Comprehensive General Guidance

for
Minnesota Routine Assessment Method (MnRAM)
Evaluating Wetland Function, Version 3.4 (beta)

9/15/2010

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1.0 Introduction to MnRAM

1.1 History

The Minnesota Routine Assessment Method (MnRAM) for Evaluating Wetland Functions originally was devised soon after the passage of the Wetland Conservation Act (WCA) in 1991. An interagency wetland workgroup sought to fill the need for a practical assessment tool that would help local authorities make sound wetland management decisions as they assumed responsibility for regulating wetland impacts.

Although the original version was soon updated to MnRAM Version 2.0 (in 1998), the fundamental approach of applying descriptive rather than numeric ratings was maintained. In subsequent years, development of heavily quantitative methods on the national level and demand for a more refined procedure on the local level led to the formation of another workgroup in January 2002. Starting with both the MnRAM Version 2.0 and a database version sponsored by an EPA grant, the workgroup examined every function, question by question, with the goal of developing a numeric model.

1.2 Functions and Values

Because land use decisions involving wetlands typically consider both functions and values, MnRAM has always included some value-related questions. Although a primary focus in this version of MnRAM is on the functional aspect of wetlands, some strictly value-related aspects are included, such as "Aesthetics" and "Commercial Uses." Value-related considerations are incorporated into some of other evaluated functions, as well. WCA Rules Chapter 8420.0103 sets out the functions and public values that are to be considered; these include public recreation and education.

1.3 User Advisories

MnRAM provides an organized, consistent procedure to document observations and conclusions about wetland processes. It is a systematic way of documenting best professional judgment. MnRAM would be considered a Tier 2 assessment methodology, a rapid assessment method. MnRAM is intended for routine planning and inventory applications as well as for project-specific evaluations. Using it requires experience and training in wetland science, since professional judgment is incorporated in several questions.

Current scientific understanding of wetlands and indicators limits our ability to predict which wetlands are ecologically sound; other limiting factors include time, expertise, and training of the people performing the evaluation. For more difficult or controversial sites, it is recommended that a diverse team of professionals conduct the evaluation together or that other more detailed assessment methods be considered.

A preliminary review of reference material such as soil data, topography, watersheds, inlets, outlets, land uses, aerial photographs, and other information is recommended prior to assessing a wetland. Establishing the history and setting of the wetland under evaluation will speed the field assessment. Questions that can potentially be answered utilizing other information sources, maps in the office, or digital data in a Geographic Information System (GIS) are marked with a "~" in the margin (in the printed version) or in red text (in the digital format). With training, practice, and experience, the fieldwork for an evaluation of a small wetland (< 1 acre), under

normal circumstances (assuming background information regarding topography, watersheds, inlets and outlets, land use, etc. has been previously gathered) in an area familiar to the evaluator(s) can be completed in less than one hour.

Wetland assessments using this methodology cannot be conducted without a site visit. Even with photos, maps, and written notes, questions will arise that should only be answered at the site. Bringing the database into the field on a laptop will prove to be the most efficient way to document wetland conditions. For uncomplicated sites, paper score sheets are available which correspond to a Microsoft Excel™ spreadsheet containing the formulas for computing the functional indices. Immediate field data-entry reduces the potential for interpretation and data-entry errors compared to gathering data in the field and trying to translate that into an assessment later.

1.4 Assessment Sites

This assessment method is intended to be applied to existing wetlands or potential restoration sites. If evaluating a wetland to determine the functions based on some projected conditions, it is necessary to assess the current status of the wetland/basin, as well. See Section 1.11 for more about using MnRAM for regulatory purposes.

1.5 MnRAM Database

The full MnRAM methodology has been programmed into a Microsoft Access™ database within which all data can be entered and stored. The database computes each functional indices using a formula. One of the fundamental benefits of a database program and this methodology in particular is that information is tabulated and stored for each of the 72 wetland parameters evaluated as well as the wetland location, other general information, and computed functional indices. The database can store records for multiple wetlands, grouped into projects or kept individually available. Wetland data can then easily be compiled into a single, central database. In addition, the database allows for the ability to analyze individual pieces of data for selected groups of wetlands or all wetlands within the database or to evaluate groups of parameters on groups of wetlands. Flexibility for conducting analyses is one of the most powerful aspects of this methodology.

1.6 Wetland Ranking

MnRAM uses numeric ranking; great care should be taken to use the results in light of local conditions and based on a landscape-level management plan. People, not the assessment, will decide what combination of functions are the most important. Each wetland is part of an integrated ecological system that should not be thought of as a group of distinct packages, but really an assemblage of interactive elements.

1.7 Wetland Management Classification

Determining the relative value of each function is an activity that must take place after the assessment is complete, in a management and planning context. A basic framework for applying wetland functions and values information to management is supplied in an associated document entitled "Management Classification." This is one basic method of applying the results of a complete assessment of wetlands within a defined management area (e.g. watershed, city, county, etc.) where the wetland functions are the basis for various management strategies.

Standards are suggested that could be applied to meet the general goals of each classification level.

The management classification includes an approach for dealing with watersheds that have few high-quality wetlands remaining. In short, if the best wetlands in an area rate "Medium" using MnRAM, an adjustment of the scale for ranking wetlands is imperative. These policy-based decisions are discussed in the management classification document.

For ease of use, both the "classic" and "increased protection" Management Classification results are shown on the summary page of the database. Other options for using the data, or for modifying the management classification scheme, are possible. Landscape differences, local values, and community preferences will guide the final determination for how the data collected via MnRAM are used.

1.8 Reference Standard Wetlands

Reference standard wetlands were defined in MnRAM 2.0 as those judged to have the highest level of overall sustainable functional capacity for that type in the Wetland Comparison Domain. In that method, the wetland under investigation was to have been compared to the reference wetland before the evaluation took place.

In the later versions of MnRAM, it is not necessary to have pre-established physical reference standard wetlands. As an assessment tool, MnRAM may be part of an initial effort to inventory local wetlands and establish such reference sites. A subject wetland will fall into place on a watershed-based ranking after many wetlands have been evaluated. Only in comparison with these compiled results will planning watershed priorities be possible.

1.9 Functional Ratings

MnRAM was developed using the concept of ideal theoretical, pre-European-settlement wetland condition as the baseline. In highly urban or agricultural watersheds, few basins may fall into the High category. Local authorities will need to take this into account when establishing a scale for management decisions (see "Wetland Management Classification," above).

Each wetland function will be rated with a numeric index according to the formulas or decision trees accompanying this methodology. The scoring system is from 0.001 to 1.0 signifying low to high[1], respectively; in the instances where an exceptional rating applies, a score of 2 accentuates the rarity. For yes-no questions, yes will receive a score of 1 and no will receive a score of zero*. Each wetland function then receives an index score with ratings as follows:

Functional Ratings	Question Score	Functional Index Score
• **Exceptional:**	**2.0**	**1.01 - 2.00**
• **High:**	**1.0**	**0.66 - 1.00**
• **Medium:**	**0.5**	**0.33 - 0.65**
• **Low:**	**0.1**	**0.001 - 0.32**
• **Not Applicable:**	**N/A**	**0.0**

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[1] Ammann and Stone, 1991

* Some questions worded yes-no are actually yes-not applicable; use caution when scoring by hand.

MnRAM includes numeric as well as general ratings. The numeric ratings are based on standardized formulas to achieve consistency among users and are, in effect, placeholders for the general rating categories of exceptional, high, medium, and low. Great care should be taken when interpreting the results. In particular, the general and numeric ratings should not be summed or averaged across different functions (or for different wetlands). Mixing the ratings of disparate functions (or different wetlands) can be misleading if not meaningless. The primary intent of MnRAM is to provide a function-by-function rating for individual wetlands (or plant communities). See discussion below regarding comparison of different wetlands.

1.10 Comparison of Two or More Wetlands

The optimum method of comparison using MnRAM ratings is that between wetland plant communities of the same type ("apples to apples") where a reference standard wetland is used. "Wetland type" refers to the wetland plant communities described in MnRAM.[2] A reference standard wetland includes the highest functioning example(s) of a specific plant community within a watershed or ecoregion. It serves as the baseline for comparing the MnRAM ratings among examples of the same plant community. For example, the reference standard hardwood swamp may have four high, two medium, and two low ratings while the hardwood swamp within a particular project site may have two medium and six low ratings. Or, if a particular function(s) is of most concern, the MnRAM rating for that specific function can be compared between examples of the same plant community within the study area.

Comparisons between examples of the same plant community type can be valid without a reference standard wetland. Because there is no baseline for the highest functioning example of a particular wetland plant community type, care must be taken to place the subject wetland in the proper context. For example, all the sedge meadows within an agricultural site may be lower functioning due to agricultural impacts, while all the sedge meadows within a northern Minnesota site may be high functioning because of the lack of disturbances.

Comparisons of function-by-function MnRAM ratings between different wetland plant community types ("apples to oranges") are problematic because different wetland plant community types function differently. Not all wetlands are flow-through wetlands, or shoreland wetlands, or provide fish habitat, or support amphibians, or have a woody canopy. While some functions are provided by nearly all wetlands, the process and intensity of those functions can be different among different plant community types. Great care is advised when drawing conclusions from "apples to oranges" comparisons. The greater the disparity between wetland plant community types, the less valid the comparison becomes. Comparing the functional levels of, for example, a precipitation-driven bog versus a floodplain forest is of little utility.

For planning purposes, the wetland function(s) of greatest concern in a particular study area could be identified. MnRAM analyses could then identify those wetlands ranked exceptional or high for that function(s).

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[2] Further refinement of this approach is to define "wetland type" as the wetland plant community + HGM classification (e.g., depressional, slope, lacustrine fringe, organic flat). For example, sedge meadow communities on slopes may have a different water source and hydroperiod than those in depressions.

1.11 Uses of MnRAM for Regulatory Purposes

MnRAM is a qualitative approach to identifying wetland functions. Because the input is qualitative the output is qualitative. Therefore, MnRAM ratings should not be used to <u>quantify</u> impacts or compensatory mitigation.

Evaluating the pre- and post-project condition of a particular wetland is often part of the regulatory process. Be advised that MnRAM is typically not sensitive enough to show changes in the functional ratings that are commensurate with the differences between pre- and post-project conditions.

Determining general compensatory mitigation needs based on a MnRAM analysis of a wetland that is proposed to be impacted is appropriate for regulatory purposes. For example, if the wetland to be impacted has four high ratings and four medium ratings, the focus of the compensation would be to design and establish compensation that replaces those specific high and medium functional ratings. This is a qualitative measure, not a quantitative one.

MnRAM has four options for the vegetative diversity/integrity function ranging from individual ratings for each plant community to averaging the ratings of two or more plant communities. For regulatory purposes, the individual rating for vegetative diversity/ integrity should be used (unless all of the plant communities have the same rating for this function). Averaging high and low ratings, for example, yields a medium rating that obscures the presence of the high-rated plant community. Averaging is not appropriate because the high-rated plant community may prompt important regulatory considerations such as avoidance or special consideration for compensatory mitigation. A second option for the vegetative diversity/integrity function— highest-rated plant community—is also appropriate for regulatory purposes.

1.12 Wetland functions/value characteristics evaluated:

1. Maintenance of Characteristic Vegetative Diversity/Integrity
2. Maintenance of Hydrologic Regime
3. Flood/Stormwater Attenuation
4. Downstream Water Quality
5. Maintenance of Wetland Water Quality
6. Shoreline Protection
7. Maintenance of Characteristic Wildlife Habitat Structure
8. Maintenance of Characteristic Fish Habitat
9. Maintenance of Characteristic Amphibian Habitat
10. Aesthetics/Recreation/Education/Cultural
11. Commercial Uses
12. Ground Water Interaction

<u>Additional Evaluation Information</u>
1. Restoration Potential
2. Sensitivity to Stormwater & Urban Development
3. Additional Stormwater Treatment Needs

Each characteristic is described in more detail in the Formulas section.

2.0 Wetland Classification Systems

This section summarizes methods that can be utilized to classify wetland resources. The last part of this section describes critical wetland resource designations.

2.1 Dominant Vegetation

Identify and record the dominant plant species within each plant community using the 50/20 Rule[3], along with rare, endangered, or threatened species. For each plant species, record the scientific name, common name, typical stratum, and regional indicator status[4] for each wetland; preferably these should be stored in the project Microsoft® Access database. The definitions of hydrologic indicator status are:

OBL: Obligate Wetland Plants occur almost always (estimated probability >99%) in wetlands under natural conditions, but may also occur rarely (estimated probability <1%) in nonwetlands.

FACW: Facultative Wetland Plants occur usually (estimated probability 67% to 99%) in wetlands, but also occur (estimated probability 1% to 33%) in nonwetlands.

FAC: Facultative Plants have a similar likelihood (estimated probability 33% to 67%) of occurring in both wetlands and nonwetlands.

FACU: Facultative Upland Plants occur sometimes (estimated probability 1% to 33%) in wetlands, but occur more often (estimated probability >67% to 99%) in nonwetlands.

UPL: Obligate Upland Plants occur rarely (estimated <1%) in wetlands, but occur almost always (estimated probability >99%) in nonwetlands under natural conditions.

Note: Categories were originally developed and defined by the USFWS National Wetlands Inventory. Regional panels assigned the indicator status for individual plant species. The three facultative categories are subdivided by (+) and (-) modifiers.

2.2 Topographic Setting

Classify each inventoried wetland by its topographic setting[5] based on a field evaluation and review of available stormwater infrastructure data:

> **Floodplain**: (8420.0110, subp. 19) A floodplain wetland is a wetland located in the floodplain of a watercourse, with no well defined inlets or outlets, including tile systems, ditches, or natural watercourses. This may include the floodplain itself when it exhibits wetland characteristics.

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[3] The 50/20 Rule, detailed in the 1987 Corps of Engineers Wetland Delineation Manual, describes a method of considering dominance within each stratum. All dominants are treated equally in characterizing the plant community to determine whether hydrophytic vegetation is present. The most abundant plant species (when ranked in descending order of abundance and cumulatively totaled) that immediately exceed 50 percent of the total dominance measure for a given stratum, plus any additional species comprising 20 percent or more of the total dominance measure for that stratum are considered dominant species for the stratum. Dominance measures include percent areal coverage and basal area, for example.

[4] in accordance with *The National List of Plant Species that Occur in Wetlands* (Reed, 1988).

[5] as defined in Minnesota Rules Chapter 8420.0110 (Wetland Conservation Act).

Flow-through: (8420.0110, subp. 20) A flow-through wetland has a well-defined outlet and one or more well defined inlets.

Isolated: (8420.0110, subp. 28) An isolated wetland is without a well-defined inlet or outlet.

Riverine: (8420.0110, subp. 43) A riverine wetland is a wetland contained in the banks of a channel that may contain moving water or that forms a connecting link between two bodies of standing water.

Shoreland: (8420.0110, subp. 44a) A shoreland wetland is a wetland located along the shoreline of a lake or edge of a deepwater habitat.

Tributary: (8420.0110, subp. 48) A tributary wetland has a well-defined outlet but is lacking a defined inlet.

Other: A wetland that does not fit into one of the three previously mentioned groups.

2.3 Circular 39

The *Wetlands of the United States* was published in 1959 by the U.S. Fish and Wildlife Service and is commonly referred to as "Circular 39"[6]. The Circular 39 Classification System was the first method that the U.S. Fish and Wildlife Service used to classify wetland basins in the U.S. It is composed of 20 wetland types of which eight are found in Minnesota. Wetland plant community types and some common vegetation found in each wetland type are provided in Table 2.1. A general description of each wetland type is provided below.

2.3.1   TYPE 1: SEASONALLY FLOODED BASIN, FLOODPLAIN FOREST

Soil is covered with water or is waterlogged during variable seasonal periods, but usually is well-drained during much of the growing season. This wetland type is found both in upland depressions and in overflow bottomlands. In uplands, basins or flats may be filled with water during periods of heavy rain or melting snow.

Vegetation varies greatly according to season and duration of flooding: from bottomland hardwoods to herbaceous plants. Where the water has receded early in the growing season, smartweeds, wild millet, fall panicum, chufa, various amaranths and other plants (i.e. marsh elder, ragweed, and cockleburs) are likely to occur. Shallow basins that are submerged only very temporarily usually develop little or no wetland vegetation.

2.3.2   TYPE 2: WET MEADOW, FRESH WET MEADOW, WET TO WET-MESIC PRAIRIE, SEDGE MEADOW, AND CALCAREOUS FEN

Soil is usually without standing water during most of the growing season, but is waterlogged within at least a few inches of the surface. Meadows may fill shallow basins, sloughs, or farmland sags, or these meadows may border shallow marshes on the landward side. Vegetation includes grasses, sedges, rushes and various broad-leaved plants. Common representative plants are *Carex* sp. (sedges), *Juncus* sp. (rushes), redtop, reed grasses, manna grasses, prairie cordgrass, and mints. Other wetland plant community types include low prairies, sedge meadows, and calcareous fens.

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[6] Shaw and Fredine, 1959

2.3.3   TYPE 3: SHALLOW MARSH

Soil is usually waterlogged early during the growing season and may often be covered with as much as 6 inches or more of water. These marshes may nearly fill shallow lake basins or sloughs, or may border deep marshes on the landward side. These are common as seep areas on irrigated lands. Vegetation includes grasses, bulrushes, spikerushes, and various other marsh plants such as cattails, arrowhead, pickerelweed, and smartweeds. Common representatives are reed, whitetop, rice cutgrass, *Carex*, and giant burreed.

2.3.4   TYPE 4: DEEP MARSH

Soil is usually covered with 6 inches to 3 feet or more of water during the growing season. These deep marshes may completely fill shallow lake basins, potholes, limestone sinks and sloughs, or they may border open water in such depressions. Vegetation includes cattails, reeds, bulrushes, spikerushes and wild rice. In open areas, pondweeds, naiads, coontail, watermilfoils, waterweeds, duckweed, water lilies, or spatterdocks may occur.

2.3.5   TYPE 5: SHALLOW OPEN WATER

Shallow ponds and reservoirs are included in this type. Water is usually less than 10 feet deep and is fringed by a border of emergent vegetation similar to open areas of Type 4. Vegetation (mainly at water depths less than 6 feet), includes pondweeds, naiads, wild celery, coontail, watermilfoils, muskgrass, waterlilies, and spatterdocks.

2.3.6   TYPE 6: SHRUB SWAMP; SHRUB CARR, ALDER THICKET

The soil is usually waterlogged during the growing season and is often covered with as much as 6 inches of water. Shrub swamps occur mostly along sluggish streams and occasionally on flood plains. Vegetation includes alders, willows, buttonbush, and dogwoods.

