuous around a wetland edge in only one condition, the evaluator must use some discretionary judgment. This can be done by dividing the wetland and its buffer into pie wedges. Only perennial vegetation will be measured as acceptable buffer cover. Percent continuity and average buffer width will be determined along with the buffer condition. It will be easier to describe how much of the buffer is a particular width or a particular land use. The indexing can then be scored with some mental weighting. The evaluator may also want to consider the amount of watershed which would enter the wetland at a particular point.

EXAMPLE

Consider this simple example. If a wetland is cut off from part of its watershed, but immediately adjacent to a road, the buffer would only be the width of the road slope which would also be the entire watershed from that side. If the other half of the wetland buffer is conventional tillage cropland, and represents the side with dominant watershed contribution, it would be hard to score an index other than conventional tillage, buffer less than 3 feet wide. If the evaluator feels the road slope does play a significant part in wetland functions because it is not mowed or burned and the plants present represent native species, etc., then a somewhat higher index score may be justifiable.

WHEN TO MEASURE

Buffers will have some temporal variation during the year and judgment should be exercised regarding the time of year when measurements are being recorded. The evaluator will be looking for indicators of past use as well as current use. The concern is that buffer could be under-rated too early in the spring, before plants have had a chance to grow, or be credited too much if haying is not taken into consideration.

WHAT TO RECORD

PERCENT CONTINUITIY _____%

AVERAGE BUFFER WIDTH _____FEET

WEIGHTED BUFFER CONDITION_____.

Model Variable	Measurement or Condition	Index						
V_{buffer}: Buffer Zone DEFINITION: Land use condition and average width of the buffer zone adjacent to the wetland. LOGIC: Buffer Area = Average buffer width X % continuity	Vigorous Well managed grassland OR idle grassland	0	0.2	0.3	0.5	0.7	0.9	1.0
	Hayland OR average managed grassland where height is reduced	0	0.1	0.2	0.4	0.6	0.7	0.8
	Over-utilized OR poorly managed grassland No litter	0	0	0.2	0.3	0.4	0.5	0.6
	Alfalfa/Grass	0	0.1	0.1	0.2	0.3	0.3	0.4
	Alfalfa only	0	0	0.1	0.1	0.1	0.2	0.2
	Buffer Condition / Buffer Area	0 to 3	3 to 10	10 to 20	20 to 30	30 to 40	40 to 47	47 to 50

WHEN TO MEASURE: Vupuse
Information on present land use is needed to accurately measure and determine the condition of this variable. The land use within ¼ mile radius of the wetland boundary can be checked in the office from land use maps but will be determined in the field. The observation of some land use conditions vary by season and are subject to Best Professional Judgment during some time periods.

WHERE TO MEASURE:

The variable Vupuse refers to land use within ¼ mile of the wetland boundary. Dominant land use will be noted for area.

WHAT AND HOW TO MEASURE:

This variable considers a disturbance gradient from native prairie to hard surface parking lot. Type of tillage, cropping system, haying, level of grazing, bare ground and amount of native and non-native species present will need be observed. Thickness of sediment near the wetland edge may give a clue to past management of the adjacent upland.

Dominant land use will be noted in both the temporary and seasonal zone if they differ and as needed to measure or determine the condition of the wetland. Information on best management practices will be noted. The amount of disturbance compared to well- managed range land will assure an accurate measurement or assessment of this variable.

Upland land use categories considered in this variable are as follows:
-- Grazed ,proper utilization, somewhat over utilized and over utilized - dominance of native or non-native plant species
-- Permanent hay land
-- Idle grass land
-- Crop rotation and type of tillage
-- Other disturbances described(parking lot).

WHAT TO RECORD ON VARIABLE SCORE FIELD FORM

Dominant land use information_____

List Best Management Practices used_____ _____

Model Variable	Measurement or Condition	Index
V_{upuse}: Upland Land Use **Definition: Dominant land use or condition of the upland watershed that contributes to the wetland.** **Logic:**	**Native prairie managed to allow adequate plant recovery time between vegetation removal.**	**1.0**
	Dominated by non-native perennial species with fair management or better. **- OR -** **Native species managed under season long grazing** **- OR -** **Perennially idle grassland cover** **- OR -** **Permanent Hayland**	**0.75**
	Native or non-native species heavily over-grazed, some bare ground, low plant vigor **- OR -** **No-till continuous high-residue crop** **- OR -** **Minimum till high-residue crops in a grass/legume rotation**	**0.5**
	Native or non-native species heavily over-grazed, high amounts of bare ground, low plant vigor, and evidence of soil erosion **- OR -** **No-till row crop, minimum till small grain**	**0.25**
	Row crop or conventional tillage small grain	**0.1**
	Urban, semi-pervious, or impervious surface.(this condition will result in maximum overland flow; a high rate of delivery to wetland) If best management practices employed, the impact may be somewhat less.	**0.0**

