# Technical Procedures for the Minnesota Wetland Status and Trends Monitoring Program: Wetland Quantity Assessment

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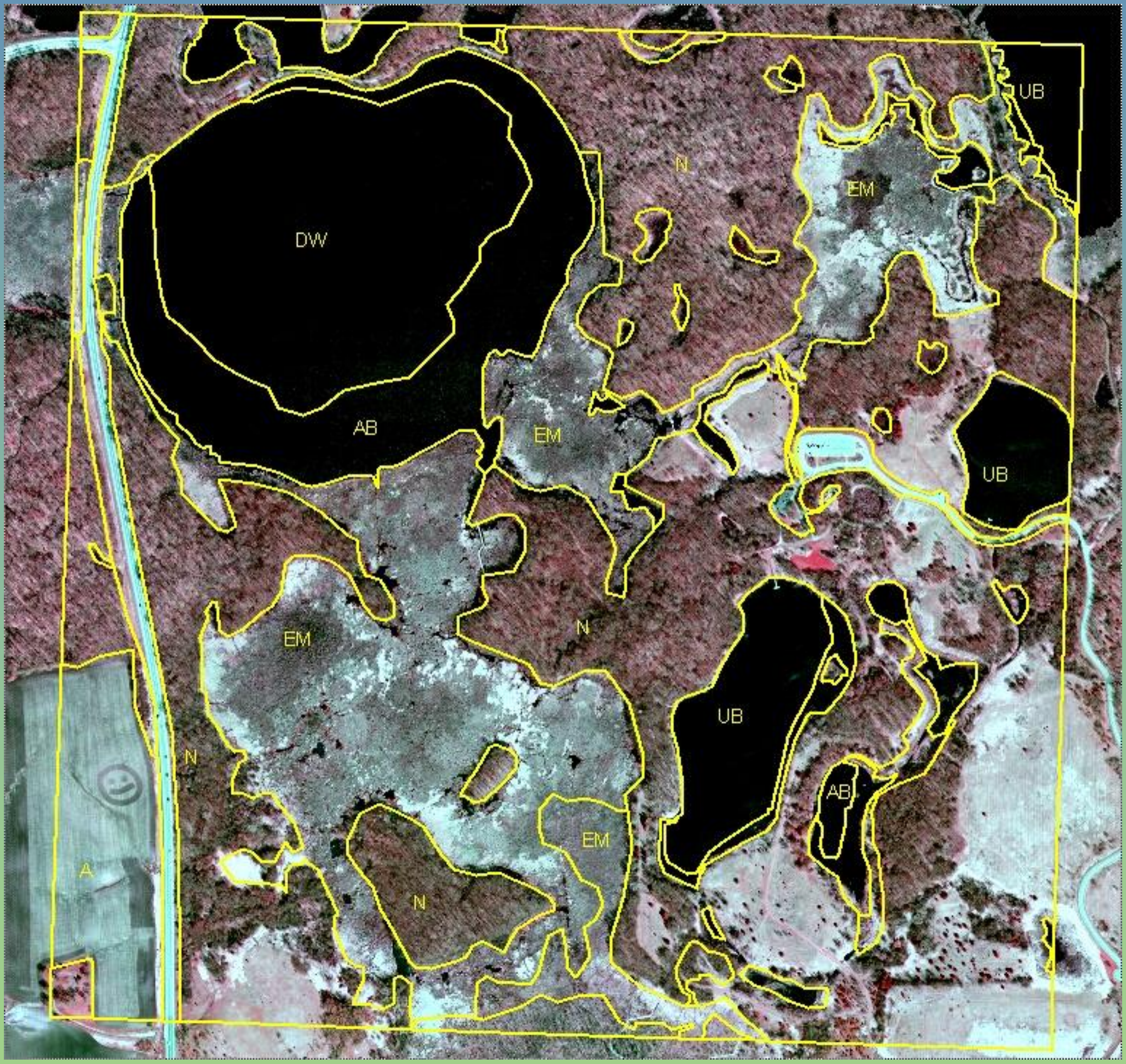


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# Contents

## 1. Introduction

The goal of the Wetland Status and Trends Monitoring Program (WSTMP) is to provide scientifically valid information regarding the quantity (extent and type) and quality of wetlands in Minnesota and to monitor changes in wetland extent and type over time. The program was originally proposed by an inter-agency task force as one of three key elements to a comprehensive wetland assessment, monitoring, and mapping strategy (CWAMMS - http://files.dnr.state.mn.us/eco/wetlands/wetland_monitoring.pdf). This program is adapted from a national wetland status and trends program developed by the U.S. Fish and Wildlife Service (Dahl 2000; Parker et al. 2004). This document describes the standard operating procedures used for the wetland quantity assessment component of the WSTMP. Procedures for the wetland quality component are described elsewhere.