Table 2.1
Wetland Communities, Classification Systems, And Common Vegetation

Wetland Plant Community Types	Classification of Wetlands and Deep Water Habitats of the United States (Cowardin et al. 1979)	Fish and Wildlife Service Circular 39 (Shaw and Fredine 1971)	Examples of Common Vegetation
Shallow, Open Water	Palustrine or lacustrine, littoral; aquatic bed; submergent, floating, and floating-leaved	Type 5: Inland open fresh water	White water lily, Yellow water lily, Northern milfoil, Largeleaf pondweed
Deep Marsh	Palustrine or lacustrine, littoral; aquatic bed; submergent, floating-leaved; and emergent; persistent and nonpersistent	Type 4: Inland deep fresh marsh	Bullrushes, Cattail, Duckweed, Water shield
Shallow Marsh	Palustrine; emergent; persistent and nonpersistent	Type 3: Inland shallow fresh marsh	Cattails, Reed canary grass, Common reed
Sedge Meadow	Palustrine; emergent; narrow leaved persistent	Type 2: Inland fresh meadow	Sedges, Canada bluejoint, Fowl bluegrass
Fresh (Wet) Meadow	Palustrine; emergent; broad and narrow-leaved persistent	Type 1: Seasonally flooded basin of flat; Type 2: Inland fresh meadow	Reed canary grass, Sawtooth sunflower, Joe-pye-weed, Giant goldenrod
Wet to Wet-Mesic Prairie	Palustrine; emergent; broad- and narrow leaved persistent	Type 1: Seasonally flooded basin of flat; Type 2: Inland fresh meadow	Cattail, gayfeather, Prairie cordgrass, Slender rush, Black bentgrass
Calcareous Fen	Palustrine; emergent; narrow-leaved persistent; and scrub	Type 2: Inland fresh meadow	Dioecious sedge, Beaked spikerush, Needle beakrush, Shrubby cinquefoil
Open Bog	Palustrine; moss/lichen; and scrub/shrub; broad-leaved evergreen	Type 8: Bog	Bog moss, Leatherleaf, Bog rosemary, Cranberry
Coniferous Bog	Palustrine; forested: needle-leaved evergreen and deciduous	Type 8: Bog	Tamarack, Black spruce, Cotton grass, Leatherleaf
Shrub-Carr	Palustrine; scrub/shrub; broad leaved deciduous	Type 6: Shrub swamp	Meadow willow, Pussy willow, Uptight Sedge, Canada blue-joint grass
Alder Thicket	Palustrine; scrub/shrub; broad-leaved deciduous	Type 6: Shrub swamp	Speckled Alder, American elder, Narrowleaf meadowsweet, Cinnamon fern
Hardwood Swamp	Palustrine; forested; broad-leaved deciduous	Type 7: Wooded swamp	Black ash, Lake sedge, Ostrich fern, Marsh marigold
Coniferous Swamp	Palustrine; forested; needle-leaved deciduous and evergreen	Type 7: Wooded swamp	Northern white cedar, Cinnamon fern, Yellow birch
Floodplain Forest	Palustrine; forested; broad-leaved deciduous	Type 1: Seasonally flooded basin or flat	Silver maple, Canada wood-nettle, Canada hornwort, Green ash
Seasonally Flooded Basin	Palustrine; flat; emergent; persistent and non-persistent	Type 1: Seasonally flooded basin or flat	Willow-weed, Pennsylvania smartweed, Barnyard grass, White goosefoot

2.3.7   TYPE 7: WOODED SWAMPS; HARDWOOD SWAMP, CONIFEROUS SWAMP

The soil is waterlogged at least to within a few inches of the surface during the growing season and is often covered with as much as 1 foot of water. Wooded swamps occur mostly along sluggish streams, on old riverine oxbows, on floodplains, on flat uplands, and in very shallow lake basins. Forest vegetation includes tamarack, white cedar, black spruce, balsam fir, red maple, and black ash. Northern evergreen swamps usually have a thick ground covering of mosses. Deciduous swamps frequently support beds of duckweeds, smartweeds, and other herbs.

2.3.8   TYPE 8: BOGS; CONIFEROUS BOGS, OPEN BOGS

The soil is usually waterlogged and supports a spongy covering of mosses. Bogs occur mostly in shallow lake basins, on flat uplands and along sluggish streams. Vegetation is woody or herbaceous or both. Typical plants are heath shrubs, sphagnum moss, and sedges. In the North, leatherleaf, Labrador-tea, cranberries, *Carex*, and cottongrass are often present. Scattered, often stunted, black spruce, and tamarack may occur in northern bogs.

2.4 Cowardin[7]

This methodology was used to classify wetlands for the National Wetlands Inventory maps beginning in the late 1970's and early 1980's. The hierarchical structure progresses from Systems and Subsystems at the most general levels to Classes, Subclasses, and Dominance Types at the most specific levels. A comparison of Circular 39 and Cowardin wetland classifications along with the typical Cowardin classification symbols are provided in Table 2.2.

2.4.1   SYSTEM

The term System refers to a complex of wetlands and deepwater habitats that share the influence of similar hydrologic, geomorphologic, chemical, or biological factors. The primary systems found in the Minnesota are Palustrine, Lacustrine, and Riverine.

L: Lacustrine (lakes and deep ponds) - Lacustrine Systems include wetlands and deepwater habitats with all of the following three characteristics:
1. Situated in a topographic depression or a dammed river channel;
2. Lacking trees, shrubs, persistent emergents, emergent mosses or lichens with greater than 30 percent areal coverage;
3. Total area exceeds 8 hectares (20 acres).

Basins or catchments less than 8 hectares in size are included if they have at least one of the following characteristics:

1. A wave-formed or bedrock feature forms all or part of the shoreline boundary; or
2. The catchment has, at low water, a depth greater than two meters (6.6 feet) in the deepest part of the basin.

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[7] Cowardin et al,. 1979.

P: Palustrine (shallow ponds, marshes, swamps and sloughs) - Palustrine Systems include all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens.

R: Riverine (rivers, creeks and streams) - Riverine Systems are contained in natural or artificial channels periodically or continuously containing flowing water. Upland islands or Palustrine wetlands may occur in the channel, but they are not part of the Riverine System.

2.4.2 SUBSYSTEM

The term Subsystem refers to a further subdivision of Systems into more specific categories. The Palustrine System has no subsystems associated with it while Lacustrine Systems have two Subsystems and Riverine Systems have four). Each Subsystem is unique for the System to which it applies.

L1: Limnetic - Extends outward from Littoral boundary and includes deepwater habitats within the Lacustrine System.

L2: Littoral - Extends from shoreward boundary to 2 meters (6 feet) below annual low water or to the maximum extent of non-persistent emergents, if these grow at greater than 2 meters.

R2: Lower Perennial

R3: Upper Perennial

R4: Intermittent

2.4.3 CLASS, SUBCLASS

The wetland Class is the highest taxonomic unit below the Subsystem level. The Class code describes the general appearance of the habitat in terms of either the dominant life form of the vegetation or the physiography and composition of the substrate. Life forms (e.g. trees, shrubs, emergents) are used to define classes because they are easily recognizable, do not change distribution rapidly, and have traditionally been used to classify wetlands. Finer differences in life forms are recognized at the Subclass level.

Mixed classes are used as sparingly as possible, under two main conditions: (1) The wetland contains two or more distinct cover types each encompassing at least 30 percent areal coverage of the highest life form, but is too small in size to allow separate delineation of each cover type; and (2) The wetland contains 2 or more classes or subclasses each comprising at least 30 percent areal coverage so evenly interspersed that separate delineation is not possible at the scale used for classification. Mixed subclasses are also allowed and follow the same rules for mixed classes[8].

AB: Aquatic Bed - Includes wetlands and deepwater habitats dominated by plants that grow principally on or below the surface of the water for most of the growing season in most years.
Subclasses include: AB1 = Algal, AB2 = Aquatic Moss, AB3 = Rooted Vascular, AB4 = Floating Vascular, AB5 = Unknown Submergent, and AB6 = Unknown Surface.

EM: Emergent - Characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years.

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[8] Cowardin et al., 1979

Subclasses include: EM1 = Persistent (plants that normally remain standing at least until the beginning of the next growing season), and EM2 = Nonpersistent (plants which fall to the surface of the substrate or below the surface of the water at the end of the growing season).

FO: Forested - Woody vegetation greater than 6 meters (20 feet) tall.
Subclass determination is based on which type represents more than 50 percent of the areal canopy coverage during the leaf-on period and Subclasses include: FO1 = Broad-leaved Deciduous, FO2 = Needle-leaved Deciduous, FO3 = Broad-leaved Evergreen, FO4 = Needle-leaved Evergreen, FO5 = Dead, FO6 = Deciduous, and FO7 = Evergreen.

SS: Scrub/Shrub - Woody vegetation less than 6 meters (20 feet) tall. The species include true shrubs, young trees (saplings) or trees that are small or stunted because of environmental conditions.
Subclass determination is based on which type represents more than 50 percent of the areal canopy coverage during the leaf-on period and include: SS1 = Broad-leaved Deciduous, SS2 = Needle-leaved Deciduous, SS3 = Broad-leaved Evergreen, SS4 = Needle-leaved Evergreen, SS5 = Dead, SS6 = Deciduous (used if deciduous woody vegetation cannot be identified on aerial photography as either Broad-leaved or Needle-leaved), and SS7 = Evergreen (used if evergreen woody vegetation cannot be identified on aerial photography as either Broad-leaved or Needle-leaved).

UB: Unconsolidated Bottom - Includes all wetlands and deepwater habitats with at least 25 percent cover of particles smaller than stones (less than 6-7 cm.), and a vegetative cover less than 30 percent.

2.4.4 WATER REGIME

Precise description of hydrologic characteristics requires detailed knowledge of the duration and timing of surface inundation, both yearly and long-term, as well as an understanding of groundwater fluctuations. Because such information is seldom available, the water regimes that, in part, determine characteristic wetland and deepwater plant and animal communities are described here in only general terms[9]. Water regimes are grouped under two major categories, Tidal and Nontidal. The Tidal Water Regime does not occur in Minnesota so is not described here.

A: Temporarily Flooded - Surface water present for brief periods during the growing season, but the water table usually lies well below the soil surface. Plants that grow both in uplands and wetlands are characteristic of this water regime. The temporarily flooded regime also includes wetlands where water is present for variable periods without detectable seasonal periodicity. Weeks, months, or even years may intervene between periods of inundation. The dominant plant communities under this regime may change as soil moisture conditions change.

B: Saturated - The substrate is saturated to the surface for extended periods during the growing season, but surface water is seldom present.

C: Seasonally Flooded - Surface water is present for extended periods especially early in the growing season, but is absent by the end of the growing season in most years. When surface water is absent, the water table is often near the land surface. The water table after

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[9] Cowardin, et al., 1979

flooding ceases is highly variable, extending from saturated to a water table well below the ground surface.

   F: Semipermanently Flooded - Surface water persists throughout the growing season in most years. When surface water is absent, the water table is usually at or very near the land surface.

   G: Intermittently Exposed - Surface water is present throughout the year except in years of extreme drought.

   H: Permanently Flooded - Water covers the land surface throughout the year in all years. Vegetation is composed of obligate hydrophytes.

2.4.5 SPECIAL MODIFIERS

Many wetlands and deepwater habitats are human-made and natural ones have been modified to some degree by the activities of humans or beavers. Since the nature of these modifications often greatly influences the character of such habitats, special modifying terms have been included here to emphasize their importance[10].

   b: Beaver – Created or modified by a beaver dam.

   d: Partly Drained – The water level has been artificially lowered, but he area is still classified as wetland because soil moisture is sufficient to support hydrophytes. Drained areas are not considered wetland if they can no longer support hydrophytes.

   f: Farmed – The soil surface has been mechanically or physically altered for production of crops, but hydrophytes will become reestablished if farming is discontinued.

   h: Diked/Impounded – Created or modified by a barrier or dam which purposefully or unintentionally obstructs the outflow of water. Both humans-made and beaver dams are included.

   r: Artificial – Refers to substrates classified as Rock Bottom, Unconsolidated Bottom, Rocky Shore, and Unconsolidated Shore that were emplaced by humans, using either natural materials such as dredge spoil or synthetic materials such as discarded automobiles, tires, or concrete.

   s: Spoil – Refers to the placement of spoil materials which have resulted in the establishment of wetland.

   x: Excavated – Lies within a basin or channel excavated by humans.

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[10] Cowardin, et al., 1979

Table 2.2
Circular 39 and Cowardin Wetland Classification Systems
Minnesota Routine Assessment Method for Evaluating Wetland Functions, Version 3.1

Circular 39 Type	SYSTEM SUBSYSTEM CLASS SUBCLASS	Common Water Regimes	Typical NWI Symbols (Cowardin System)

Type 1	PALUSTRINE (P)
	   Emergent (EM)
	      Persistent (1)
	     Forested (FO)
	      Broad-Leaf Deciduous (1)
		Temporarily Flooded (A)
		Intermittently Flooded (J)
			PEM1A
			PEM1J
			PFO1A
			PFO1J

Type 2	PALUSTRINE (P)
	   Emergent (EM)
	      Persistent (1)
		Saturated (B)	PEM1B

Type 3	PALUSTRINE (P)
	   Emergent (EM)
	      Persistent (1)
		Seasonally Flooded (C)
		Semipermanently Flooded (F)
			PEM1C
			PEM1F

Type 4	PALUSTRINE (P) OR LACUSTRINE (L)
	   Littoral (2)
	   Emergent (EM)
	     Aquatic Bed (AB)
	     Unconsolidated Bottom (UB)
		Semipermanently Flooded (F)
		Intermittently Exposed (G)
		Permanently Flooded (H)
			PEMF L2EM2F
			PEMG L2EM2G
			PABF L2EM2H
			PABG L2ABF
			PUBF L2ABG
			PUBG L2ABH

Type 5	PALUSTRINE (P) OR LACUSTRINE (L)
	   Limnetic (1)
	   Littoral (2)
	     Aquatic Bed (AB)
	     Unconsolidated Bottom (UB)
		Intermittently Exposed (G)
		Permanently Flooded (H)
			PABG L2ABG
			PABH L2ABH
			PUBG L2UBG
			PUBH L2UBH
			
			          L1UBH

Type 6	PALUSTRINE (P)
	   Scrub-Shrub (SS)
	     Broad/Needleleaf Deciduous (1,2)
	     Broad/Needleleaf Evergreen (3,4)
	     Dead (5)
		All nontidal regimes except Permanently Flooded (A,B,C,F,J,G)	PSS1,2,3,4, or 5A
			PSS1,2,3,4, or 5B
			PSS1,2,3,4, or 5C
			PSS1,2,3,4, or 5F
			PSS1,2,3,4, or 5J
			PSS1,2,3,4, or 5G

Type 7	PALUSTRINE (P) Forested (FO)	All nontidal regimes except Intermittently Flooded and Permanently Flooded (A,B,C,F,J)	PFO1,2,4, or 5A PFO1,2,4, or 5B PFO1,2,4, or 5C PFO1,2,4, or 5F PFO1,2,4, or 5J

Type 8	PALUSTRINE (P)
	   Scrub-Shrub (SS)
	     Broad + Needleleaf Deciduous (1,2)
	     Broad + Needleleaf Evergreen (3,4)
	     Dead (5)
	   Forested (FO)
	     Broad + Needleleaf Deciduous (1,2)
	     Broad + Needleleaf Evergreen (3,4)
	     Dead (5)
	   Moss-Lichen (ML)
	   Emergent (EM)
		Saturated (B)	PSS1,2,3,4, or 5B
			PFO1,2,3,4, or 5B
			PMLB
			PEMB

	RIVERINE (R)
	   Lower Perennial (LP)
	     Upper Perennial (UP)
	     Intermittent (IN)
	     Unconsolidated Bottom (UB)
		Intermittently Exposed (G)
		Permanently Flooded (H)
			RUBG
			RUGH

2.5 Critical Wetland Resource Designations

Wetlands in the assessment area should be evaluated for designation as critical resources based on several features defined in Minnesota Statutes. These critical wetland resources should be classified into the Preserve management class due to their special functions. Criteria for designating wetlands as critical resources are as follows:

- Outstanding Resource Value Waters (Minn. Rules 7050.0180)
- Designated Scientific and Natural Areas (Minn. Rules 86A.05)
- Wetlands with known occurrences of Threatened or Endangered Species (Minn. Stat. 84.0895)
- State Wildlife Management Areas (Minn. Stat. 86A.05, subpart 8)
- State Aquatic Management Areas (Minn. Stat. 86A.05, subpart 14).
- Wellhead Protection Areas (Minn. Stat. 103I.101, MN Rules Chapter 4720).
- Sensitive Ground Water Areas (MN Rules 8420.0548, Subp. 6).
- Designated trout streams or trout lakes (MN Rules 6264.0050).
- Calcareous fens (MN Rules 8420.1010 through 8420.1060).
- High priority areas for wetland preservation, enhancement, restoration and establishment (MN Rules 8420.0350, subpart 2).
- Designated Historic or Archaeological Sites
- State or federal designated wild and scenic rivers (MN Rule Chapter 7050)
- Mn Pollution Control Agency "special waters search" mapping utility: www.pca.state.mn.us/water/stormwater/specialwaters

2.6.1 OUTSTANDING RESOURCE VALUE WATERS

"Outstanding resource value waters" are defined in MN Rules 7050.0180 as waters within the Boundary Waters Canoe Area Wilderness; Voyageur's National Park; and Department of Natural Resources designated scientific and natural areas; wild, scenic, and recreational river segments; Lake Superior; those portions of the Mississippi River from Lake Itasca to the southerly boundary of Morrison County that are included in the Mississippi Headwaters Board comprehensive plan dated February 12, 1981; and other waters of the state with high water quality, wilderness characteristics, unique scientific or ecological significance, exceptional recreational value, or other special qualities which warrant stringent protection from pollution.

2.6.2 CALCAREOUS FENS

Calcareous fens are defined in MN Rules 8420.1020 as peat-accumulating wetlands dominated by distinct groundwater inflows having specific chemical characteristics. The water is characterized as circumneutral to alkaline, with high concentrations of calcium and low dissolved oxygen content. The chemistry provides an environment for specific and often rare hydrophytic plants[11]. Minnesota Rules 8420.1010-1070 sets out minimum standards and criteria for the identification, protection, and management of calcareous fens as authorized by Minnesota Statutes, section 103G.223. The MnDNR is charged with identifying and maintaining a list of calcareous fens in the state and maintains a database of them. Calcareous fens are also listed in the Classifications for Waters in Major Surface Water Drainage Basins[12]. Finally, the rules for

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[11] MN Rules 8420.1020

[12] MN Rules 7050.0470

Nondegradation of Outstanding Resource Value Waters[13] also lists identified calcareous fens in the state.