WHEN TO MEASURE: Vwetuse

Information on past and present land use is needed to accurately measure and determine the condition of this variable. Past or historical land use within the wetland should be checked in the office by viewing current and old land use maps. Other avenues of information for determining past land use would be from the producer or owner of the tract of land. Current land use will be determined in the field. The observation of some conditions vary by season and are subject to Best Professional Judgment during some time periods.

WHERE TO MEASURE:

The variable Vwetuse refers to land use within the jurisdictional boundary of the wetland assessment area. Land use will be noted for both the temporary and seasonal zone if present.

WHAT AND HOW TO MEASURE:

This variable considers a disturbance gradient from native prairie to hard surface parking lot. Evidence of tillage in the past or present, and its impact in each zone may be needed. Frequency of haying, level of grazing, and evidence of compaction or ruts from machinery or livestock needs to be determined and recorded. The time in years of current and past land uses/changes, if available, can help explain condition. Examining the soil may reveal tillage layers in some cases. Also, the detrital biomass may be a clue to past use.

Land use will be noted in both the temporary and seasonal zone if they differ and as needed to measure or determine the condition of the wetland. Information on the amount of disturbance compared to well-managed range land will assure an accurate measurement or assessment of this variable.

Wetland land use categories considered in this variable are as follows:
-- Grazed; proper utilization, somewhat over-utilized, and heavily over-utilized
-- Hayed; Frequency and where
-- Idle
-- Small grains
-- Row crops
-- Other disturbances described (parking lot).

WHAT TO RECORD ON VARIABLE SCORE FIELD FORM

Land use & condition(s) in various years in temporary zone _____

Land use & condition(s) in various years in seasonal zone, if present_____

Model Variable	Measurement or Condition	Index
V_{wetuse}: Wetland Land Use **DEFINITION: Dominant land use and condition of the wetland.**	**No adverse impacts in the wetland, such as compaction, suppression of vegetation, or ruts resulting from activities such as tillage, grazing overuse , or untimely haying.**	**1.0**
	Adverse impacts are present but slight, such as: **Grazing use of seasonal wetland is excessive in temporary zone and proper in seasonal zone** **- OR -** **Temporary wetland plants exhibit overuse.** **- OR -** **Haying has been untimely or excessive, causing ruts, compaction, or reduced stand vigor.**	**0.75**
	Adverse impacts are moderate, such as: **Grazing use of seasonal wetland is excessive in temporary & seasonal zones** **- OR -** **Temporary wetland is heavily overused.** **- OR -** **Seasonal wetland with frequently tilled temporary zone and seasonal zone is mostly perennial vegetation properly managed or idle.** **- OR -** **Temporary wetland is seldom tilled; idle > 3 years out of 4.**	**0.50**
	Adverse impacts are severe, such as: **Temporary zone is tilled most years and seasonal zone is cultivated occasionally, or a temporary wetland is tilled most years but has significant vegetative growth.**	**0.25**
	Adverse impacts are extreme such as feedlot, stockpond dominating the wetland, or wetland is mostly filled.	**0.1**
	Wetland is impervious: (i.e. pavement or asphalt) Restoration is not practical.	**0.0**

VI . Appendix1

A. Comments on Variables

Vhydalt: **All hydrology values except Vsource have been incorporated into the variable Vhydalt. This variable could be split into 2 variables; one to cover surface outlet and filling of the wetland and the other to cover removal of the saturation by Vsubout (tile) adjusted to the proper spacing**

Vsorpt: **The V_{sorpt} variable is being developed for the Interim HGM Model on depressions in the Lake Dakota Sand Plains. As defined, this variable is applied to the A horizon or upper 6 inches of the soil.**

At this time the soils considered are the Rosewood, Venlo, Fossum and Hamar series that are hydric. Other states interested in using this Model are South Dakota and Nebraska. Colors and Organic Matter Levels will need to be checked and adapted as this is applied in the field.

Soil pH is also an indicator of sorptive capacity of soils. May need to develop as a primary indicator, but probably is not easily enough done in a routine Functional Assessment.