## 2. Sampling Design

The WSTMP relies on repeated interpretation of aerial photography for 4,990 randomly distributed 1-$mi^2$ primary sample units (PSUs). The monitoring program uses a cyclical, interpenetrating panel structure based on the Generalized Random Tessellation Stratified (GRTS) design to ensure that random samples are spatially distributed across the state (Stevens and Olsen 2004). There are two types of PSUs: “Common plots” and “Panel plots”. There are 250 common plots located statewide that are photographed with medium format color imagery during spring, leaf-off condition and interpreted every year. The remaining 4,740 plots are divided into three panels with 1,580 PSUs. Imagery is acquired and interpreted once every three years, on a rotating basis, for each panel. Once the first cycle is completed, the PSUs will be sampled again to detect and measure change. The first year of data acquisition for the WSTMP was 2006 and the data acquisition for the first full-cycle of the program was completed in 2008.

## 3. Imagery Acquisition

This project relies primarily on photo-interpretation of spring, snow-free, leaf-off aerial imagery. Current color imagery is acquired for one cyclical panel (1580 PSUs) and all 250 common plots each year. One thousand eight hundred thirty (1830) plots are sampled each year.

Imagery is acquired using 645-format, true-color film (41 X 56 mm frame size). The typical altitude of the flight is 6700 feet and imagery is acquired as stereo pairs with 60% overlap. Three images are collected for each PSU, a southern image, a centered image, and a northern image. Negatives of all three images are scanned at 2400 DPI to provide a nominal ground sampling distance of 2 feet. The center image for each plot is geo-referenced using the most recent imagery from the National Aerial Imagery Program (NAIP) as the base. For the first full three-year mapping cycle, photographic quality prints are made for all three images for each PSU. These images are used for stereo photo interpretation. In subsequent cycles, stereo-imagery will be acquired, but only processed on an as needed basis.

Imagery is acquired approximately between March 1st and May 15th under snow-free conditions. Spring imagery has several advantages for wetland delineation. Imagery that cannot be acquired during this window is collected during early summer. First, the ground conditions tend to be at their wettest in spring, making many wetland interpretations easier. For example, the boundaries of prairie pothole marshes may be easier to determine when the depression is filled with water. The water table tends to be closest to the surface making other types of wetland easier to identify as well. Second, imagery acquired before leaf-out conditions allows the photo-interpreter to see the surface beneath the tree canopy, which is critical for identifying forested wetlands.

Other imagery is used as well. Fall, leaf-color imagery is collected in color-infrared format for the DNR forestry assessment program. This imagery provides additional information on tree species and the hydroperiod.

Summer imagery from the USDA's National Aerial Imagery Program (NAIP) is used to assess wetlands during the growing season. Since summer photography shows growing vegetation, certain wetland types such as: aquatic bed, emergent subclasses, unconsolidated bottom, and cultivated wetlands are easier to detect. NAIP imagery at 1-meter resolution was acquired for Minnesota in 2003 in true color (red, green, and blue). This imagery is also an important historical reference. NAIP imagery was collected at 1-meter resolution again in 2008, but as 4-band imagery, including the addition near-infrared band. Black and white (panchromatic) imagery acquired by the U.S. Geological Survey in 1991 during spring, leaf-off conditions is also used as a historical reference. As other imagery sources become available, they will be used as well.

Using multiple imagery datasets from different seasons, different years, and different hydrologic conditions, provides the most accurate basis for wetland photo-interpretation.

## 4. Ancillary Data

Ancillary data such as a 24K digital raster graphic (DRG), and the National Wetland Inventory (NWI) layer, are also used for wetland detection. The most important role of the DRG is to show the elevation, drainage patterns, and potential wetlands. In addition to wetland identification, the DRG defines upland features such as roads, and sometimes difficult to identify features such as gravel pits and mining activities. While the DRGs are useful, they are rather dated and must be used with caution.

In addition, the NWI layer is also used in the delineation process. The National Wetland Inventory is provided by the U.S. Fish and Wildlife Service and utilized as a guide. When this layer is displayed on the spring imagery, it is a tool to alert the interpreter of potential wetlands, and not be used as a basis for placing boundary lines. The NWI layer may not be entirely reliable because of its age and issues with the source data for some parts of the state. Local updates to wetland inventories may be available for some areas. These ancillary data sources may be used as well.

## 5. Feature Delineation

### 5.1. Scope

Classification of wetlands and uplands should be complete and topologically correct for each PSU. There shouldn't be any gaps or overlaps between polygons. Wetland and upland delineations should be clipped or snapped to the PSU boundaries.