2.6.3   SCIENTIFIC AND NATURAL AREAS

State scientific and natural areas (SNA) are established to protect and perpetuate, in an undisturbed natural state, those natural features which possess exceptional scientific or educational value (MN Statutes 86A.05). This may include but is not limited to any of the following features: geological processes; significant fossil evidence, an undisturbed plant community, an ecological community significantly illustrating the process of succession and restoration to natural condition following disruptive change; a habitat supporting a vanishing, rare, endangered, or restricted species of plant or animal; a relict flora or fauna persisting from an earlier period; or a seasonal haven for concentrations of birds and animals, or a vantage point for observing concentrated populations, such as a constricted migration route. The area should embrace an area large enough to permit effective research or educational functions and to preserve the inherent natural values of the area.

2.6.4   HABITAT FOR DESIGNATED ENDANGERED, THREATENED, OR SPECIAL CONCERN SPECIES

Endangered and threatened plant and animal species are protected in Minnesota as specified in MN Statutes 84.0895. In MN Statutes, Subp. 3, species of wild animal or plant are designated as:

1. **Endangered**, if the species is threatened with extinction throughout all or a significant portion of its range; or
2. **Threatened**, if the species is likely to become endangered within the foreseeable future throughout all or a significant portion of its range; or
3. **Species of special concern**, if although the species is not endangered or threatened, it is extremely uncommon in this state, or has unique or highly specific habitat requirements and deserves careful monitoring of its status.

In 1987, the Minnesota County Biological Survey (MCBS) began a systematic survey of rare biological features. The goal of the MCBS is to identify significant natural areas and to collect and interpret data on the distribution and ecology of rare plants, rare animals, and native plant communities. The MCBS data for the assessment area (if available) should be examined for sites with moderate, high and outstanding biologic diversity significance.

The MnDNR Natural Heritage and Nongame Research Program (Natural Heritage Program) collects, manages, and interprets information about nongame animals, native plants, and plant communities to promote the wise stewardship of these resources. The Natural Heritage Program has developed a ranking system that is intended to reflect the extent and condition of natural communities and species in Minnesota.[14] These 'state ranks' have no legal ramifications, they are used by the Natural Heritage Program to set priorities for research and for conservation planning. They are grouped as follows:

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[13] MN Rules 7050.0180, Subp. 6

[14] Aaseng et al., 1993.

State Element Rank:

S1: Critically imperiled in the state because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extirpation from the state.

S2: Imperiled in state because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extirpation from the state.

S3: Rare or uncommon in state (on the order of 21 to 100 occurrences).

S4: Apparently secure in state with many occurrences.

S5: Demonstrably secure in state and essentially ineradicable under present conditions.

SH: Of historical occurrence in the state, perhaps having not been verified in the past 20 years, and suspected to be still extant.

SN: Regularly occurring, usually migratory and typically nonbreeding species for which no significant or effective habitat conservation measures can be taken in the state.

SR: Reported from the state, but without persuasive documentation which would provide a basis for either accepting or rejecting the report.

SRF: Reported falsely.

SU: Undetermined. Possibly in peril in the state but status uncertain; need more information.

SX: Extirpated within the state.

The Natural Heritage Program information database should be searched to determine if any endangered, threatened, or special concern species have been sighted within 500 feet of the assessment area. The list of species, the subwatershed location, legal protection status, state element rank and county should be compiled.

2.6.5   STATE WILDLIFE MANAGEMENT AREAS

State wildlife management areas are established to protect those lands and waters which have a high potential for wildlife production and to develop and manage these lands and waters for the production of wildlife, for public hunting, fishing, and trapping, and for other compatible outdoor recreational uses[15]. State wildlife management areas satisfy the following criteria:

1. Includes appropriate wildlife lands and habitat, including but not limited to marsh or wetlands and the margins thereof, ponds, lakes, stream bottomlands, and uplands, which permit the propagation and management of a substantial population of the desired wildlife species; and
2. Includes an area large enough to ensure adequate wildlife management and regulation of the permitted recreational uses.

A map of all MnDNR Wildlife Management Areas can be found at: www.dnr.state.mn.us/maps/compass.html.

2.6.6   DESIGNATED TROUT STREAMS AND LAKES

Designated trout streams and lakes in the state of Minnesota are inhabited by trout other than lake trout. Fishing and other restrictions have been placed on these waterbodies to protect and

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[15] MN Statute 86A.05, subpart 8

foster the propagation of trout. Wetlands associated with these lakes are an integral part of the whole ecosystem that functions to maintain the characteristics necessary to support the fishery.[16]

2.6.7 AQUATIC MANAGEMENT AREAS

Minnesota Statutes 86A.05, Subpart 14, allows for the establishment of aquatic management areas to protect, develop, and manage lakes, rivers, streams, and adjacent wetlands and lands that are critical for fish and other aquatic life, for water quality, and for their intrinsic biological value, public fishing, or other compatible outdoor recreational uses. Aquatic management areas may be established to protect wetland areas under ten acres that are donated to the department of natural resources. Aquatic management areas must meet one or more of the following criteria:
1. Provides angler or management access;
2. Protects fish spawning, rearing, or other unique habitat;
3. Protects aquatic wildlife feeding and nesting areas;
4. Protects critical shoreline habitat; or
5. Provides a site for research on natural history.

2.6.8 WELLHEAD PROTECTION AREAS

Wellhead protection is defined as a method of preventing well contamination by effectively managing potential contaminant sources in all or a portion of the well's recharge area. The statutory authority for wellhead protection comes from Minnesota Statutes 103I.101. The rules for establishment of Wellhead Protection Plans are found in Minnesota Rules Chapter 4720, which are administered by the Minnesota Department of Health. Wetlands present within wellhead protection areas are likely to be predominantly recharge wetlands. Since wetlands typically collect surface water runoff from a larger upland area, recharge wetlands within wellhead protection areas have a greater probability of transmitting pollutants to a public groundwater supply than other wetlands. Wellhead protection plans are developed and implemented by the public water supplier, which is typically a city or the Minnesota Department of Health. The state rules governing wellhead protection can be accessed on the web at: www.revisor.leg.state.mn.us/arule/4720/.

2.6.9 SENSITIVE GROUNDWATER AREAS

The Wetland Conservation Act requires that projects proposing to impact wetlands must evaluate whether the impacts would have an adverse impact on groundwater quality[17]. If it is determined that a proposed replacement plan would have a significant adverse impact on groundwater quality, the replacement plan must be denied. Wetlands determined to be primarily recharge wetlands as a result of a functional assessment using *MNRAM Version 3.1* should be evaluated for the potential to affect groundwater resources[18].

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[16] A list of all state trout streams and lakes can be found at: www.revisor.leg.state.mn.us/arule/6264/

[17] Minnesota Rules 8420.0548, Subpart 6

[18] Evaluate according to the guidelines in: *Criteria and Guidelines for Assessing Geologic Sensitivity of Ground Water Resources in Minnesota*, Minnesota Department of Natural Resources, 1991.

2.6.10 HIGH-PRIORITY AREAS FOR WETLAND PRESERVATION, ENHANCEMENT, & RESTORATION

Water management plans prepared by water management organizations in the metropolitan areas under Minnesota Statutes, section 103B.231 must identify those areas that qualify as high priority areas for wetland preservation, enhancement, restoration, and establishment[19]. These priority areas shall be included in the next scheduled water management plan update. Plans should give strong consideration to identifying as high priority areas, minor watersheds having less than 50 percent of their original wetland acreages, and intact wetlands, diminished wetlands, and the areas once occupied by wetlands that have been diminished or eliminated and could feasibly be restored taking into account the present hydrology and use of the area. Plans should give strong consideration to identifying as high priority areas all type 1 or 2 wetlands, and other wetlands at risk of being lost by permanent conversion to other uses. When individual wetlands are identified as high priority for preservation and restoration, the high priority area shall include the wetland and an adjacent buffer strip not less than 16.5 feet wide around the perimeter of the wetland and may include up to four acres of upland for each wetland acre.

Plans may identify additional high priority areas where preservation, enhancement, restoration, and establishment of wetlands would have high public value by providing benefits for water quality, flood water retention, public recreation, commercial use, and other public uses. High priority areas should be delineated by minor or major watershed.

2.6.11 STATE AND FEDERAL DESIGNATED SCENIC AND WILD RIVERS

The rules for the protection of state designated scenic and wild rivers is set forth in Minnesota Rules Chapter 6105[20] as administered by the MnDNR. Wild rivers are defined as those that exist in a free-flowing state with excellent water quality and with adjacent lands that are essentially primitive and scenic rivers are defined as those that exist in a free-flowing state with adjacent lands that are essentially primitive. Management plans must be developed before a river can be included in the wild and scenic river system. The plans must give emphasis to the preservation and protection of the area's scenic, recreational, natural, historic, and similar values while placing no unreasonable restrictions upon compatible, preexisting, economic uses of particular tracts of land.

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[19] Minnesota Rules 8420.0350, Subp. 2

[20] The state rules can be accessed at: www.revisor.leg.state.mn.us/arule/6105/.

3.0 Field Assessment and Data Analysis Procedures
(sample)

In any inventory project, the data collected should include: wetland location and extent, digital photographs of each wetland, wetland classification, dominant vegetation, wetland functions, hydrologic regime, and identification of potential restoration sites within larger assessment areas.

In general, begin by specifically defining the assessment area. Create baseline wetland inventory and assessment maps utilizing available information including: Minnesota Department of Natural Resources Public Waters Inventory maps, National Wetlands Inventory maps, soil survey data, parcel data, topography, and digital orthoquad aerial photographs to help identify wetland areas. The presence of each wetland should be verified in the field. Dominant wetland types may be classified using any one of the classification systems described in Section 2.0[21], in addition to, at the very least, the U.S. Fish and Wildlife Service Cowardin System[22].

The following sample procedure is excerpted from documentation of a Minnehaha Creek wetland inventory project.

3.1 Field Assessment Maps/Data

The total watershed area within which the Functional Assessment of Wetlands (FAW) was conducted covers about 181 square miles. Maps were created for field use to locate sites, to assist in completing the wetland assessments, and to act as a field notebook for recording necessary data. Each field map covered one full section of land (one square mile).

3.2 Wetland Base Data: Hennepin Conservation District Wetland Inventory

The Hennepin Conservation District (HCD) had conducted a remote sensing wetland inventory (HCWI) within the District prior to the beginning of this project. The wetlands that had been identified in the inventory were used as a base layer for the FAW field maps to show where existing and potential wetlands are located. In conducting the wetland inventory, HCD followed a stepped procedure, described below.

First, potentially drained wetlands were identified based on depressional areas with hydric soils or transitional soils, or poorly drained depressions identified on the soil survey without clear evidence of wetland hydrology. Areas identified on the NWI were included. Areas appearing on the Metropolitan Mosquito Control maps were also highlighted, as these are known to pond water periodically.

Next, areas that appeared to have wetland hydrology on infrared (IR) stereo photos, as identified by tone, texture, and presence of a depression, were identified. Then, aerial photography from the past 15 years was evaluated in combination with data of yearly precipitation (wet, normal, dry) to evaluate wetlands that were identified during the IR and soil/topography review. During the aerial photography review each high lighted site was defined as either: (1) dry cropped, (2) dry and no crop, (3) wet and crop stress, (4) wet and no crop, (5) wet and drowned out, or (6) ponded.

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[21] Classify wetlands using the U.S. Fish and Wildlife Service Circular 39 System, Shaw and Fredine, 1959.
[22] Cowardin et al., 1979.

Areas that appear to have wetland hydrology every year and do not appear to be drained were classified as wetlands with unaltered hydrology (EWET and shown as green polygons on the base maps) in the GIS. The areas showing evidence of wetland hydrology in one-third or more 'normal' precipitation years were classified as wetlands with altered hydrology (AWET and shown as blue polygons on the base maps). Estimated restorable areas that did not appear to have wetland hydrology during at least one-third of the normal precipitation years, or could not be observed due to tree cover, were identified as potential wetlands (RWET yellow polygons on the base maps) in the GIS. The extent of these potential wetlands was determined using either: 1) the size during the wettest year, 2) the boundary of the depressional soil unit on the soil survey, and/or 3) the boundary of the NWI or Mosquito Control District mapping.

3.3 Field Assessment Base Data

Each wetland polygon or wetland complex identified in the inventory was given a unique Wetland ID number. The ID number consists of the township number, followed by the range number, followed by the section number and finally a unique three-digit number for each wetland within the section. A letter designation (D or E) is placed at the beginning of the wetland ID. A "D" indicates that the wetland is completely or partially drained and an "E" indicates that there was not clear evidence that the wetland has been hydrologically altered. Other data on the base maps included soil type and inclusions and the approximate acreage of each wetland. Color aerial photographs from 2000 were used as a base layer on the field maps for the FAW under the wetland polygons and soil data. In addition, section numbers, parcel lines, road names, and subwatershed boundaries were added to the field maps that were plotted at a scale or 1 inch equals 200 feet.

Separate topography maps were created for use in the field. The topography maps were created in ArcView 8 using 5-ft contours with a subtle hill shading and the ~160 subwatershed boundaries at a scale of approximately 1 inch equals 800 feet. The topography maps were made at a larger scale, to include complete subwatershed areas for assessing wetland location within a subwatershed and proximity to recreational water bodies.

3.4 Field Assessment Procedures

The section maps, topographic maps, digital camera and a letter explaining the project to property owners were used each day during fieldwork. All existing wetlands and all potential wetlands greater than 0.25 acre were evaluated in the field for wetland function and for restoration potential. If potential wetlands under 0.25 acres in size were found to contain rare and/or unique features, they were assessed.

Property owners were informed of the project by publishing public notices in each local newspaper and/or newsletter. To begin an assessment, the property owner was identified using the parcel lines on the maps and an attempt was made to contact the owner. If the property owner was available, the field evaluator briefly described the project and asked the owner for permission to access the wetland(s) on their property. If the property owner refused access, a note was made on the section map.

The objective of the field assessment was to answer all questions in the Access database, excluding those highlighted in red that were evaluated using existing digital data analyzed using GIS. This included an evaluation of the presence and abundance of hydrophytic and invasive vegetation to identify and appraise the plant community, seeking out surface drain tile inlets, ditches or any other drainage feature to identify hydrogeomorphology, litter and buffer of the wetland, land-use within the subwatershed, and apparent public use of the wetland. The soil and

topography maps were used in the field to determine the presence of hydric soils, and the topographic position of each wetland within the subwatershed. Both the Cowardin and Circular 39 classifications were assigned to each wetland during the field assessments.

3.5 Field Map Notation

Field notes were written on the maps using a permanent marker, preferably in red. Each evaluated wetland or potential wetland was marked on the map using the following mapping symbols:

NW = **Not Wetland**: Identified as a wetland or potential wetland on the inventory but observed to be dominated by upland vegetation in the field; these would typically be accompanied by an **X** through the wetland polygon.

A = **Assessed Wetland:** wetlands that were assessed in the field.

NA = **Not assessed**: typically wetlands below the threshold size of 0.25 acres and identified as potential wetlands in the inventory or wetlands present on inaccessible private property

NAW = **Not Assessed Wetland:** wetlands that were not assessed, but were verified as a wetland, typically classified as potential wetlands and less than 0.25 acres in size with no unique or notable characteristics.

SW = **Stormwater Pond:** clearly excavated out of upland and created to manage stormwater.

R = **Restorable Wetland:** drained wetlands that were only assessed for restoration potential.

Wetland boundaries were revised on field maps when field evaluations indicated a significant difference in the edge of dominant hydrophytic vegetation from the inventory mapping. If a wetland boundary was changed, an "X" was written through the old boundary to indicate the creation of a new boundary.

3.6 Guidelines for Field Map Notation

New wetland IDs were assigned to new wetlands found in the field but not identified on the inventory or portions of large wetland complexes that needed to be split. The database was reviewed to find the next sequential "D" or "E" designation ID number for the section in which the majority of the wetland resides. The new Wetland ID was entered into the database and the new ID was written within or next to the wetland polygon on the map.

Wetlands separated by roads or railroads (i.e. those with only a restricted hydrologic connection and no ecological connection) were evaluated as unique wetlands. Partially drained wetlands that were determined to be restorable were evaluated as wetlands and for restoration potential. In this case, the existing wetland areas were labeled with an **A** and the drained portions were labeled separately with an **R**, but all parts of the wetland basin were identified with the same Wetland ID.

At completion of each day, or the completion of a section, the dates and persons conducting field evaluations were indicated in the upper right corner of each map, and 'COMPLETE' was written in the upper left corner when the entire section was completed. If there were wetlands crossing the section line that have not been fully assessed or mapped they were indicated in the upper left corner of the map.

3.7 Photographs

A digital photograph was taken of each evaluated wetland and drained wetland that was assessed for restoration potential. An arrow was drawn on the map with the point of the arrow at the point where the photograph was taken from, indicating the approximate direction of the photo. Photographs were tracked by writing the photo number next to the location arrow. The photo point locations were digitized in GIS within the corresponding wetland polygon, and UTM coordinates for each point were generated. A list could also be made in a field book indicating the Wetland ID and the photograph number. Each photograph was subsequently renamed using the unique Wetland ID (i.e. D1172401001).

3.8 Identifying Potential Wetland Mitigation Sites

All drained wetlands identified in the inventory and other drained wetlands identified in the field were evaluated for the potential to restore those wetlands. Wetlands with restoration potential typically met one or more of the following conditions:
- Mapped hydric soils or hydric soil inclusions
- Wetland hydrology signatures on past aerial photos
- The area was a depression in the landscape
- Wetland hydrology was currently absent within part or all of the depression
- Evidence of ditching, tiling, or other feature that has removed the hydrology should be present
- Drained wetlands within permanently altered land uses (i.e. golf courses) were determined to not be restorable in most cases.

The approximate restorable area was delineated on the map, even if it was adjacent to an existing wetland. The currently non-wetland area which has potential to be restored was marked with an **R** to indicate which Wetland ID the restored area was associated with. A photograph was taken and the photo point was indicated on the map.

3.9 Procedures for Field Work

The functions of each wetland were evaluated by completing the Microsoft Access® database using laptop computers that were carried in the field. The wetland records from all field crews were combined by exporting completed records and importing them into a master database.

The photo ID number generated by the digital camera for each wetland photo was entered into the database which also corresponded to the photo number indicated on the field maps to allow easier tracking. For each assessed wetland, the field evaluator recorded their initials and the date of the assessment within the database for future reference. The database contains *The National List of Plant Species that Occur in Wetlands*[23], which includes common and scientific names and the indicator status for each species. This list was used for entering the dominant plant species (typically those dominants according to the 50/20 rule) within each wetland along with the cover class for each species.