Access to and the ability to query the North Dakota Laboratory Data computer database would add credibility and improve the refinement of this variable. Awaiting development of this ability at this time. Other states with Laboratory Data would be of help in adapting these indicators.

The uniformity or pureness of color as described by the salt and pepper effect for the sandy soils is a clue to the organic matter levels of these sandy soils and also to some degree in the loamy and silty textured soils. A change in pureness of color may not be described by color chip, but can be seen with the naked eye. This was noticed when comparing older(10+ years) no-till and grassland soils to annually tilled and cultivated cropland soils.

Ideally, a color index such as the one developed by Illinois would greatly facilitate the use of this variable in the field for sandy hydric soils.

A field method of measuring Soil Organic Matter(SOM) is being looked into. This would allow a quick way to assess SOM in the field for this variable and may provide for more index categories for the Sand Plain Interim Model.

Vdetritus: **The measurement standard for this variable will likely change as this interim model is tested and applied further south. The detritus thickness will likely decrease, and when thickness of a reference standard is established, it can be applied in the following variable.**

Model Variable	Measurement or Condition	Index
$V_{detritus}$: Detritus **DEFINITION: The typical inter and intra-seasonal amount of dead plant material in several stages of decomposition.** **LOGIC:**	**75% to 125% of reference standard**	**1.0**
	50% to 75% or >125% of reference standard	**0.75**
	25% to 75% of reference standard	**0.5**
	Litter layer 10% to 25% of reference standard.	**0.25**
	Litter layer >0% to 10% of reference standard.	**0.1**
	Litter absent	**0.0**
	(Note: Reference Standard for the _____Area is ___ to ___ inches in the Temporary Zone and ___to ___ inches in the Seasonal Zone.)	

Vpcover: This variable should measure the amount of living plant matter present on the wetland throughout the growing season and the following dormant season, scaled in comparison to pre-European influence. Vpcover should also be scaled according to the duration of the vegetative cover. The emphasis should probably be on the growing season, when plants trap solar energy, transpire water, produce biomass, and grow roots that enhance soil porosity & organic matter content.

NRCS native hayland production data is a good measure of vegetative production on non-cultivated wetlands; however, it does not address the temporal gaps that are typical of vegetative cover on cropped wetlands.

Vpratio: This variable is currently scaled to measure only the ratio of native to non-native species in a wetland. The variable needs to serve as a better measure of the quality of the plant community. Three other qualitative factors should also be addressed by the variable: The variable should be scaled to reflect the proportion of the desired species present, similar to the rangeland condition rating system. The variable scaling should also distinguish between invasive, early-succession species and late-succession species. The variable should also address the total diversity of the wetland plant community.

FUTURE MEASUREMENT METHOD: Databases will probably be developed that will enable the computer to determine the Vpratio index score, based on the plant survey done by the assessor. Extensive species surveys would provide a better resource assessment.

Floristic Quality Index (FQI) is a system of evaluating plant communities that may be suitable to replace the current Vpratio index condition or rating categories. FQI will be evaluated along with data from a study of 240 northern prairie potholes that was conducted in 1997.

Vwpairs

For areas where Duck Breeding Pair Maps are not available, alternative variables are available for the "MAINTENANCE OF HABITAT INTERSPERSION AND CONNECTIVITY AMONG WETLANDS" function. The following four variables may be substituted for the Vwpairs variable if measurements are checked and adapted to the domain being applied.

The ¼ or 1 mile radius is inscribed from the center of the assessed wetland; however, if the center radius does not seem appropriate due to wetland size or shape, inscribe the radius from the edge of the assessed wetland.

Vwdistance

The measurement of this variable is the distance in feet from the assessed wetland to the nearest semi-permanent or wetter wetland in any direction, measured edge to edge. When verifying office data, note any changes that affect the measurement of the nearest semi-permanent or wetter wetland. If changes are made based on field observation, make adjustments to measurement of this variable.

Vwdistribution

The measurement of this variable is the similarity of the assessed wetlands distribution on the landscape compared to the well-distributed complex that is typical of natural conditions within a 1 mile radius of the assessed wetland's center. When verifying office data, note any changes that affect the measurement of this variable. If changes are made based on field observation, make adjustments to measurement of this variable.

Vwdiversity

The measurement of this variable is the diversity of wetland water regimes within a ¼ mile radius of the center of the assessed wetland. When verifying office data, note any changes that affect the measurement of the diversity. If changes are made based on field observation, make adjustments to measurement of this variable.