When there were numerous species of one type (i.e. willow, sandbar); the appropriate species was used when known, otherwise the general name was used. When wetlands with uncommon vegetation (e.g. sedges, tamarack, sphagnum moss, bog species) were evaluated, those species were recorded, even if they weren't dominant for the entire wetland. Species were

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[23] Resource Management Group, 1999.

usually selected from the drop-down list to avoid misspellings and improper names. If a species was not present in the plant list, it was added to the species list.

Upon return to the office, each assessed wetland was checked to verify that there was one complete Access database record, one digital photograph, and one wetland polygon marked with an A or an R on the field maps. Also, maps were checked for initials of the field evaluator, and the dates of the fieldwork.

The following sample procedure is excerpted from documentation of a Minnehaha Creek wetland inventory project.

4.1 GIS Wetland Shapefile

The field evaluation notation for each wetland was entered into the ArcView wetland shapefile table and the wetland boundaries were revised to note any significant changes to the inventory. This included: adding new wetland boundaries, deleting incorrect boundaries, merging wetland polygons, and splitting wetland polygons. Field assessment notations were added in GIS according to those listed in the Field Evaluation Notation section above. Following are some of the general guidelines followed in updating the inventory wetland shapefile:

- Upon completion of the FAW, each Wetland ID should only have <u>ONE</u> wetland polygon with an **A** in the *Assessment* field.
- Wetland polygons from the HCWI were generally not deleted; if an area was determined to not be wetland, an **NW** was entered in the *Assessment* field.
- Multiple polygons identified with the same Wetland ID in the inventory were either combined, split up and given different Wetland ID numbers, or given different designations in the *Assessment* field when indicated as necessary by the field assessment notes.
- The area of each assessed wetland was computed in ArcView after all boundary revisions were made and prior to completing the GIS data analyses.
- Where only minor alterations in the boundary of a wetland were indicated on the field maps, the boundaries were not revised in GIS. If only a portion of the wetland polygon is indicated as changing significantly, just that portion of the wetland was revised. The minor wetland boundary changes indicated on the field maps could be used to refine the digital wetland boundaries in the future.
- A photo location point was digitized in ArcView within each assessed wetland polygon.

4.2 GIS Data Analyses

Seven wetland functional parameter questions were evaluated using analyses of existing digital data in GIS. The resulting evaluation data were then imported into the database where all of the functional evaluation data are managed. The following values are given for classifications that were assigned for each of the questions answered using GIS (which are the same values used throughout MnRAM):

Exceptional = 2.0	Discharge = 0.1
High = 1.0	Recharge = 0.0
Medium = 0.5	Yes = 1.0
Low = 0.1	No = 0.1

Following is a brief description of the wetland functional parameter questions analyzed using GIS and a brief description of the criteria and analyses performed in GIS.

Question #2: Are rare plant species or state or federally listed species known to be in/near wetland?

A 200-foot buffer was established around each wetland in ArcView. The wetland and buffer area were then checked for the presence of any state or federally listed species within that area. The wetland polygon with buffer area was used to intersect rare species GIS data provided by the MnDNR Natural Heritage Inventory Database. Values for responses of yes or no were returned based on the outcome of the analysis.

Question #12: Describe the predominant upland soils within the subwatershed that affect the overland flow characteristics.

A 500-foot buffer was established around each wetland polygon. The Soil Conservation Service hydrologic soil group data (i.e. A = sand, B = sandy loam, C = clays loams, and D = plastic and swelling soils) within the 500-foot buffer was evaluated to determine which soil group represents the majority of the area. These resulting values were based on the following rules:

High: Majority of soils C, D, or combinations with C or D
Medium: Majority of soils hydrologic soil group B
Low: Majority of soils hydrologic soil group A

Question #14: Describe the density of wetlands within the subwatershed.

First, an analysis was conducted to determine the proportion of each subwatershed area comprised of wetlands, lakes, or ponds. Then it was determined within which subwatershed each wetland was located. Based on the subwatershed wetland/waterbody density, a value of high, medium, or low was attributed to each wetland based on the following rules:
Classification Rules:

High: Wetlands/water making up < 10% of subwatershed area
Medium: Wetlands/water making up 10-20% of subwatershed area
Low: Wetlands/water making up > 20% of subwatershed area

Question #28: Describe the soils within the wetland.

The digital soil survey data for Hennepin and Carver Counties was evaluated to identify all "organic" wetland soils. The soil mapping underlying each assessed wetland was evaluated for the presence or absence of organic soils. A value for each wetland was determined based on whether the majority of soils were organic or mineral according to the following criteria:
Classification Rules:

Recharge: Majority of soils in the wetland are mineral.
Discharge: Majority of soils in the wetland are organic

Question #30. Indicate conditions that best fit the wetland based on wetland size and the hydrologic properties of the soils within 500 feet of the wetland.

Again, the 500-foot buffer around each wetland was used for this analysis along with the area of each wetland (previously computed in GIS). If the total wetland area is greater than or equal to 200 acres, the wetland is discharge. If the wetland is less than 200 acres in size and

the surrounding upland soils within 500-feet are in the A or B hydrologic soil group, then the wetland is discharge. Otherwise the wetland was determined to be recharge for this question.

Question #34. Is the wetland known to be used recently by rare wildlife species (or state or federally listed wildlife)?

Similar to Question 12, a 500-foot buffer around each assessed wetland was checked for known rare wildlife species using GIS data provided by the MnDNR Natural Heritage Inventory database. Based on the analysis results, the field for Question 34 was populated with the numeric values:

   Yes =   1.0
   No =   0.1

Question #35. Is the wetland or a portion of the wetland a rare natural habitat or community as identified by the MnDNR Natural Heritage Inventory database or the County Biological Survey.

Is the wetland plant community scarce or rare within the watershed, imperiled, or critically imperiled (state rankings S1 and S2)? If this applies, then Special Features question b is answered yes and the wetland wildlife habitat function level rating is exceptional.
Each wetland was compared to the rare habitat features from the County Biological Survey (CBS). An attribute was added to the CBS table data indicating the state rank so that those communities rated S1 and S2 that intersected the wetland were answered yes and the others were answered no. Based on the analysis results, Question 35 was populated with the numeric following values:

   Yes =   1.0
   No =   0.1

Question #48. Is any part of the wetland in public or conservation ownership?

The property ownership of each evaluated wetland was analyzed using the Hennepin and Carver County Parcel data. The "Find Majority Area" was used with the *ExemptCode* field being the field and Watershed ID being the value summarized. If the area of "E" = 0, then there is no public ownership (Value = "LOW"). If the area of "N" = 0, then there the entire wetland is under public ownership (Value = "High"), if not, then some of wetland is under public ownership, (Value = "Medium"). If there is no summary for wetland, the wetland must fall outside of parcels in shapefile, usually this would be road ROW. If so, assume the value = "high."

4.2.1 CREATING GIS ANALYSES SUMMARY TABLE AND IMPORTING INTO DATABASE

A summary table was then created for importing the results of the GIS analyses into the database. The summary table must be formatted as shown below for proper import to the database. Each Wetland ID presented in the summary table must have a valid answer for each of the questions analyzed using GIS (i.e. Questions 2, 12, 14, 28, 30, 34, 35, and 48). Running the database import routine operates such that the data for the questions described above will be overwritten for each Wetland ID presented in the summary table. Each time this data was imported the existing data in Access will be overwritten. Missing data for any question will result in that particular question being populated with a value of 0 (zero) for that Wetland ID. In

most cases, a 0 (zero) is not valid. The table must be in comma-delimited format in the EXACT question order shown below:
"Wetland_ID","Q12_val","Q14_val","Q28_val","Q30_val","Q48_val","Q02_val","Q34_val","Q35_val"
E-117-24-14-008,0.5,0.1,0.1,0.0,0.1,0.1,0.1,0.1

This summary table was then imported into the database using the "Import GIS Data" button on the *General Information* tab of the data entry form. Within the *Import Dialog* box within the "Import GIS Data" button, the *Update GIS Fields* option is chosen and the file name and extension was entered in the *Select a File to Import* box.

4.2.2 CREATING SUMMARY TABLE AND IMPORTING GENERAL INFORMATION EVALUATED UTILIZING GIS

Several other pieces of information were generated using GIS to the improve accuracy and eliminate the possibility of data entry errors. The data generated included:

1. **Municipality/Township** (both primary and secondary) within which the wetland lies.
   A GIS polygon dataset developed by the Metropolitan Council (i.e. County_CTU.shp) containing boundaries of cities, township and unorganized territory (CTU) in the Twin Cities 7-county metropolitan area was used to determine the municipal location of each assessed wetland. The linework for this dataset comes from individual counties and is assembled by the Metropolitan Council for the MetroGIS community. The data was current as of April, 2000. Up to two pieces of data were generated from this analysis indicating the city(ies) or township(s) within which the wetland is located (i.e. "InfoCityName" and "InfoCityName2" fields). The first parameter, InfoCityName is the city within which the majority of the wetland lies, and the second, InfoCityName2 is for wetlands that cross municipal boundaries and indicates the city within which the smaller portion of the wetland lies. Each assessed wetland polygon was evaluated in GIS to determine within which city the majority of the wetland lies.
2. **Subwatershed** within which the majority of the wetland lies.
   The GIS polygon dataset provided by the Minnehaha Creek Watershed District containing the boundaries of the 16 subwatersheds in the District (Figure 1.1) was used to determine within which subwatershed the majority of each wetland lies (i.e. "InfoSubwatershed" field).
3. **Wetland Area** in acres of each assessed wetland and potential wetland restoration areas.
   The area of each wetland and potential wetland restoration area was computed in GIS using the approximate, field-verified wetland boundaries that had been digitized in GIS.

4.2.2.1 City/Subwatershed Data Import

The city and subwatershed location information was then tabulated into a summary table for importing into the database. Again, a comma delimited file format was used as shown below:
"Wetland_id","InfoCityName","InfoCityName2","InfoSubwatershed"
D-028-24-26-001,Richfield,,Richfield/South Minneapolis
D-117-22-12-035,Hopkins,Minnetonka,Upper Minnehaha Creek

This summary table was then imported into the database using the "Import GIS Data" button on the *General Information* tab on the data entry form. Within the *Import Dialog* box within the "Import GIS Data" button, the *Update Gen'l Information* option is chosen and the file name and extension was entered in the *Select a File to Import* box.

4.2.2.2 Wetland Area Data Import

The wetland area information was then tabulated into a summary table for importing into the
McRAM database. Again, a comma delimited file format was used as shown below:
"WETLAND_ID","INFOCURRENTSIZE"
D-118-23-16-007,0.47
D-118-23-13-026,2.28
This summary table was then imported into the database using the "Import GIS Data" button on
the *General Information* tab of the data entry form. Within the *Import Dialog* box within the
"Import GIS Data" button, the *Update Wetland Areas* option is chosen and the file name and
extension was entered in the *Select a File to Import* box.

4.3 Data Management and Data Use in GIS

All wetland functional data and general information is maintained in the MnRAM Access®
database. Only the wetland polygons and *Assessment* status for each Wetland ID are maintained
in GIS. The wetland functional data and general information stored in the database can be
temporarily referenced in GIS for preparing maps and conducting spatial analyses.

4.3.1 ACCESSING AND UTILIZING DATA FROM THE DATABASE

1. Create ODBC connection to Database as follows (these directions are for Windows2000):
    a. Go to the control panel and select administrative tools.
    b. Select the "Data Sources (ODBC)" icon
    c. Select the System DSN tab
    d. Push the "Add" button
    e. It will ask for a "driver", select the Microsoft Access driver (*.mdb).
    f. Type in "Master Database" for Data Source Name. Type in a description (not
        required).
    g. Specify the MnRAM database location by pushing the "select" button.
    h. When done, say OK and leave the setup program.

2. If the Access table has not been loaded into the ArcView project, do the following:
    a. From the projects menu in ArcView, select "SQL Connect", a dialog box will
        appear.
    b. Select "Master Database" from the dropdown list, then press "Connect".
    c. A list of "Tables" appears. Select **tblSummaryGISDataFinalNums** (contains the
        computed numeric scores for all functions except groundwater and storm water
        sensitivity) from the list.
    d. Double click on <all columns> in the columns list
    e. Name the output table **tblSummaryGISDataFinalNums**
    f. Push the query button. This should load the Access table into ArcView as an
        ArcView table.
Repeat steps a through f for the following tables:

tblSummaryGISDataFinal   (contains the Assessment status [*fldStatus*]along with the text
    ratings for each function)

tblSummaryGISDataTwoFinal   (contains the Assessment Status, Circular 39 types,
    Hydrologic Setting, Geomorphic setting, City1, City 2, Subwatershed, Wetland Size,
    Cowardin type, and Community description)

Each of these tables can be joined to the Wetland shapefile in GIS using the Wetland_ID as the common field. To map wetland types in GIS based on the dominant Circular 39 wetland type, a wetland classification lookup table must also be joined to the Wetland shapefile. From the ArcView project window, add Table *wet_lkup_sens_121602b.txt*, join to the Wetland shapefile using the *Circular 39* field as the common field and the *Dom_Type* field contains the dominant wetland type for each assessed wetland. The Circular 39 wetland types shown on the Wetland Classification figures for each municipality (i.e. Figures 6.27-6.56) are either the dominant wetland type within the assessed wetland or a known subdominant Exceptionally sensitive wetland type, if present (i.e. Types 7 and 8 wetlands). This data is contained in the field *Design* in the Table *wet_lkup_sens_121602b.txt*. Virtually any of the data tables contained in the database can be joined to the GIS Wetland shapefile as described above, however, just those tables containing the most commonly utilized data are described above.

4.4 Quality Assurance and Quality Control

Several procedures were implemented to ensure the accuracy and completeness of the data generated during the course of the project. Five primary data products were generated as a result of the project:

1. Field Assessment Maps
2. Wetland GIS Shapefile
3. Database Records
4. Wetland Photographs
5. Wetland Photo Points

Each data product contains valuable information that is either explicitly presented in this report or is part of the project record that will be integral for future use. It was important to ensure that each of these five products contained data corresponding to each unique Wetland ID.

Field Assessment Maps are part of the project record and contain all of the direct field notations including approximate wetland boundary mapping, wetland assessment status, Wetland IDs, field evaluator identification, field evaluation dates, wetland photo numbers, and wetland photo location. Many of the wetland boundaries that were revised from the inventory were not incorporated into the final GIS Wetland shapefile, so the field assessment maps provide valuable wetland boundary information not included in this report. The wetland assessment status data was incorporated into the GIS Wetland shapefile and should correspond precisely. The Wetland ID represents the unique identifier for each wetland and is the most important piece of information that must be connected to all data collected for each wetland. The identification of field evaluators, dates of each wetland assessment, and photo numbers are valuable for tracking down any data entry errors that may be present.

Wetland GIS Shapefiles contains the unique spatial wetland location and extent data, which was used as the baseline data on field assessment maps from the inventory. The original inventory shapefile was updated and revised based on the field assessments conducted throughout the project. Each assessed wetland must have a unique Wetland ID to which all other data generated during the project is tied.

Database Records contain all of the wetland functional data collected in the field and analyzed using GIS which must correspond directly to the Wetland ID noted on the field maps and contained in the Wetland GIS shapefile. The database is the primary data storage program for all

data generated during the project except the spatial wetland location and extent data. It is imperative that each Wetland ID in the database corresponds to the proper wetland in the Wetland shapefile.

Wetland Photographs were taken at the time each wetland was assessed in the field and provides a visual record of each wetland from that point in time. Each digital photograph was automatically assigned a number by the camera when the photo was taken. That wetland photo number then was manually tracked and renamed using the unique Wetland ID number.

Wetland Photo Points represent the approximate location from which the photograph was taken. This location data was designated on the field maps and digitized into a photo point shapefile in GIS at the approximate location from which the photo was taken and within the wetland polygon.

4.5 Automated ArcView and McRAM Database QA/QC

The first quality assurance/quality control analysis was conducted in GIS to ensure that each unique Wetland ID contained only one wetland polygon indicated with an **A** (assessed) in the *Assessment Status* field. The second QA/QC analysis was developed to initially check for a one-to-one correspondence between wetland assessment records in the database and "assessed" wetland polygons in ArcView following the completion of the field wetland assessments. From that analysis, a table is produced containing four data columns with the possible values as follows:

1. GIS Status: The shapefile indicates whether or not the wetland was indicated as assessed in the wetland shapefile.

   > Assessed – Assessment field contains an "A", shown as assessed on map
   > Not Assessed – Assessment field contains "NA", shown as not assessed
   > N/A – indicated as no record in ArcView

2. GIS Message: If the Wetland ID exists in the shapefile, but not the Access database

   > OK – there is a polygon in the shapefile and the database
   > No Shapefile Record – There is no Wetland ID in the shapefile.
   > More than One Shapefile – more than one polygon with the same Wetland ID and both shown as "Assessed"

3. Access Status: Indication in Access database table whether or not the wetland has a completed assessment record or restoration potential evaluation.

   > Assessed – Wetland has a completed wetland database record.
   > Not Assessed – The "Complete Box" in the database has not been checked
   > N/A – indicated as no record/ID in Access database

4. Access Message: If the Wetland ID exists in the Access database but not in the shapefile.

   > Assessed – Database record for this Wetland ID has the Complete Box checked.
   > No Table Record – No data in the database for this ID.

A new table summarizing the results will be created. Those with "Assessed" in column 1 and 3, have corresponding records in GIS and Access. Those with different values in columns 1 and 3

must be analyzed in further detail as do those without an "OK" in column 1 or 3 some aspect of the database or shape file is missing. Based on these results inconsistencies were amended. The final, automated QA/QC procedure conducted involved an analysis of wetland photo points to ensure that each "assessed" wetland polygon contain one, and only one, wetland photo point digitized within the wetland polygon.

4.5.1 MANUAL ARCVIEW AND DATABASE QA/QC

All spatial wetland assessment data was mapped in ArcView for each municipality within the District. The wetland functional data was presented in three sets of tables for each municipality. A manual QA/QC procedure was conducted to ensure that the spatial wetland assessment data and database wetland functional data were consistent. The municipal Wetland Classification maps and municipal Wetland Data Tables were manually checked to ensure that each unique, assessed Wetland ID contained one wetland polygon and one database record. The QA/QC procedure for ensuring that one digital photograph was present for each assessed wetland was conducted on approximately a weekly basis throughout the duration of the project. Each field evaluator created a log of wetlands assessed and original photo numbers that was then double-checked after the wetland photos were renamed.