Vwlandscape

The measurement of this variable is the percent of the landscape, within a mile radius of the center, of the assessed wetland that is native prairie and/or other perennial vegetation which is managed for primary or secondary wildlife use. When verifying office data, note any changes in permanent vegetation or management. If changes are made based on field observation, make adjustments to measurement of this variable.

Where to measure: Vwdistance

The distance from the edge of the assessed wetland to the nearest semi-permanent or wetter wetland in the landscape is captured by this variable. The measurements are made from the boundary edge of the wetland being assessed to the nearest boundary edge of the semi-permanent or wetter wetland in any direction in the landscape.

When to measure:

Distance measurements for this variable can be made while gathering the data for Vwbasin, Vsource, Vhydalt, Vwlandscape. Vwdistribution and Vwdiversity. The initial measurement is easily done in the office and verified in the field.

How and what to measure:

Identify the assessed wetland on NWI and/or FSA wetland inventory maps. On a scaled map, measure the edge-to-edge distance between the assessed wetland and the closest semi-permanent or wetter wetland found in any direction. Record the distances in feet.

WHAT TO RECORD:

Distance to the nearest semi-permanent or wetter wetland _____.

Model Variable	Measurement or Condition	Index
$V_{wdistance}$: Distance to Semi-permanent or Wetter DEFINITION: The distance from the edge of the assessed wetland to the nearest semi-permanent or wetter wetland, in feet. LOGIC:	Less than 660 feet (less than 1/8 mile)	1.0
	660 feet to 1320 feet.(between 1/8 to1/4 mile)	0.75
	1320 feet to 2640 feet.(between ¼ to ½ mile)	0.5
	2640 feet to 5280 feet.(between ½ to 1 mile)	0.25
	5280 feet to 10540 feet.(between 1 to 2 miles)	0.1
	>10540 feet. (greater than 2 miles)	0.0

Where to measure: Vwdistribution

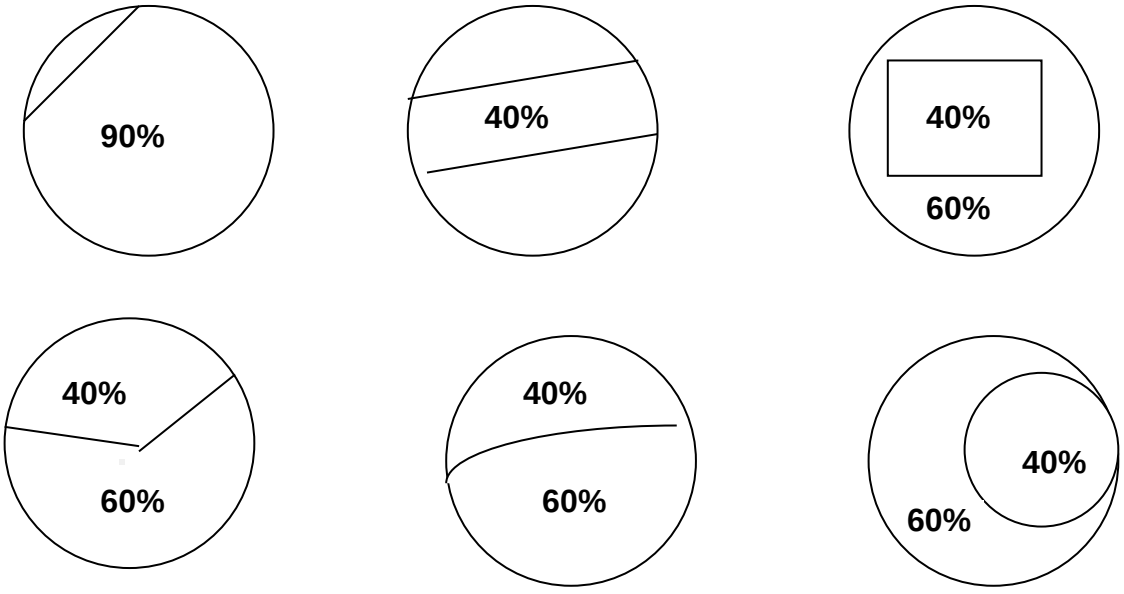
The measurement of this variable is the similarity of the wetland distribution on the assessed landscape, within a 1 mile radius of the assessed wetland's center, compared to the well distributed complex that reflects high quality habitat conditions.

When to measure:

Measurements for this variable can be made while gathering the data for Vwbasin, Vsource, Vhydalt, Vwlandscape. Vwdistance and Vwdiversity. The initial measurement is easily done in the office, but field verification is needed.