4.6 GIS Information:

Data Standards and Practices in Metro/Minnesota

County and Minor Civil Division Coding Exchange Standards (Statewide)
   The three-digit FIPS and state standard county code as adopted as a standard for state
   agencies has been adopted as a MetroGIS standard for data exchange.
   http://www.metrogis.org/data/standards/index.shtml

Minnesota Land Cover Classification System
   Developed minimum mapping units and can let you know how to cost out a project of this
   magnitude. They used the MetroGIS community to aid in their development of a standard
   product, gain statewide buy-in and then approve/adopt the standard and use for a regional
   dataset.

Contact Information:
   Bart Richardson, DNR Metro Region, Phone: 651-772-6150

MetroGIS Contact Information:
   Randy Johnson, Metropolitan Council, MetroGIS Project: 651-602-1638

More information about GIS data is available at the following websites:

   National Wetlands Inventory (NWI) Polygons:
   http://deli.dnr.state.mn.us/metadata/index_th.html

   County Soil Surveys:
   (metro Counties) www.datafinder.org/metadata/orthos2000.htm
   (statewide): http://lucy.lmic.state.mn.us/metadata/doq.html

check area LGU for updated photography or other resources

Watershed Basins (minor watershed):
(statewide) http://deli.knr.state.mn.us/metadata/full/bas95ne3.html

Parcel (land ownership):
(metro only) http://www.datafinder.org/catalog.asp
statewisde contact information only): http://www.lmic.state.mn.us/cty_contacts.html

MCBS Native Plant Communities:
http://deli.dnr.state.mn.us/metadata/full/mnnpcpy2.html

Mn Scientific and Natural Areas:
http://deli.dnr.state.mn.us/metadata/full/snaxxpy3.html

MCBS Sites of Biodiversity Significance:
http://deli.dnr.state.mn.us/metadata/full/mnsbspy2.html

Color Infrared (CIR):
http://www.dnr.state.mn.us/airphotos/ordering.html

5.0 Quick Reference—how to install the program, enter data, and get reports

Using the MnRAM database

This section is meant to supplement, not replace, user training on the wetland assessment method. Training will explain the method and rational behind the questions; this section will explain how to use the program itself. It assumes a level of familiarity with data entry and computers in general and will not attempt to explain common terms or actions.

A Visual User Manual is available over the Internet as a PowerPoint™ presentation. It gives a virtual tour of the database as well as descriptions and explanations of the questions.

ALL MNRAM MATERIALS ARE AVAILABLE AT THIS WEBSITE:
www.bwsr.state.mn.us/wetlands/mnram/index.html

5.1 Installing the Program

Download the program to your hard drive. At the website, the text version (Microsoft Word™), field sheets (Excel™), and other materials are also available.

5.2 Opening the Database/Naming Wetland Conventions

When you open the database, Access will give several warning screens. Do not be alarmed; these are standard and cannot, at this time, be avoided. Answer <Okay> or <Run Program> as necessary and you will get to the main screen.

The first time you open a blank database, the main screen will appear blank with some button options to the right. Use your mouse to click the top button: "Add New Wetland." This brings up a pop-up window as shown below. The cursor should be at an open field where you first enter the site name (any mix of numbers or letters is possible). Click on the arrow near the County column to choose the County (a two-digit
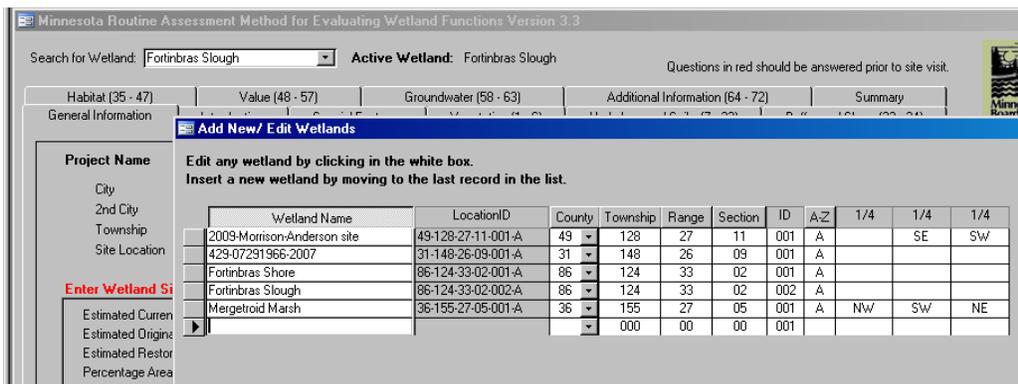
County Code will fill in automatically). Enter the three-digit Township number, the two-digit Range number, and the two-digit Section number. The three-digit ID is for differentiating basins among clusters of wetlands that exist in the same section. Starting with the northern-most site, number them counterclockwise (NE to NW to SW to SE) in order (001, 002, etc.).

The next field is indicates whether this is the first (A), second (B), third (C) or subsequent assessment of the wetland. Up to three ¼ section locations can be added as in the following example: SW ¼ of the SW ¼ of the SW ¼. Together, these numbers make up a unique Wetland ID.

You can add several sites at once, or do one at a time. After you have entered your sites, close the Add window.

The list of wetland names you have entered will appear in the drop-down list at the "Search for Wetland" field in the upper left. Highlight one to begin entering data. The cursor can be advanced from field to field by using the "Tab" or "Enter" key. Use your mouse to switch tabs to a new set of questions.
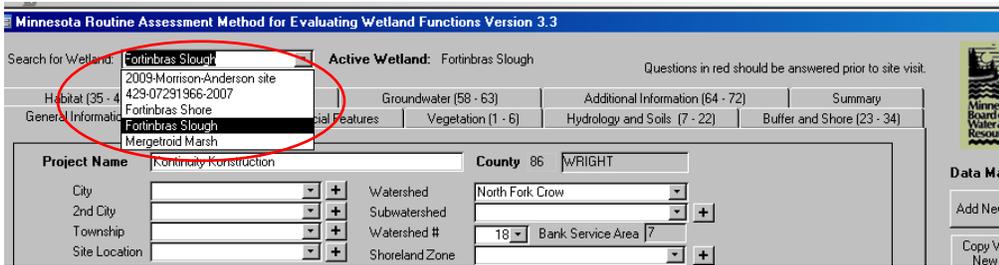
5.3 Entering Data

To activate a Wetland record for inclusion into reports or for export to another database, the "Complete Box" must be checked. There are several data quality checks built into the database to capture potential errors. Please take care to answer all of the questions (except for Questions 30-35 when Shoreline Protection does not apply and Questions 65-70 when Wetland Restoration potential does not apply), as all questions must be answered for the functional index calculations to perform.
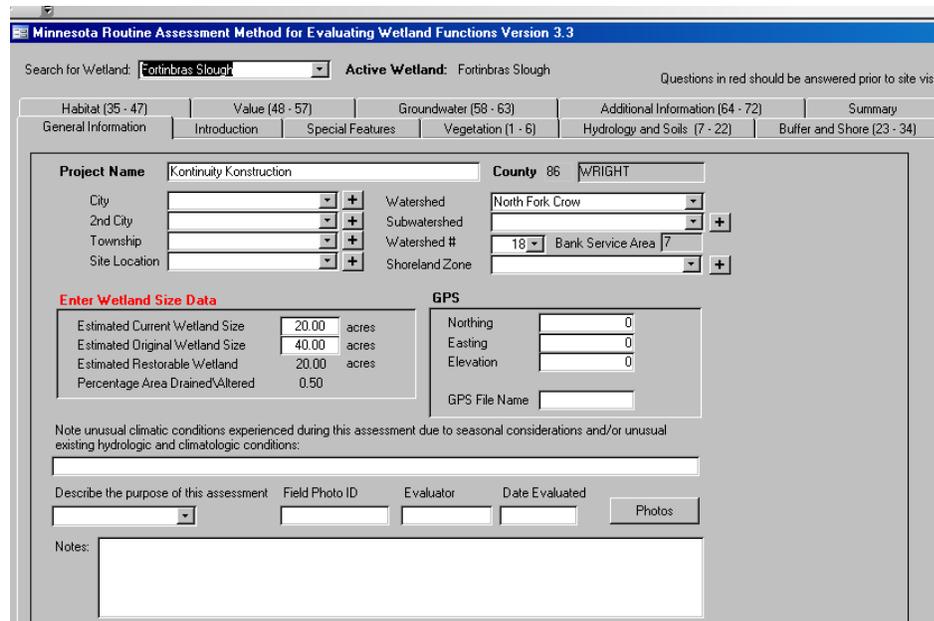
Fields that have a drop-down list available look like this: [____ ▼] If the choice you want is not listed, you may be able to add it to the list by pressing the + button and entering the data. In some cases (such as the list of watersheds or vegetative communities), you will not be able to modify the list.

The next tab, "Introduction," gives the history and overall purpose of the wetland assessment method, as well as the ranking structure. Because of space limitations, it is a summary of the information contained in the Comprehensive Guidance.

The "Special Features" tab gives a list of checkboxes, "A" through "U", which should be checked if they apply to the wetland. To check a box, either click on the box with the mouse, or, if the box is highlighted (with a dotted line around it by tabbing or entering through), then type "Shift +" to check the box.

As on all screens, use the mouse to move the scroll bar in order to see the lower portion of the page without having to tab all the way through it.

Before answering any question, click on the [?] to show the guidance, which points out the purpose of the question and assists in choosing the correct response.

The main questions begin on the next tab: "Vegetation (1-6)." Up to five communities may be listed under Question #1.

Question #2 Dominant Species refers to vegetative species making up 10 percent or more within the entire wetland and all non-native or invasive species. This list is for your reference only; there are no formula connections based on the Dominant Species list.

The drop-down list is set to search by group common name but you can change to search by common or scientific name using the Display Name Toggle. As you start typing in the first open field, choices will be offered. Open the drop-down list to see full list and pick the appropriate choice. If you want to enter a species that is not on the list, contact BWSR MnRAM support to request it.
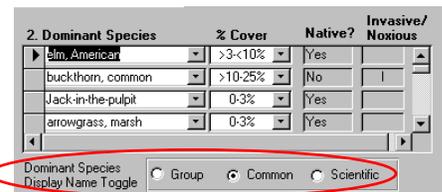
An indicator for whether a species is native/non-native or invasive/noxious will fill in automatically from the list.

Question #3 Veg Index is answered in the table shown under Question #1. It is the Vegetative Index rating that you give to each distinct Wetland Plant Community.

Because of programming restrictions, the database version does not allow you to split out dominant species by Community Type, as in the Excel and paper versions. Because the species list is for reference only, this will not affect the ratings. In later versions, this discrepancy will be eliminated.

The rest of the questions on this tab are self-explanatory.

Hydrology and Soils (7-22) is the next tab. Guidance for many questions is available by clicking the question mark next to a field: [?]. Questions shown in red need additional resources to answer and may be answered in the office ahead of time. Answers to all other questions should be recorded in the field.

Buffer and Shore (23-34) is the next tab. Questions #24-26: remember that these refer to *all* the land surrounding the wetland out to 50 feet, whether or not it would be considered "buffer." See the definition provided in the guidance to Question 23. The total of the three boxes for each question must add up to 100 or you will not be able to move off of that tab.

The next set of tabs, starting with Habitat (35-47) is "in back" of the first row. When you click on any of these rear tabs, the entire second row of tabs moves forward.

Questions #37 and #38: click on the box labeled "image" to see the choices.

5.4 Summary and Reports

The last tab summarizes the functional ratings using preset formulas to calculate final scores for each function. Because there are four ways to calculate and report vegetative diversity and integrity, these results are listed separately.

Check the Complete box and press <Refresh> to see the summary values on screen. <Print Summary> will show a one-page report of the functional ratings. That report may be printed for inclusion in reports.

To get a listing of the responses to all the questions, use the Individual Site Report. This report does not show the functional ratings, just the values you entered for each question. A description of the reports is given in Sections 5.5.5 – 5.5.7.

5.5 Extra Features

5.5.1 WETLAND PHOTO

First, load digital wetland photos into a specified drive and folder. Pressing <Photos> at the General Information tab will bring up a window for handling photo files. The "open folder" icon allows you to browse to the location where you stored the photos and link them to the site. Although not required, a standard naming convention to tracking photos is advised. One method is to name with the full Wetland ID, with the numbers given by County, Township, Range, Section, ID, and Letter. The camera icon, when clicked, will open the photograph. Double-click the photo to return to the database record. Although more than one photo may be linked to a site, be aware that photo records take up a great deal of disk space and plan accordingly.
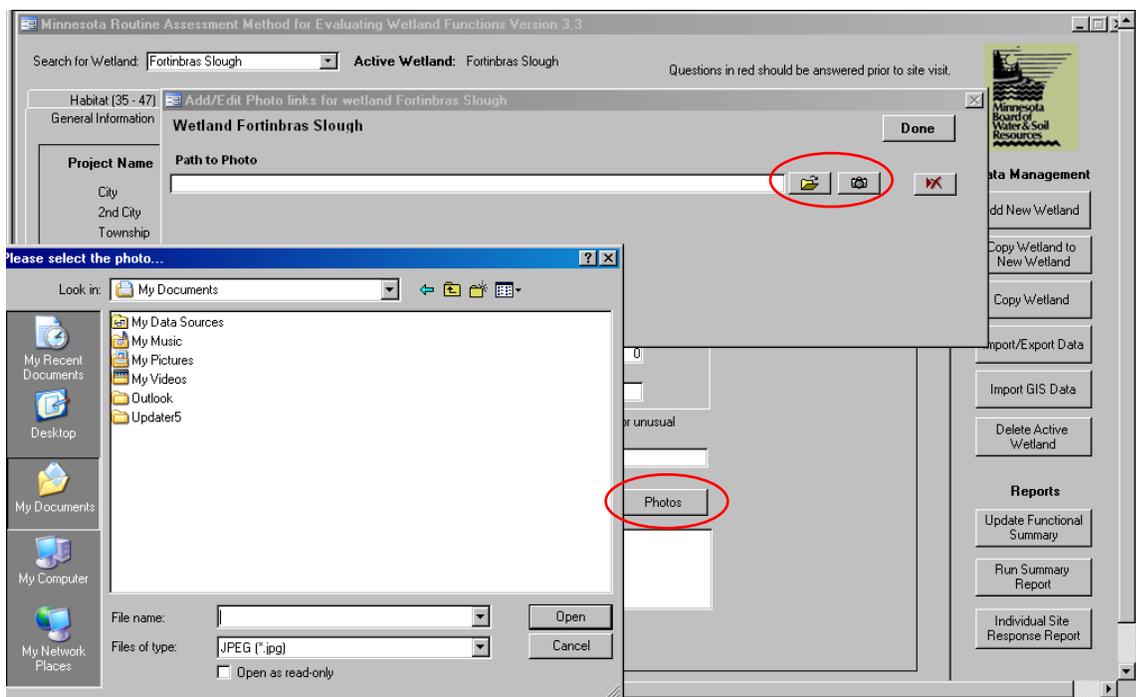
5.5.2 IMPORT-EXPORT DATA

 "Import/Export Data" is used to export assessment data from one database and import that data into another copy of the database. This feature is useful when it is desirable to compile data from multiple users into a single location or to import existing data into a newer version of the database. Only records that have had the "Complete" box checked (on the "General Information" tab) will be included in the export. Click on the import data box, type in the specific file path (including a "\" at the end of the first line and type in the folder name in the user box) where the data the data is located, select import or export and click <Import Record>.

5.5.3 IMPORT GIS DATA

Three types of GIS data can be imported using this feature. Import data must be set up in a comma-delimited file format in the exact order shown below. The dialog box describes three options: which are described below along with the data that is included in each import routine:

Option #	Description	Data included
1	Update Wetland Areas: "WETLAND_ID","INFOCURRENTSIZE"	Wetland ID, wetland size (in acres)
2	date Gen'l Information: "Wetland_id","InfoCityName","InfoCityName2","InfoSub watershed"	Wetland ID, first city, second city (leave blank if only in one city), subwatershed
3	Update GIS Fields: "Wetland_ID","Q19_val","Q21_val","Q58_val","Q60_val","Q51 _val","Q04_val","Q35_val","6_val"	Wetland ID, Questions # 19, 21, 58, 60, 51, 4, 35, 36

For each Wetland ID included in an import file, the data included in each import routine will be overwritten over any existing data in the database. If a blank is provided for any of the data, a null value will be entered for that question within that Wetland ID record.

5.5.4 COPY WETLAND TO NEW WETLAND / COPY WETLAND RECORD

This time-saver feature allows all the ratings of one wetland assessment record to be copied into the record of another. This feature is most useful during inventory situations for wetlands with similar morphological characteristics, location, land uses, and hydrologic features. The receiving record must be reviewed with care to ensure that important, but subtle differences are not overlooked. It is recommended that you use this only with wetlands that are in close proximity to each other on the landscape.

If you already have Wetland Names entered for both the "to be copied" site and the duplicate wetland, use the simple <Copy Wetland> button. Otherwise, <Copy Wetland to New Wetland> allows you to create a new wetland record "on the fly".

5.5.5 UPDATE FUNCTIONAL SUMMARY

This feature is used to update added data to the report tables during a working session. Wetland subsets can be chosen here similar to the reporting feature. Update Functional Summary **must be**

run during a working session **prior to running reports**, otherwise, data entered during the working session will not appear in the reports.

5.5.6 RUN SUMMARY REPORT

Two reports can be generated:
>   1) Functional Assessment Summary (this is a two-page report).
>   2) Wetland Community Summary.

Because wetland vegetative community information can be extensive and is often used for different purposes, this report is separate from the functional rating report.

You can choose to view the ratings as either Numeric (i.e. 0.64, 1.0) or Text (i.e. high, medium, low). Choosing the numeric view allows you to see how close a rating may have been to the next category (a rating of 0.65, for example, will result in a Medium rating, whereas a 0.66 is High).

Each report can be run with either all data (every site will appear) or filtered by subset categories: Complete/Incomplete, Project, City, and Subwatershed.

If you want to be able to see the results from a group of sites, name all the sites with the same Project Name (i.e. "Timber Woods Development"). If you want the results of one site, choose a unique Project Name for that site (i.e. "Haldeman Driveway Project").

For a comprehensive report showing both vegetative and functional rating information together from a single site, with both numeric and text ratings, press the <Print Summary> button on the Summary tab. You can print the report that appears onscreen.

5.5.7 INDIVIDUAL SITE REPORT

The last report button on the General Information tab will produce a report that shows the responses to most questions. If you need to show this in a report or want to compare input between two or more sites, this report provides a concise record of the entries. It does not provide a summary of the results, however: to get a record of the functional ratings, go the Summary tab and choose <Print Summary>.

5.6 Using the Data—Management Classification

Once wetlands have been assessed, the data stored in the MnRAM database may be used for local planning, regulatory determinations, or other general use. Wetland Management Classification is intended to give local resource managers a framework for using the wetland data to make land use and wetland management decisions. The Wetland Management Classification system provides a scientifically based approach to ranking wetland functions. A document explaining the Management Classification system is available at the BWSR website. The last two pages show the flow charts that have been programmed into the MnRAM database.

There are two prepared options for sorting wetlands, Basic and Increased Protection. The results of both sort options are given at the end of the Summary page.

Also shown are the functions and ratings that caused the wetland to fall into the management category shown. Understanding how management classification works is easiest using the visual aide of the flowcharts.

6.0 Functional Rating Formulas

GENERAL NOTE: Some questions are not applicable to particular wetlands and will be scored N/A. In these cases, rather than count N/A as zero, an alternate equation is provided that eliminates the question from the formula altogether. Because not every question has N/A as an option, formulas that do not include N/A-option questions have only one configuration.

Formulas with a "reverse rating" (marked as "R") take the actual response and "flip" its value for the calculation, so that a question response of "A" high (value of 1.0) will be calculated as low (value of 0.1). In such a formula, medium ratings stay medium.

6.1 VEGETATIVE DIVERSITY/INTEGRITY

Table 3: Vegetative Diversity/Integrity Summary

The functional rating is based primarily on the diversity of vegetation within the wetland in comparison to an undisturbed condition for that wetland type. An exceptional rating results from one of the following conditions: 1) highly diverse wetlands with virtually no non-native species, 2) rare or critically impaired wetland communities in the watershed, or 3) the presence or previous sighting of rare, threatened, or endangered plant species. A high rating indicates the presence of diverse, native wetland species and a lack of non-native or invasive species. Wetlands that rate low are primarily dominated by non-native and/or invasive species.

This table may be used when calculating Vegetative Diversity/Integrity Functional Index manually. It shows four options for calculating and presenting floristic data. If you are entering data directly into the MnRAM database, this table does not apply.

	3A Proportion of Wetland	3B Individual Community Scores	3C Highest Quality	3D Non-Weighted Average	3E Weighted Average
Community #1	T	A		A	A
Community #2	U	B		B	B
Community #3	V	C		C	C
Community #4	W	D		D	D
Community #5	X	E		E	E
Community #6	Y	F		F	F
Community #7	Z	G		G	G
Wetland Rating Value	1.0		**Highest Value**	(A+B+C+D+E +F+G)/7 = **Ave.**	(A*T)+(B*U)+(C*V)+(D *W)+(E*X)+ (F*Y)+(G*Z) = **Wt. Ave.**

If any questions #4-6 are answered yes and/or if any of the Special Features b, d, or i have been selected, enter Exceptional for the functional index. If not, compute the contribution to vegetative diversity and integrity by each plant community by doing the following: multiply the ranking for each community

(Question #3b) by its total proportion in Question 3a (percent of total). Then, the functional index for the entire wetland can be calculated four ways (as follows) and should be utilized according to the scope of the project:

   3b) Individual Community Scores: maintain raw data as recorded.

   3c) Highest Quality Community: report the highest-functioning community.

   3d) Non-Weighted Average Quality of all Communities: straight average

   3e) Weighted Average Quality Based on Percentage of Each Community: multiply each community rating by its percentage, then add all together.

Vegetative Diversity/ Integrity					
	3a. Proportion of Wetland	**3b. Individual Community Scores**	**3c. Highest Rated Community Quality**	**3d. Non-Weighted Average**	**3e. Weighted Average**
Community #1	T	A			
Community #2	U	B	**If Spec. Features b, d or i are checked then rate Exceptional (2); if either question 4, 5, or 6 are Yes, then rate Exceptional (2); else:**		
Community #3	V	C			
Community #4	W	D			
Community #5	X	E			
Community #6	Y	F			
Community #7	Z	G			
Overall Wetland Value Rating	1.0		: Highest Value of A-G	: (A+B+C+ D+E+F+G)/7 = Ave.	:(A*T)+(B* U)+(C*V)+ (D*W)+(E* X)+(F*Y)+(G*Z) = Wt. Ave.

6.2 *MAINTENANCE OF CHARACTERISTIC HYDROLOGIC REGIME*

A wetland's hydrologic regime or hydroperiod is the seasonal pattern of the wetland water level that is like a hydrologic signature of each wetland type. It defines the rise and fall of a wetland's surface and subsurface water. The constancy of the seasonal patterns from year to year ensures a reasonable stability for the wetland[24]. The ability of the wetland to maintain a hydrologic regime characteristic of the wetland type is evaluated based upon wetland soil and vegetation characteristics, land use within the wetland, land use within the upland watershed contributing to the wetland, and wetland outlet configuration. Maintenance of the hydrologic regime is important for maintaining a characteristic vegetative community, and is closely associated with other functions including flood attenuation, water quality and groundwater interaction.

Measures the degree of human alteration of the wetland hydrology, either by outlet control or by altering immediate watershed conditions. Each parameter is weighted equally.

MnRAM #	Excel #	Variable Description	Type of Interaction
13	E17	Outlet—natural hydrologic regime	Controlling
14	E18	Dominant upland land use	Compensatory
15	E19	Soil condition/wetland	Compensatory
20 R	F24	Stormwater runoff/pretreatment-Reversed	Compensatory

Hydrologic Regime Index = $(13+14+15+20_{reverse})/4$

6.3 *FLOOD AND STORMWATER STORAGE/ATTENUATION*

A wetland's ability to provide flood storage and/or flood wave attenuation is dependent on many characteristics of the wetland and contributing watershed. Characteristics of the subwatershed that affect the wetlands ability to provide flood storage and attenuation include: soil types, land use and resulting stormwater runoff volume, sediment delivery from the subwatershed, and the abundance of wetlands and waterbodies in the subwatershed. Wetland characteristics which affect the wetland's ability to store and or attenuate stormwater include: condition of wetland soils; presence, extent, and type of wetland vegetation; presence and connectivity of channels; and most importantly outlet configuration. Higher rated wetlands will have an unaltered or restricted outlet, undisturbed wetland soils, dense emergent vegetation without channels, a high proportion of impervious surfaces in the subwatershed, large runoff volumes, clayey upland soils, and few wetlands present within the subwatershed.

This formula is based on the Surface Water Storage Functional Capacity Index scoring concept and equation[25]. The formula was altered with the addition of three surface flow characteristics and two stormwater runoff parameters (Stormwater Runoff Quality/Quantity and Subwatershed Wetland Density) along with the removal of two parameters (Soil Porosity and Subsurface Outlet, which is already characterized in another parameter). This index is comprised of 5 primary processes, which are weighted equally; included in each major process are one to three characteristics that equally contribute to that process.

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[24] Mitsch and Gosselink, 2000

[25] Lee et al., 1997

1. **Outlet Characteristics**: Outlet characteristics
2. **Upland Watershed**: Upland land use, Upland soils,
3. **Wetland Condition/Land Use**: Wetland land use, sediment delivery
4. **Runoff Characteristics:** Stormwater runoff quality/quantity, subwatershed wetland density
5. **Surface Flow Characteristics**: Flow-through emergent vegetation density, surface flow characteristics

Flood and Stormwater Storage Index Computation:

Entire Formula: Outlet for flood retention$\{12\}$ + (Dominant upland use$\{14_{reversed}\}$+ Upland soils$\{19\}$)/2 + (Soil condition$\{15\}$ + Sediment delivery$\{18\}$)/2 + Stormwater runoff pretreat&det$\{20\}$ + Subwatershed wetland density$\{21\}$)/2 + (Percent emergent vegetative cover$\{16\}$ + Flow-through emergent vegetative roughness$\{17\}$ + Channels/sheet flow$\{22\}$)/3)/5.

1. If 12=0, then: $((14_{reversed} +19)/2+(15+18)/2+(20+21)/2+(16+17+22)/3)/4$

2. If 12>0, then: $(12+(14_{reversed} +19)/2+(15+18)/2+(20+21)/2+(16+17+22)/3)/5$

> No changes to the formula are necessary if 16=0.

Flood and Stormwater Storage/Attenuation Variables

MnRAM #	Excel #	Variable Description	Type of Interaction
12	E16	Outlet—flood attenuation	Controlling—optional
14-R	F18	Dominant upland land use—reversed	Compensatory
19	E23	Upland soils	Compensatory
15	E19	Soil condition	Compensatory
18	E22	Sediment delivery	Compensatory
20	E24	Stormwater pretreatment &detention	Compensatory
21	E25	Subwatershed wetland density	Compensatory
16	F20	Emergent vegetation % cover	Comp.—optional
17	E21	Emergent vegetation flood resistance	Comp.—optional
22	E26	Channels/sheet flow	Compensatory

6.4 *DOWNSTREAM WATER QUALITY PROTECTION*

This rates the wetland's ability and opportunity to protect valuable downstream resources. Valuable downstream resources include recreational waters (i.e. lakes, streams, rivers, creeks, etc) and potable water supplies. The level of functioning is determined based on runoff characteristics, sedimentation processes, nutrient cycling, and the presence and location of significant downstream water resources. Runoff characteristics that are evaluated include: land use and soils in the upstream watershed, the stormwater delivery system to the wetland, and sediment delivery characteristics. The ability of the wetland to remove sediment from stormwater is determined by emergent vegetation and overland flow characteristics. A high nutrient removal rating indicates dense vegetation and sheet flow to maximize nutrient uptake and residence time within the wetland. The opportunity for a wetland to protect a valuable water resource diminishes with distance from the wetland so wetlands with valuable waters within 0.5 miles downstream have the greatest opportunity to provide protection, as do those that receive more (and less-treated) runoff.

Compute Functional Index for Downstream Water Quality Protection
This functional index computation was derived from a combination of Nutrient Cycling and Retention of Particulates functions in the HGM Prairie Pothole draft guidebook[54] with the downstream sensitivity concept from *The Minnesota Wetland Evaluation Methodology*. Three major processes make up equal portions of the Downstream Water Quality Protection function[26] with a measure of opportunity to protect downstream resources; each process is comprised of two to four observable parameters.

1. **Rate, Quantity, and Quality of Runoff to the Wetland**: this is characterized by the conditions in the upstream watershed; both land use and soils, that affect the sediment and nutrient loads to the wetland, and by the existing storm water delivery system to the wetland (Upland watershed conditions, storm water runoff, evidence of sediment delivery, and upland buffer each comprise 1/16 of the entire downstream water quality functional index based on their contribution to sediment removal).
2. **Sedimentation**: this is characterized by the presence of flow-through emergent vegetation density and by the overland flow characteristics within the wetland. A wetland with primarily sheet flow through the wetland and dense emergent vegetation density will allow sediment to drop out more effectively than a wetland with channel flow and no vegetation (When all parameters are applicable; emergent vegetative density and overland flow characteristics each make up 1/8 of the total downstream water quality functional index based on their contribution to sediment removal).
3. **Nutrient Uptake**: this is characterized by the outlet configuration and vegetative characteristics. A wetland with long water retention times has more capacity to remove nutrients from the water column via physical and biological processes. Vegetation slows floodwaters by creating frictional drag in proportion to stem density which allows sediment particles to settle out, thereby improving the water quality for downstream uses (Outlet characteristics and vegetative density each make up 1/8 of the total downstream water quality functional index based on their contribution to nutrient uptake).
4. **Downstream Sensitivity**: if the wetland contributes to the maintenance of water quality within one-half mile of a recreational water body or potable water supply source downstream, it operates at a higher functioning level than a similar wetland farther from or without significant

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[26] Derived from a combination of Nutrient Cycling and Retention of Particulates functions in the HGM Prairie Pothole draft guidebook (Lee et al., 1997) with the downstream sensitivity concept from *The Minnesota Wetland Evaluation Methodology*.

downstream water resources (This factor accounts for ¼ of the total downstream water quality functional index).

Downstream Water Quality Functional Index Computations:

1. If 12=0, then: $(14+20+18+(\mathbf{23}+\mathbf{24}+\mathbf{26})/3+(\mathbf{16}+17)/2+27)/6$

2. If 12>0, then: $(14+20+18+(\mathbf{23}+\mathbf{24}+\mathbf{26})/3+(\mathbf{16}+17)/2+27+12)/7$

> No changes to the formula are necessary if 16=0.

Entire Formula:
(Dominant upland land use{14} + Stormwater runoff pretreatment & detention{20} + Sediment delivery {18} + (Upland buffer width{23_{WQ}} + Upland buffer vegetative cover{24} + Upland buffer slope {26})/3 + (Flow-through %emergent vegetative cover{16} + Flow-through emergent vegetative roughness{17})/2 + Downstream sensitivity{27}+ Outlet for flood{12})/7

Downstream Water Quality Variables

MnRAM #	Excel #	Variable Description	Type of Interaction
14	E18	Dominant upland land use	Controlling
20	E24	Stormwater runoff pretreatment & detention	Controlling
18	E22	Sediment delivery	Controlling
23	G27	Upland buffer width—water quality valuation	Comp.
24	G28	Upland area management	Comp.
26	G34	Upland area slope	Comp.
16	F20	Emergent vegetation (% cover)	Comp.—optional
17	E21	Emergent vegetation (roughness coefficient)	Comp.—optional
27	E39	Downstream sensitivity	Comp.
12	E16	Outlet for flood	Controlling--optional

6.5 MAINTENANCE OF WETLAND WATER QUALITY

The sustainability of a wetland is partially driven by the quality and quantity of stormwater runoff entering the wetland. The ability of the wetland to sustain its characteristics is evaluated based on characteristics of the contributing subwatershed and indicators within the wetland. Subwatershed conditions which affect the wetland's sustainability in relation to water quality impacts include: upland land use; sediment delivery characteristics to the wetland; stormwater runoff volumes and rates; and the extent, condition, and width of upland buffer. Indicators of nutrient loading to the wetland indicate that a diverse wetland may not be sustainable. Indicators that a wetland has been affected by nutrient loading include the presence of monotypic vegetation and/or algal blooms.

This functional index was derived from a combination of sources including MNRAM, HGM, WEM, WET, and experiences of the project team. The sustainability of a wetland is partially driven by the quality and quantity of stormwater runoff entering the wetland. The ability of the wetland to sustain its characteristics is evaluated based on characteristics of the contributing subwatershed and indicators within the wetland. Subwatershed conditions which affect the wetland's sustainability in relation to water quality impacts include: upland land use; sediment delivery characteristics to the wetland; stormwater runoff volumes and rates; and the extent,

condition, and width of upland buffer. Indicators of nutrient loading to the wetland indicate that a diverse wetland may not be sustainable. Indicators that a wetland has been affected by nutrient loading include the presence of monotypic vegetation and/or algal blooms.

Wetland Water Quality Functional Index Computation:

$(3e*2 + 14 + 20_{reversed} + (\textbf{23} + \textbf{24} + \textbf{26})\textbf{/}3 + 18 + 28)/7$

Entire Formula:
(Vegetative Diversity/Integrity{3e*2} + Dominant upland land use{14} + Stormwater runoff pretreatment & detention{$20_{reversed}$} + (Upland buffer width{23_{WQ}} + Upland buffer vegetative cover {24} + Upland buffer slope {26})/3 + Sediment delivery {18})/2 + Nutrient loading {28})/7

Wetland Water Quality Variables

MnRAM #	Excel #	Variable Description	Type of Interaction
3e	D6*2	Vegetative Diversity/Integrity	Contributing
14	E18	Dominant upland land use	Contributing
20 R	F24	Stormwater runoff pretreatment and detention—RR	Contributing
23	G27	Upland buffer width—water quality valuation	Contributing
24	G28	Upland area management	Contributing
26	G34	Upland area slope	Contributing
18	E22	Sediment delivery	Contributing
28	E40	Nutrient loading	Contributing

This functional index was derived from a combination of sources including MNRAM, HGM, WEM, WET, and experiences of the project team. The sustainability of a wetland is partially driven by the quality and quantity of stormwater runoff entering the wetland. The ability of the wetland to sustain its characteristics is evaluated based on characteristics of the contributing subwatershed and indicators within the wetland. Subwatershed conditions which affect the wetland's sustainability in relation to water quality impacts include: upland land use; sediment delivery characteristics to the wetland; stormwater runoff volumes and rates; and the extent, condition, and width of upland buffer. Indicators of nutrient loading to the wetland indicate that a diverse wetland may not be sustainable. Indicators that a wetland has been affected by nutrient loading include the presence of monotypic vegetation and/or algal blooms.

6.6   SHORELINE PROTECTION

Shoreline protection is evaluated only for those wetlands adjacent to lakes, streams, or deepwater habitats. The function is rated based on the wetlands opportunity to protect the shoreline; i.e. wetlands located in areas frequently experiencing large waves and high currents have the best opportunity to protect the shore. In addition, shore areas composed of sands and loams with little vegetation or shallow-rooted vegetation will benefit the most from shoreline wetlands. The wetland width, vegetative cover, and resistance of the vegetation to erosive forces determine the wetland's ability to protect the shoreline.

Each of the five parameters contributes equally[27]: based primarily on the characteristics presented in WEM with a simple, straightforward computation of the index assuming all characteristics contribute equally.

MnRAM #	Excel #	Variable Description	Type of Interaction
29	E41	Shoreline?	Controlling
30	E42	Rooted shoreline vegetation (% cover)	Contributing
31	E43	Wetland width (average)	Contributing
32	E44	Emergent vegetation erosion resistance	Contributing
33	E45	Shoreline erosion potential	Contributing
34	E46	Bank protection ability	Contributing

Shoreline Protection Functional Index Computation:

If 29=1, then:
Shoreline Protection Index = (30+31+32+33+34)/5

Entire Formula:
(Rooted shoreline vegetation {30} + Average shoreline wetland width {31} + Emergent vegetation erosion resistance {32} + (Shoreline erosion potential {33} + Bank protection ability {34})/5

6.7 MAINTENANCE OF CHARACTERISTIC WILDLIFE HABITAT STRUCTURE

The ability of a wetland to support various wildlife species is difficult to determine due to the specific requirements of the many wildlife species that utilize wetlands. This function determines the value of a wetland for wildlife in a more general sense, and not based on any specific species. The characteristics evaluated to determine the wildlife habitat function include: vegetative quality, outlet characteristics (which control hydrologic regime), upland land use, wetland soil type and conditions, water quality of storm water runoff entering the wetland, upland buffer extent, condition, and diversity; the interspersion of wetlands in the area; barriers to wildlife movement; wetland size; vegetative and community interspersion within the wetland; and amphibian breeding potential and overwintering habitat.

Thirteen parameters are weighed equally as described below; vegetative quality is weighted double the other factors. The questions are borrowed or modified from MNRAM, WET, WEM, and HGM methodologies, combined to provide a measure of wildlife habitat in general, not focusing on any particular species.

If Rare Wildlife (35) or Rare Natural Community (36) are true, then this Index is Exceptional.