How and what to measure:

Use the NWI and/or FSA wetland maps to locate the assessed wetland and inscribe a circle scaled to a 1 mile radius around its center. Visually estimate the size of a contiguous block where wetlands are present or absent within the 1 mile radius on the map. Map work observations will need to be verified in the field.



WHAT TO RECORD:

Percent of contiguous area within a 1 mile radius that has a presence or absence of wetlands.

Presence _____. Absence _____.

Model Variable	Measurement or Condition	Index
$V_{wdistribution}$: Wetland Distribution on the Landscape **DEFINITION: A measure of the similarity of the wetland distribution on the assessed wetland's landscape compared to the well-distributed complex that reflects high quality habitat.** **LOGIC:**	**Wetlands within a mile radius are present on an area comprising a contiguous block of > 60%.** **-OR-** **Wetlands within a mile radius are absent on an area comprising a contiguous block of < 40%.**	**1.0**
	Wetlands within a mile radius are present on an area comprising a contiguous block of 10 to 60%. **-OR-** **Wetlands within a mile radius are absent on an area comprising a contiguous block of 40 to 90%.**	**0.5**
	Wetlands within a mile radius are concentrated within a block that comprises less than 10% of the area.	**0.1**
	No other wetlands present within the mile radius of evaluated area.	**0.0**

Where to measure: Vwdiversity

The measurement of this variable is the diversity of Palustrine wetland water regimes (Cowardin Classification System) within a ¼ mile radius of the assessed wetland.

When to measure:

Measurements for this variable can be made while gathering the data for Vwbasin, Vsource, Vhydalt, Vwlandscape, Vwdistance and Vwdistribution. The initial measurement is easily done in the office, but field verification should be done.

How and what to measure:

Use the NWI maps to locate the assessed wetland and inscribe a circle scaled to a ¼ mile radius. Visually observe and record the different water regimes (Palustrine – Cowardin Classification System Classes) present within the ¼ mile radius. Consult with the FSA Wetland Inventory Map for wetlands currently present on the landscape and verify in the field.

WHAT TO RECORD:

List the different wetland water regimes present. _____.

Model Variable	Measurement or Condition	Index
$V_{wdiversity}$: Diversity of Wetland Water Regimes **DEFINITION: A measure of the diversity of wetland water regimes found within ¼ mile radius of the center of the assessed wetland. (i.e., PEMA, PEMC, PEMF).** **LOGIC:**	**Temporary, seasonal and semi-permanent or wetter present. (PEMA, PEMC and PEMFor PABF)**	**1.0**
	Temporary and semi-permanent or wetter present -OR- Seasonal and semi-permanent or wetter present	**0.75**
	Temporary and seasonal present	**0.5**
	Only seasonal present -OR- Only semipermanent or wetter present	**0.25**
	Only temporary present	**0.1**
	No wetlands present	**0.0**

Where to Measure: Vwlandscape

The measurement of this variable is the percent of the landscape within a mile radius of the center of the assessed wetland that is native prairie and other perennial vegetation which is managed for primary or secondary wildlife use.

When to Measure:

This variable is most conveniently measured in the office using recent aerial photography. A land use or recent soil map may provide the needed land use information. Verify the land use in the field. This measurement can be made while gathering the data for Vwbasin, Vsource, Vhydalt, Vwdistance, Vwdistribution and Vwdiversity

How and What to Measure:

Use a recent land use map, soil map or NWI map to locate the assessed wetland and draw a circle scaled to a 1 mile radius around its center. Measure the acreage of native prairie plus other perennial vegetation that is managed for primary or secondary wildlife use. This percentage can be estimated except where there is some doubt about which index category best represents the area, then use a dot counter or planimeter to measure the area.

What to Record: **Measurement(s):**

Percent of native prairie or other perennial vegetation that is managed for primary or secondary wildlife use _____.

MAINTENANCE OF HABITAT INTERSPERSION AND CONNECTIVITY AMONG WETLANDS		
Model Variable	**Measurement or Condition**	**Index**
$V_{wlandscape}$: Perennial Vegetation in the Landscape **DEFINITION: The native prairie and other perennial vegetation that is managed for primary or secondary wildlife use present within a mile radius of the center of the assessed wetland.** **LOGIC:**	**Landscape surrounding the wetland is >75% percent native prairie or other perennial vegetation that is managed for primary or secondary wildlife use.**	**1.0**
	Landscape surrounding the wetland is 25 to 75% percent native prairie or other perennial vegetation that is managed for primary or secondary wildlife use.	**0.50**
	Landscape surrounding the wetland is 10 to 25% percent native prairie or other perennial vegetation that is managed for primary or secondary wildlife use.	**0.25**
	Landscape surrounding the wetland is made up of <10% annual plants or perennial vegetation that is managed for primary or secondary wildlife use.	**0.1**

The preceding variables of Vwdistance, Vwdistribution, Vwdiversity and Vwlandscape can be substituted for Vwpairs using the following formula.