If Special Features d, g, or j are checked, then this Index is Exceptional, otherwise, follow conditions below:
If 37=0 and 38=0 and 39=0 [Vegetation (37) and Community interspersion (38) and Wetland Detritus (39) are all n/a], then:
(3e*2+40+41+(**23**+**24**+**25**)/3+13+ 20)/7

If 38=0 and 39=0 [Community interspersion (38) and Wetland Detritus (39) are n/a], then:
(3e*2+37+40+41+(**23**+**24**+**25**)/3+ 13+20)/8

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[27] Based primarily on the characteristics presented in WEM.

If 37=0 and 39=0 [Vegetation (37) and Wetland Detritus (39) are n/a], then:
(3e*2+38+40+41+(**23**+**24**+**25**)/3+ 13+20)/8

If 37=0 and 38=0 [Vegetation (37) and Community interspersion (38) are n/a], then:
(3e*2+39+40+41+(**23**+**24**+**25**)/3+ 13+20)/8

If 39=0 [Wetland Detritus (39) is n/a], then:
(3e*2+37+38+40+41+(**23**+**24**+**25**)/3+13+20)/9

If 38=0 [Community interspersion (38) is n/a], then:
(3e*2+39+37+40+41+(**23**+**24**+**25**)/3+13+20)/9

If 37=0 [Vegetation interspersion (37) is n/a], then:
(3e*2+39+38+40+41+(**23**+**24**+**25**)/3+13+20)/9

If 37>0 and 38>0 and 39>0, then:
(3e*2+39+37+38+40+41+(**23+24+25**)/3+13+20)/10

Entire Equation:
(Vegetative Diversity/Integrity{3e*2} + Wetland Detritus {39} + Vegetation Interspersion {37} + Community Interspersion {38} + Wetland Interspersion {40} + Wildlife Barriers {41} + (Upland buffer width {23$_{wildlife value}$} + Upland Area Management{24} + Upland area diversity {25})/3 + Outlet natural hydrologic regime {13}+ Stormwater runoff pretreatment and detention 20$_{reversed}$)/10

MnRAM #	Excel #	Variable Description	Type of Interaction
41	E53	Wildlife barriers	Controlling
3e	D6	Vegetative Ranking (communities' weighted average)	Compensatory
39	E51	Wetland detritus (n/a)	Contributing
23	I27	Upland buffer average width—wildlife valuation	Contributing
24	G28	Upland area management	Contributing
25	G31	Upland area diversity	Contributing
13	E17	Outlet natural hydrologic regime	Contributing
20 R	F24	Stormwater runoff pretreatment & detention—reversed	Contributing
37	F49	Vegetation interspersion (n/a)	Contributing
38	F50	Community interspersion (n/a)	Contributing
40	E52	Wetland interspersion	Contributing

6.8 MAINTENANCE OF CHARACTERISTIC FISH HABITAT

The ability of the wetland to support native fish populations is determined by structural factors within the wetland as well as water quality contributions from upland factors. Wetlands rated High are lacustrine or riverine and provide spawning/nursery habitat, or refuge for native species (included but not limited to game fish). Wetlands rated Low for fish habitat do not have a direct hydrologic connection to a waterbody with a native fishery or have poor water quality.

MnRAM #	Excel #	Variable Description	Type of Interaction
46	E58*2	Fish habitat quality	Controlling
29	D41	Fringe wetland?	Contributing
24	G28	Adjacent area management	Compensatory

18	E22	Sediment delivery	Compensatory
20 R	F24	Storm water runoff—reversed	Compensatory
28	E40	Nutrient load	Compensatory
30	E42	Percent cover	Compensatory
31	E43	Wetland shoreline width	Compensatory
33 (R)	F45	Shoreline erosion potential	Compensatory

Fish Habitat Functional Index Computation:

If Special Features a or g are checked, then Fishery Habitat Index = Exceptional.

If 46=0, then Fishery Habitat = N/A

If 29=0, Fishery Habitat Index = $[(46*2)+24+18+20_{reversed}+28]/6$

If 29>0, Fishery Habitat Index = $[(46*2)+24+18+20_{reversed}+28+\mathbf{30}+\mathbf{31}+\mathbf{33(R)}]/9$

6.9   *MAINTENANCE OF CHARACT. AMPHIBIAN HABITAT FOR BREEDING/OVERWINTERING*

The characteristic ability of a wetland to support various amphibian species is difficult to determine due to the specific requirements of the many amphibian species that depend on wetlands. This function determines the value of a wetland for amphibians in general, not based on specific species. An adequate wetland hydroperiod and the presence or absence of predatory fish are considered to be limiting variables for this function. In general, wetlands must remain inundated until early to mid-June to allow the larval stages to metamorphose into adults. Because many amphibians are partly terrestrial, the characteristics evaluated to determine the amphibian habitat function include numerous hydrology and terrestrial measures. The characteristics evaluated include: upland land use, upland buffer width, water quality of storm water runoff entering the wetland, barriers to wildlife movement, and amphibian breeding potential and overwintering habitat.

An adequate wetland hydroperiod (Question 42) is considered to be the primary limiting variable for this functional index. If the hydroperiod is insufficient for breeding, the wetland rating for amphibian use will be Not Sufficient. The status of predatory fish in the wetland (Q.43) is a secondary limiting factor to the final rating; the lowest rating for this variable, however, is 0.1 (Low), rather than zero (Not Sufficient).

Amphibians' ability to use a particular wetland for over wintering is a contributing factor in rating the wetland's functional index (Q.44). Because most amphibians are partly terrestrial, the extent of upland buffer habitat surrounding the wetland (Q.23) is an important habitat component[28] and is weighted by a factor of two. Question 14 (Upland Land Use) is also included as an indicator of the quality of the surrounding upland habitat[56]. Unnatural fluctuations in water depth in wetlands from conducted storm water runoff can impair reproductive success in amphibians, which often attach their eggs to stems of wetland vegetation, e.g., salamanders, tree frogs, green frogs, and wood frogs[29]. Extreme water level fluctuations during winter may also cause mortality in overwintering reptiles and amphibians[30]. Thus,

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[28] Knutson et al., 2000
[29] Richter and Azous, 1995
[30] Hall and Cuthbert, 2000

Question 20 is included in the formula, with a reverse rating. Question 41 (Barriers) is included because access to and from the wetland by amphibians is an important factor in habitat quality[31].

Amphibian Habitat Functional Index Computation:

If 42=0, then N/A

Otherwise: Amphibian Habitat Index = $(43) * [(44 + 2*23_{wildlife} + 14 + 41 + 20_{reversed})/6]$

Entire Formula:

If Amphibian Breeding Potential-Hydroperiod {42} is applicable, then: (Amphibian Breeding Potential-Predator Fish {43}) * {[(Amphibian Overwintering Habitat {44}+ 2*Upland Buffer Width (23)$_{Wildlife}$ + Dominant Upland Land Use {14} + Barriers {41} + Stormwater Input {20$_{reverse}$}]/6}

Amphibian Habitat Variables

MnRAM #	Excel #	Variable Description	Type of Interaction
42	D54	Amphibian breeding potential—hydroperiod	Controlling
43	D55	Amphibian breeding potential—fish presence	Controlling
44	E56	Amphibian overwintering habitat	Compensatory
23	I27	Upland buffer width	Compensatory
41	E53	Wildlife barriers	Compensatory
14	E18	Dominant upland land use	Compensatory
20	F24	Stormwater runoff pretreatment & detention—RR	Compensatory

6.10   AESTHETICS/RECREATION/EDUCATION/CULTURAL/SCIENCE

The aesthetics/recreation/education/cultural and science function and value of each wetland is evaluated based on the wetland's visibility, accessibility, evidence of recreational uses, evidence of human influences (e.g. noise and air pollution) and any known educational or cultural purposes. Accessibility of the wetland is key to its aesthetic or educational appreciation. While dependent on accessibility, a wetland's functional level could be evaluated by the view it provides observers. Distinct contrast between the wetland and surrounding upland may increase its perceived importance. Also, diversity of wetland types or vegetation communities may increase its functional level as compared to monotypic open water or vegetation. Excess negative human influence on the wetland is counted double in the formula.

All questions contribute equally to the overall index.

MnRAM #	Excel #	Variable Description	Type of Interaction
48	E60	Rare educational opportunity	Controlling
49	E61	Wetland visibility	Compensatory
50	E62	Proximity to population	Compensatory
51	E63	Public ownership	Compensatory
52	E64	Public access	Compensatory
53	E65	Human influence—wetland	Compensatory

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[31] Knutson, et al., 1999; Findlay and Bourdages, 2000; Semlitsch, 2000.

54	E66	Human influence—viewshed	Compensatory
55	E67	Spatial buffer	Compensatory
56	E68	Recreational activities in wetland	Compensatory

Aesthetics/Recreation/Education/Cultural/Science Functional Index Computations:

If Special Features c, h, or u is checked[32], or

If 48=1, then Index = Exceptional;

If 53=0.1 (Low), then = (50+51+52+2*53+54+55+56)/8

If 53>0.1, then = (49+50+51+52+53+54+55+56)/8

Entire Formula

(Wetland Visibility {49} + Proximity to Population {50} + Public Ownership {51} + Public Access {52} + Human Influence - Wetland {53} + Human Influence - Viewshed {54} + Spatial Buffer {55} + Recreational Activities in Wetland {56})/8

6.11   COMMERCIAL USES

This question considers the nature of any commercially-valuable use of the wetland and requires the assessor to consider how such use may be a detriment to the sustainability of the wetland. Some row crops can be planted in Type 1 wetlands after spring flooding has ceased and still have adequate time to grow to maturity. This non-wetland-dependent agricultural use of wetlands may include hay, pasture/grazing, or row crops such as soybeans or corn. Wetland-dependent crops include wild rice and cranberries, which rely on the wetland hydrology for part of their life cycle.

Sustainable uses of the wetland would not require modifying a natural wetland. Products in this category would include collection of botanical products, wet native grass seed, floral decorations, wild rice, black spruce, white cedar, and tamarack. Sustainable uses may require modification of the natural hydrology, such as for wetland-dependent crops (rice, cranberries). Haying and grazing can be less intrusive agricultural activities utilized more or less casually when hydrologic conditions permit; light pasture and occasional haying would be considered more or less sustainable. Like peat-mining, cropping is an unsustainable use of the wetland as it is results in severe alterations of wetland characteristics (soil, vegetation, hydrology).

MnRAM #	**Excel #**	Variable Description	Type of Interaction
57	**E69**	Commercial crop—hydrologic impact	Controlling

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[32] c = Designated scientific and natural area; h = Archeologic or historic site designated by the State Historic Preservation Office; u = State or Federal designated wilderness area.

Commercial Uses Functional Index = 57

6.12 GROUND-WATER INTERACTION

The ground water interaction function is the most difficult to assess. Here the most likely type of ground water interaction is determined, i.e. recharge or discharge, or a combination. In many cases, a wetland will exhibit both recharge and discharge characteristics, however one is usually more dominant. Several wetland and watershed characteristics are evaluated to determine the likely interaction including: wetland soil type, upland land use, upland soil types and wetland size, wetland hydroperiod, wetland outlet characteristics, and topographic relief.

The purpose of this function is strictly to determine the likelihood of the appropriate ground-water interaction based on observable characteristics of the wetland and watershed. The significance of ground water as a component of the wetland water budget is the most difficult functional characteristic to determine without large quantities of detailed hydrologic and geologic information. The following methodology takes the most easily observable and distinct measures of recharge/discharge relationships from the *Wetland Evaluation Technique*[33] and the *Hydrogeomorphic Assessment Methodology*[34]. In many wetlands, surface water and ground water both make significant contributions to the water budget, but occasionally recharge or discharge is dominant. The goal here is to identify the dominant ground-water interaction (if there is one) to help guide future management and provide an indication when additional information may be warranted.

- If 5 or 6 of questions 58-63 are answered the same, this indicates a strong likelihood that the most frequently stated interaction exerts the primary influence on the wetland.
- If 3-4 questions are answered the same, then the wetland is likely influenced by a combination of both recharge and discharge interactions (i.e. both types of ground water interaction are likely to be present at some point during most years).

58. Wetland Soils – from HGM system functional assessments and Novitzki
59. Subwatershed Land Use/Imperviousness – taken from WET Volume I
60. Wetland Size and Upland Soils – taken from WET Volume I and HGM
61. Wetland Hydrologic Regime– taken from WET Volume I and HGM
62. Inlet/Outlet Configuration – taken from WET Volume I and HGM
63. Upland Topographic Relief – taken from WET Volume I

Special Concerns for Recharge Wetlands
  Wherever ground water recharge is indicated as the **primary** interaction and the wetland lies within a sensitive ground water area (**Special Feature Question q**), a contribution area to a public water supply, or a wellhead protection area (**Special Feature Question r**), it should be recorded as Exceptional for the ground water/wetland function.

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[33] Adamus, et al., 1987
[34] Magee and Hollands, 1998

6.13 WETLAND RESTORATION POTENTIAL

The potential for wetland restoration is determined based on the ease with which the wetland could be restored, the number of landowners within the historic wetland basin, the size of the potential restoration area, the potential for establishing buffer areas or water quality ponding, and the extent and type of hydrologic alteration. Each variable uses the High, Medium, Low rating rather than raw numbers—see MnRAM for individual ranges.

MnRAM #	Excel #	Variable Description	Type of Interaction
64	**D79**	Wetland Restoration Potential	Controlling
65	F80	Number of Landowners Affected	Contributing
21	E25	Subwatershed Wetland Density	Contributing
66b	F82	Total Wetland Restored Size (Potential)	Contributing
66c	F83	Calculated potential new wetland area	Contributing
67	F84	Potential Buffer Width	Contributing
68	F85	Likelihood of Restoration Success	Contributing

If 64="Yes", then Wetland Restoration Potential = (65+21+66b+66c+67+68)/6,

Otherwise, if 64="No" then "N/A"

Entire Formula
(Landowners Affected by Restoration (65)+Subwatershed Wetland Density (21)+ Wetland Restoration Size (66b)+Proportion of Wetland Drained (66c)+Potential Buffer Width (67)+Likelihood of Restoration Success (68))/6

6.14 WETLAND SENSITIVITY TO STORMWATER INPUT AND URBAN DEVELOPMENT

The sensitivity of the wetland to stormwater and urban development is determined based on guidance within the *Storm-Water and Wetlands: Planning and Evaluation Guidelines for Addressing Potential Impacts of Urban Storm-Water and Snow-Melt Runoff on Wetlands*, State of Minnesota Storm-Water Advisory Group, June 1997. The database pulls this rating directly from the Plant Community entry. If any of the following plant communities are present, this value will always be Exceptional: 3B, 4A, 4B, 7A,7B, 10A,13A,14A, 16B.

Use habitat proportions from Vegetative Integrity section and enter into a formula to compute answer according to the following criteria[35].

Exceptional = Sedge meadows, open and coniferous bogs, calcareous fens, low prairies, wet to wet-mesic prairies, coniferous swamps, lowland hardwood swamps, or seasonally flooded basins.

A = Shrub-carrs, alder thickets, diverse fresh wet meadows dominated by native species, diverse shallow and deep marshes, and diverse shallow, open water communities.

B = Floodplain forests, fresh wet meadows dominated by reed canary grass, shallow and deep marshes dominated by cattail, reed canary grass, giant reed or purple loosestrife, and shallow, open water communities with low to moderate vegetative diversity.

C = Gravel pits, cultivated hydric soils, or dredge/fill disposal sites.

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[35] Taken directly from State of Minnesota Storm-Water Advisory Group, 1997.

6.15   ADDITIONAL STORMWATER TREATMENT NEEDS

This rates the sustainability of the wetland with regard to stormwater discharges to the wetland. The need for additional stormwater treatment prior to discharge to the wetland is rated based on the overall rating for Maintenance of Wetland Water Quality. If a wetland is severely degraded by stormwater inputs, the rating will be low, since a diverse, high quality wetland will not be sustainable.

Use functional rating for Maintenance of Wetland Water Quality (MWWQ) as follows (this index is rated strictly from the measure of the water quality in the wetland and the sustainability, i.e. if the water quality in the wetland is low, additional stormwater treatment is needed to protect the wetland and the rating is low):

Use Value for Maintenance of Wetland Water Quality Index (D76, Excel spreadsheet) and apply to criteria below.

A = Maintenance of Wetland Water Quality Index >0.66 (no additional treatment needed)
B = 0.33 < Maintenance of Wetland Water Quality Index # < 0.66 (sediment removal needed)
C = Maintenance of Wetland Water Quality Index < 0.33 (sediment and nutrient removal
       needed)

Most reference material will be available at the Board of Water & Soil Resources library. Please report errors or omissions to the BWSR MnRAM contact person.

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8.0 Appendices

Appendix 1: Possible Best Management Practices, Detailed Listing

Type of Practice	Area of Benefit	Storm Protection Benefit	Pollutants Controlled	Construction Requirements
Institutional Source Controls				
Public Education (Billing inserts, news releases, radio public service announcements, school programs, and pamphlets)	Not applicable.	Reduced pollutant load to storm drain system.	Can reduce improper disposal of paints, varnishes, thinners, pesticides, fertilizers, and household cleansers, and chemicals, etc.	None.
Litter Control	Site dependent.	Reduced potential for clogging and discharge.	Household and restaurant paper, plastics, and glass.	Increase number of trash receptacles and regulary service.
Recycling Programs	Site dependent.	Reduction in potential for clogging and harmful discharge.	Household paper, glass, aluminum, and plastics. Oil and grease from auto maintenance.	Collection and sorting stations.
"No Littering" Ordinance	Storm drain system and receiving water.	Prohibits littering and prevents litter from entering storm drains.	Paper, plastics, glass, food wrappers, and containers.	None.
"Pooper Scooper" Ordinance	Storm drain system and receiving water.	Requires animal owners to clean up and properly dispose of animal wastes.	Coliform bacteria and nitrogen/urea.	None.
Develop and Enact Spill Response Plan	Site dependent.	Prevent pollutants from entering storm drain.	Hazardous chemical, harmful chemicals, oil, and grease.	None.
Clean Up Vacant Lots	Site dependent.	Prevent debris from accumulating on lot. Prevent site from appearing as a "dump" for others to use for disposal. Eliminate sources of hazardous waste.	Hazardous and/or harmful chemicals, wind blown for water borne debris.	None.
Prohibit Illegal and Illicit Connections and Dumping into Storm Drain System	Storm drain system and receiving water.	Reduces pollutant load entering storm drains.	Coliform bacteria, nitrogen, contaminants, and toxic or harmful chemicals.	None.