Vwpairs = (Vwdistance + Vwdistribution + Vwdiversity + Vwlandscape)/4

B. Field Forms for Data Collection for Functional Assessment

1. **Table A-1 Variable Score Field From**
    a. **Stored file(Variascoreff) on floppy disk in Word 7.0**
2. **Table A-2 Functional Score Field From**
    a. **Stored file (Funcscoreff) on floppy disk in Word 7.0**
3. **Table A-3 Variable Data Worksheet**
    a. **Stored file (Variadataw) on floppy disk in Excel 7.0**
4. **Table A-4 Comparison of Wetland Assessment Area and the Mitigation Area**
    a. **Stored file (MITCHART) on floppy disk in Word 7.0**
5. **Table A-5 Relationship of Variables to Wetland Function for Sand Plain Wetlands**
    a. **Stored file (Prioritychart) on floppy disk in Excel 7.0**

C. Explanation of Files Stored on the Computer Disk

1. Readme.doc

a. Contains an explanation of the following files on the floppy disk.

2. Sand Plain HGM Interim Model.doc

a. This file is in Word 7.0 format, and was developed in Windows 95

b. This file is a copy of the Sand Plain HGM Interim Model. It provides model rationale, function, variable and indicator descriptions for functional assessment of the wetlands on the Sand plains of Lake Dakota in North and South Dakota and adjacent sand plains in North Dakota.

3. The following three files were developed in Windows-95 Msoffice -95. These three files were developed together and when stored in correct directories will write information to a database format when saving.

a. Sand Plain HGM.xls

-This file is in Excel 7.0 format and should be downloaded into C:\Windows\Personal\sandplain directory unless otherwise adapted.

-This file was used to develop the template which is linked to the access database file.

b. Sand Plain HGM.xlt

-This file is in Excel 7.0 format and should be downloaded into C:\Msoffice\Templates directory unless otherwise adapted

-This template file is used to enter data and upon saving will write data to the linked access database file.

c. Sand Plain HGM Database.mdb

-This file is in Access 7.0 format and should be downloaded into C:\Windows\Personal\sandplain directory unless adapted.

-The data stored in this Access file can be easily transferred to a database file in UNIX.

4. Variascoreff.doc

-This file is in word 7.0 on floppy disk

-This is a field form which can be used to record the Variable score.

5. Funcscoreff.doc

-This file is in word 7.0 on floppy disk.

-This is a field form which can be used to record Functional Score.

6. **Variadataw.xls**

   -This file is in Excel 7.0 on floppy disk.

   -This is a field form which can be used to record pre- and post-activity for wetland functional scoring for more than one wetland along with the corresponding wetland acreage.

7. **MITCHART.doc**

   -This file is in word 7.0 on floppy disk.

8. **HGM Sand Plain.wk1**

   -This file is in LOTUS 1-2-3 wk1 on floppy disk.

   -This file can be used to enter information to calculate Functional Capacity Indexes, Function Capacity Units and Minimal Effects.

   -Also included is an example format to calculate Time/Delay Ratios which is included for use in Mitigation.

D. Literature Cited (Existing literature about this model in addition to citations in Northern Prairie Pothole HGM Model)

Water Resources #18 by ND State Water Commission

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Schulze, Nagel, Van Scoyoc, Henderson, Baumgardner. 1993. Significance of Organic Matter in Determining Soil Colors. SSSA Special Publication no. 31 71-90

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Derby, N. E., Knighton R. E. and Steele D. D. 1994. Temporal and Spatial Distribution of Nitrate Nitrogen Under Best Management Practices http//www.soilsci.ndsu.nodak.edu/papers/1994_nd

Hopkins, David Glenn, Ph.D., Department of Soil Science, College of Agriculture, North Dakota State University, February 1997. Hydrologic and abiotic constraints on soil genesis and natural vegetation patterns in the sandhills of North Dakota. Ph.D. Thesis.

A USGS – Northern Prairie Wildlife Research Center survey of prairie pothole wetlands conducted in 1997 is unpublished.

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