Type of Practice	Area of Benefit	Storm Protection Benefit	Pollutants Controlled	Construction Requirements
Identify, Locate, and Prohibit Illegal or Illicit Discharge to Storm Drain System	Area-wide.	Halt hazardous and harmful discharges, whether intentional or negligent.	Sewage from cross connections, oil, grease, direct disposal of pesticides and fertilizers, contaminated water, paint, varnish, solvents, water from site dewatering, swimming pool and spa water, flushing water from radiators and cooling systems, and hazardous or harmful chemicals.	Monitor storm drain system for flows and water quality.
Require Proper Storage, use, and Disposal of Fertilizers, Pesticides, Solvents, Paints and Varnishes, and Other Household Chemicals (oil, grease, and antifreeze, etc.)	Site dependent (City, State, or County-wide).	Reduce pollutant load to storm system.	Household hazardous materials.	None.
Restrict Paving and Use of Nonporous Cover Materials in Recharge Areas	Recharge area site.	Promotes infiltration to groundwater and reduces runoff volume and velocity. Filters pollutants.		Establishment of vegetation or use of recharge/infiltration materials.
Nonstructural Source Controls				
Street Sweeping	Street right-of-way.	Reduction in potential for clogging storm drains with debris. Some oil and grease control possible.	Paper and plastics, leaves and twigs, dust, and oil and grease.	Acquire street sweeping equipment.
Sidewalk Cleaning	Sidewalk right-of-way in areas of heavy foot traffic.	Reduction in pollutants entering storm drain.	Oil and dirt.	None.
Clean and Maintain Storm Drain Channels Annually	Channel capacity and receiving water. Upstream flood control benefits. Includes benefits to channel wildlife habitat and vegetation.	Prevent erosion in channel. Improve capacity by removing silt and sedimentation. Remove debris that is habitat destroying or toxic to wildlife.	Silt and sediment and the contaminants contained therein. Plastic, glass, paper, and metal thrown or washed in channel.	None.
Clean and Inspect Storm Inlets and Catch Basins Annually	Site dependent flood control benefits.	Allows proper drainage to prevent flooding and continued proper operation of facilities.	Silt and sediment and the contaminants contained therein. Plastic, glass, paper, and metal thrown or washed into facilities.	None.
Clean and Inspect Debris Basins Annually	Site dependent flood control benefits.	Allows proper drainage to prevent flooding and continued proper operation of facilities.	Silt and sediment and the contaminants contained therein. Plastic, glass, paper, and metal thrown or washed into facilities.	None.

| Type of Practice	Area of Benefit	Storm Protection Benefit	Pollutants Controlled	Construction Requirements
Storm Drains Cleaned and Maintained Every 3 to 6 Years	Flood control and water quality benefits.	Allows proper drainage to prevent flooding and continued proper operation of facilities.	Silt and sediment and the contaminants contained therein. Plastic, glass, paper, and metal thrown or washed into facilities.	None.
Storm System Pump Stations Cleaned and Maintained Annually	Site dependent flood control and water quality benefits.	Prevents flooding and allows continued proper operation of facilities.	Silt and sediment and the contaminants contained therein. Plastic, glass, paper, and metal thrown or washed into facilities.	None.
Inspect and Maintain Sewer System	Storm drain system and receiving water.	Prevents and eliminates sewer system surcharges.	Contaminants, toxics, and coliform bacteria.	None.
Minor Structural Source Controls				
Storm Drain Inlet Protection	Storm drain drainage area.	Prevent debris from entering storm drain.	Dirt, leaves, twigs, paper, plastic, and other incidentals.	Not available.
Outlet Protection	Storm drain receiving water.	Prevent erosion at the outlet of pipes or paved channels and protect downstream water quality.	Turbidity and sediment.	Structural apron lining at the outlet location. Made of riprap, grouted riprap, concrete, or other structural materials.
Slope Stabilization and Erosion Control Measures	Site and topography dependent.	Reduce silt and sediment load to storm drains.	Silt and sediment and the contaminants therein.	None.
Interceptor Swale	Dependent on flow velocity. Max. velocity for earth channel is 6 fps. Max. velocity for vegetated or riprap channel is 8 fps.	Shorten length of exposed slopes and intercept and divert storm runoff from erodible areas.	Sediment and silt and the contaminants contained therein.	Excavation drainageway across disturbed areas or rights-of-way.
Improve and Maintain Natural Channels	Channel capacity and receiving water. Upstream flood control benefits. Includes benefits to channel wildlife habitat and vegetation.	Prevent erosion in channel. Improve capacity by removing silt and sedimentation. Remove debris that is habitat destroying or toxic to wildlife.	Silt and sediment and the contaminants contained therein. Plastic, glass, paper, and metal thrown or washed in channel.	None.
Diversion Channel	Dependent of flow velocity. Maximum velocities: 5 fps for vegetated channel and 8 fps for riprap channel. Not for use on slopes greater than 15%. Drainage area should be 5 acres or less.	Intercept and convey runoff to outlets at nonerosive velocity.	Sediment and erosion controls.	Lined drainageway of trapezoidal cross section.
Grass-Lined Channel	Site dependent but of larger capacity than interceptor or perimeter swales.	Intercept runoff and convey runoff from site.	Sediment and silt and the contaminants contained therein.	Excavation of channel or improvements to natural channel. Stabilization with vegetation.

Type of Practice	Area of Benefit	Storm Protection Benefit	Pollutants Controlled	Construction Requirements
Storm Drain Drop Inlet Protection	Areas less than 1 to 2 acres.	Filters sediment from runoff before it enters inlet. Provides relatively good protection.	Sediment and the contaminants contained therein.	Barrier around storm drain inlet. Useful for areas where storm drain is operational before area runoff area is stabilized.
Riprap	Site dependent	Provides stabilization and erosion control for stream banks and channels, outlet, and slopes.	Erosion and sediment.	Placement of rock on area to be stabilized. May also require use of filter fabric liner.
Gabions	Site dependent	Provides stabilization and erosion control for stream banks, outlet, and slopes.	Erosion and sediment.	Placement of wire cage will with rocks over area to be stabilized. May also require use of filter fabric liner.
Vegetative Control	Applicable and effective for most sites.	Provides stabilization and erosion control for streambanks, swales, channels, outlets, slopes, open disturbed areas. Can be up to 99% effective with established cover. Temporary seeding can be up to 90% effective.	Erosion and sediment.	Site preparation (can include land leveling and installation of irrigation system), seeding or planting, and netting or mulching to establish seed. Can also include other sodding, ground cover, shrubs, trees, and native plants.
Filter Strips	Site dependent.	Receives overland flow slowing runoff and trapping particulates. Can be 30 to 50% effective for sediment control.	Silt, sediment, trash, organic matter, and to an extent, soluble pollutants through infiltration.	Grading and vegetative establishment. Should have a minimum width of 15 to 20 feet. Good performance is achieved with a 50 to 75 foot width.
Fence Open Channels	Site dependent.	Prevent windblown trash from entering channel. Prevents illegal dumping in channel.	Trash and pollutants.	Construction of fences.
Discharge Elimination Methods				
French Drains and Subsurface Drains	Dependent on site topography and soil permeability.	Provides drainage of "wet" soils to allow establishment of vegetation. Can reduce runoff.	Sediment.	Underground perforated pipe leading to a surface water outlet. Pipe size, bedding and depth is dependent on site conditions.
Infiltration Trench and Dry Well	Small drainage areas. Runoff from rooftops, parking lots, residential, etc.	Provides temporary storage of runoff and infiltration to soil. Not for use in areas where groundwater could become contaminated.	Prevents 100% of pollutants from entering surface water. Oil, grease, floating organic matter, and settleable solids should be removed before water enters trench.	Excavation of a shallow trench 2' to 10' deep. Backfilled with coarse stone aggregate.

Type of Practice	Area of Benefit	Storm Protection Benefit	Pollutants Controlled	Construction Requirements
Exfiltration Trench	Site dependent.	Prevent silting on underlying filter gravel or rock bed. Retain first flush, reduce runoff volume and peak discharge rate and promote water quality improvement.	Prevents pollutants from entering surface water. Oil, grease, floating organic matter, and settleable solids should be removed before water enters trench.	Uses perforated pipe with suitable membrane filter material. Installed before receiving water outlet or in groundwater recharge area.
Porous Pavement	Site dependent. Requires relatively flat surface.	Allow infiltration of surface runoff. Reduce runoff volume and pollutant loadings from low volume traffic areas.	Oil and grease.	Install porous pavement. May require twice as much paving material as standard asphalt to achieve same strength.
Retention Basin	Best for sites of 5 to 50 acres.	Promotes infiltration to groundwater and reduces runoff volume and velocity. Filters pollutants.	Sediment, trace metals, nutrients, and oxygen-demanding substances.	Excavation of a basin over permeable soils. Size is site dependent. Depth is 3 to 12 feet.
Floatables and Oil Removal				
Clarifiers and Oil and Water Separators on Parking Structures	Parking lot structure and receiving water.	Collect debris before it can enter storm drain.	Oil, grease, and antifreeze from vehicles and foods and food wrappers.	Install grit and separators.
Oil and Grit Separators	Site dependent. For heavy traffic areas or areas with high potential for oil spills.	Remove pollutants.	Sediments and hydrocarbons.	Install oil and grit separators on storm drains.
Sediment/Grease Trap	Installed on storm drain inlets.	Intercept and trap sediment and grease from runoff.	Sediment, oil, and grease.	Install sediment and grease traps.
Solids Removal				
Detention Basin	Four acres of drainage area for each acre/foot of storage provided to retain a permanent pool of water.	Temporary storage of storm runoff until release. Can also improve water quality.	Sediment, trace metals, hydrocarbons, nutrients, and pesticides.	Excavation of a basin over soils which will cause excessive seepage. May require a liner. Can be used aesthetically as a small pond in landscaping.
Extended Detention Basin	Size for a minimum detention time of 24 hours.	Temporary storage of runoff for an extended period of time. Can improve water quality.	Sediment, trace metals, hydrocarbons, nutrients, and pesticides.	Excavation of a basin over soils which will cause excessive seepage. May require a liner. Can be used aesthetically as a small pond in landscaping.
Bar Screens	Site dependent.	Restrict passage of objects which may obstruct pump station suction bays.	Large debris.	Install bar screens before pump station suction bays.

Appendix 2: Ecological Classification System

The Ecological Classification System (ECS) is part of a nationwide mapping initiative developed to improve our ability to manage all natural resources on a sustainable basis. This is done by integrating climatic, geologic, hydrologic and topographic, soil and vegetation data.

Three of North America's ecological regions, or biomes, representing the major climate zones converge in Minnesota: prairie parkland, deciduous (Eastern broadleaf) forest and coniferous (Laurentian mixed) forest. The presence of three biomes in one non-mountainous state is unusual, and accounts for the diversity of ecological communities in Minnesota.
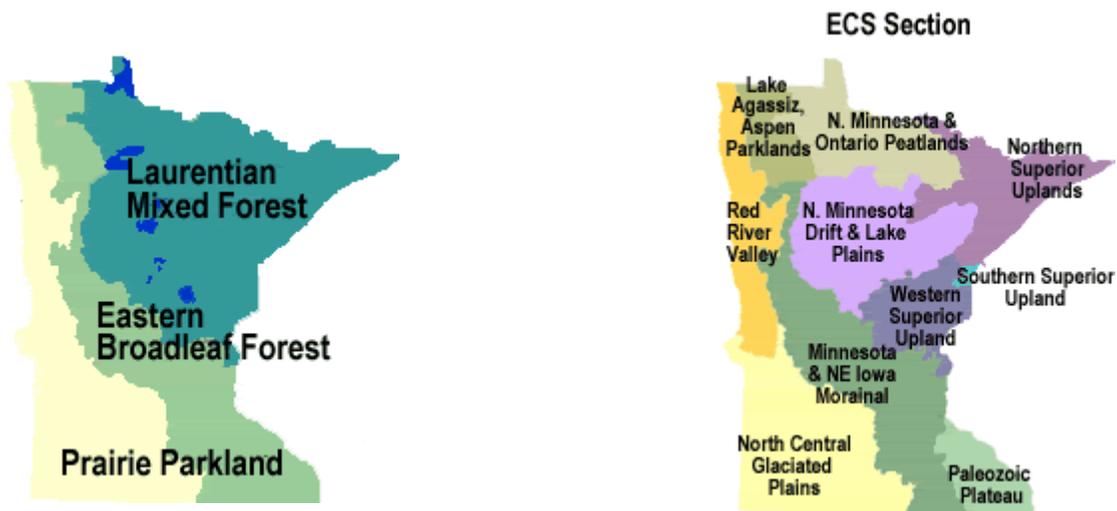
Appendix 3: Glossary

Aquatic Bed (AB) – A class within the Cowardin Wetland Classification system. Includes wetlands and deepwater habitats dominated by plants that grow principally on or below the surface of the water for most of the growing season in most years.

Best Management Practices: Land management actions that can be implemented to protect wetlands from various nonpoint source pollutants. In general, they must be designed and often implemented to meet site-specific needs. Typically, BMPs are chosen and implemented for their ability to treat or reduce sediment, nutrient removal and to reduce excess surface water from entering the wetland.

Buffer: A buffer is an unmanicured upland area dominated by permanent native and noninvasive vegetation immediately adjacent to the wetland boundary.

Discharge: Wetland systems in which water preferentially discharges from groundwater into the wetland.

Emergent shoreline vegetation: These plants grow along edges of lakes and ponds, or on wet ground away from open water. Examples of such vegetation include: cattail, bulrush, loosestrife, and reed canary grass.

Exotic Plant: A plant not originally from this area or location.

Facultative Plants: Plants with a similar likelihood of occurring in both wetlands and nonwetlands (estimated probability 33% to 67%).

Facultative Upland Plants: Plants that sometimes occur in wetlands (estimated probability 1% to 33%), but occur more often in nonwetlands (estimated probability >67% to 99%).

Facultative Wetland Plants: Plants that usually occur in wetlands (estimated probability 67% to 99%), but also occur in nonwetlands (estimated probability 1% to 33%).

Flood Attenuation: The slowing of a flood wave by spreading water flow laterally over the ground surface or by the increased resistance of water flow through emergent vegetation.

Genera: Genera or genus is a level of taxonomy and is typically the first part of a scientific name that is utilized to identify a plant or animal. The scientific name for purple loosestrife is *Lythrum salicaria* (*Lythrum* is the genus name, while *salicaria* is the specices name).

Geographic Information System (GIS): A system designed to work with data referenced by spatial or geographic coordinates.

Hydric Soils: Soils that are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in the upper part.

Hydrologic Regime (Hydroperiod): The seasonal pattern of wetland water level that is like a hydrologic signature of each wetland type. It defines the rise and fall of a wetland's surface and subsurface water. Constancy of seasonal patterns from year to year ensures a reasonable stability for the wetland.

Hydrophytic Vegetation: Macrophytic plant life growing in water, soil, or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content.

Inundation: Covering or flooding of the land surface with water.

Invasive Plant: A non-native plant that escapes from where it was planted and invades native plant communities.

Macrophyte: A plant that is physiologically adapted to live in sediment, which is saturated or inundated for an extended duration or permanently.

Monotypic Vegetation: Vegetative communities dominated by a single plant species.

National Wetland Inventory (NWI): An inventory of the Nation's wetland resources and deepwater habitats conducted by the U.S. Fish and Wildlife Service containing information on the extent and characteristics of wetlands identified primarily from aerial photographs.

Native Vegetation: Plant species that are indigenous to Minnesota or that expand their range into Minnesota without being intentionally or unintentionally introduced by human activity and are classified as native in the Minnesota Plant Database.

Non-invasive Vegetation: Plant species that do not typically invade or rapidly colonize existing, stable plant communities.

Non-native Plant: A plant introduced by human activities to areas where they do not naturally occur.

Nutrient Loading: The import of nutrients (phosphorus and nitrogen) carried in runoff water.

Obligate Upland Plants: Plants that rarely occur in wetlands (estimated <1%), but almost always occur in nonwetlands (estimated probability >99%) under natural conditions.

Obligate Wetland Plants: Plants that occur almost always (estimated probability >99%) in wetlands under natural conditions, but which may also occur rarely (estimated probability <1%) in nonwetlands.

Pretreatment: Removal of nutrients or sediment from stormwater runoff prior to discharging into a wetland.

Recharge: Wetland systems in which water preferentially seeps into groundwater.

Reference Standard Wetland: Reference Standard Wetlands are the least disturbed/altered wetlands within the Wetland Comparison Domain.

Submergent Aquatic Vegetation: The entire plant is usually underwater, but the flowers and fruits may rise above the water surface. Submergent species are rooted in the sediment and have underwater leaves. They can grow from shallow water to depths greater than 20 feet.

Subwatershed: Major watersheds are split up into subwatersheds, each of which defines the land area in which all water drains to a defined point.

Terrestrial Exotic Plant: A plant not originally from this area that is best adapted to life on ground that is not saturated or inundated for extended periods of time.

Watershed: The land area in which all water drains to a defined point.

Wetland: Lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. Wetlands must:

   (1) have a predominance of hydric soils;
   (2) be inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support a prevalence of hydrophytic vegetation typically adapted for life in saturated soil conditions; and
   (3) under normal circumstances, support a prevalence of hydrophytic vegetation.

Wetland Community: A characteristic assemblage of various vegetation species typically found in specific wetland conditions.

Wetland Comparison Domain: A Wetland Comparison Domain is defined in the MnRAM 2.0as the geographic area, generally of a size so as to include some relatively undisturbed Reference Standard Wetlands (e.g., the political boundary, major or local watershed boundary or ecoregion subsection), used for functional comparison.

Wetland Conservation Act (WCA): The Wetland Conservation Act became effective on January 1, 1992. WCA rules are administered by Local Government Units (LGU) with oversight provided by the Board of Water and Soil Resources and technical assistance from the Soil and Water Conservation Districts. The Department of Natural Resources conservation officers and other peace officers provide enforcement of the WCA. The primary goals of the WCA are to:

1. Achieve no net loss in the quantity, quality, and biological diversity of Minnesota's existing wetlands.

2. Increase the quantity, quality, and biological diversity of Minnesota's wetlands by restoring or enhancing diminished or drained wetlands.

3. Avoid direct and indirect impacts to wetlands from activities that destroy or diminish the quantity, quality, and biological diversity of wetlands.

4. Replace wetland values where avoidance of activity is not feasible or prudent.

Wetland Functions: Physical, chemical, or biological processes or attributes of a wetland -- simply something a wetland does. For example, the process of retaining surface water is a commonly cited wetland function.

Wetland Creation: The conversion of a persistent upland into a wetland by human activity.

Wetland Restoration: Reestablishment of a historical wetland in an area in which wetland hydrology has been removed.

Wetland Value: A wetland value is the extent to which a wetland function is perceived as beneficial to an individual or society. Reduced flood damage to downstream properties is a value generally associated with the function of surface water retention.