### 5.2. Scale

The maximum scale for wetland delineation is 1:5000. If a feature can't be seen at a scale of 1:5000, it shouldn't be captured. It is permissible to zoom-in beyond 1:5000 to better digitize a feature that can be seen at this scale.

## 5.3. Minimum Mapping Unit

The target minimum mapping unit for wetlands is 1-acre, but all wetlands that can be seen at the maximum mapping scale of 1:5000 should be delineated. All wetlands above one acre should be mapped. **Do NOT avoid digitizing wetlands smaller than one acre.** However, a trade-off is required to avoid spending too much time pouring over tiny wetlands and trying to delineate them. If a wetland is difficult to delineate at 1:5000 scale, make your best call and move on. Contrarily, if the wetland is smaller than 1 acre and it is easy to see and delineate at 1:5000 scale, then delineate and classify it.

Delineate all upland polygons greater than 5 acres, even if only a portion of the feature falls within the PSU. For example, if a 6-acre forest stand falls on the edge of a PSU, such that only 1 acre of the stand is in the PSU, delineate it.

## 5.4. Linear Features

Digitize linear water and wetland features wider than 16 ft. Use the GIS measure tool to estimate the average width of the feature. For features that taper, use the measurement tool to determine the point where the average width is less than 16 ft and stop delineation of the polygon at that point, and continue delineating when the feature reaches 16 ft again.

Digitize linear upland features, such as roads, wider than 33 ft. This width should include the maintained right-of-way or road shoulder. Use your best judgment on this determination. Be especially careful with upland roads that separate wetlands. If in doubt, digitize these roads.

## 5.5. Feature Precedence

In some instances, more than one feature may be present at a given two-dimensional location. Wetlands and deepwater habitats take precedence over some features. For example, if a power line cuts through a wetland, delineate the wetland accordingly, and continue to delineate the power line as rural development wherever the wetland area ends. At this time, this rule does not apply for bridges over wetlands and deepwater habitat (see side-table issues in Appendix D).

## 5.6. Boundary Interpretation

Determining the boundary of a wetland is the most difficult part of mapping. Normally, transitions are found at the boundary from upland vegetation to wetland vegetation, from nonhydric to hydric (wetland) soils, and from land that is not flooded to areas that are subject to flooding or saturation (Wilen et al. 1996).

Current spring, leaf-off imagery should be the standard dataset for determining wetland boundaries. Other imagery may be used if the boundary appears sharper in the ancillary imagery, but the boundary should be checked against the spring imagery to ensure coherence.

Several visual clues in color imagery may indicate a wetland.

### *5.6.1. Standing water or saturated soil*

Standing water is one of the most obvious indicators of a wetland. Water will appear black to grey, sometimes tinted due to suspended sediment or algae. The texture is generally smooth. Saturated soils in spring imagery, when little vegetation is present, usually appear darker than surrounding similar soils.

### 5.6.2. *Wetland vegetation*

Wetland vegetation may at times appear more vigorous than surrounding vegetation. The vigor of the vegetation is usually easier to see in infrared imagery, but may appear in natural color imagery as well. Patterns in vegetation may also be an important clue. Orderly patterns such as rows or very smooth vegetative surfaces indicate human activity, whereas a more random and mottled appearance suggest a more natural area and potential wetland.

### 5.6.3. *Topography and spatial relationships*

The spatial context of objects in the aerial imagery is also an important indicator when delineating wetlands. For example, basins that have a permanent or semi-permanent flooded center may have a seasonally flooded band around the center and a temporarily flooded outer band. Unplanted depressions in farm fields might indicate wetlands. Low areas adjacent to rivers and streams may be seasonally or temporarily flooded riparian wetlands.

## 5.7. Initial Delineation Process

The initial photo-interpretation is performed by trained student photo-interpreters, followed by a 100% secondary review by senior photo-interpreters at the Minnesota Department of Natural Resources, Resource Assessment Program (DNR-RAP) in Grand Rapids, MN.

- Perform initial wetland delineation directly on laminated hardcopy stereo-imagery, using a stereoscope.
- Delineate the obvious wetland features first. This typically includes all open water features including lakes, rivers, streams, and open water wetlands. Depressional marshes (e.g. prairie potholes) are also usually fairly obvious, especially on stereo-imagery.
- Find wetland features that are adjacent to the obvious wetland features.
- Delineate any other wetland features that are visible in the imagery. Refer to the photo-interpretation selection key for wetland signatures.
- Using ArcGIS, with the geo-referenced imagery, manually transfer the delineations from the hardcopy image using heads-up digitizing.
- Check the initial digital wetland boundaries against available ancillary data including 24K DRGs, original NWI, and other available imagery. Adjust boundaries as needed based on ancillary data.
- Check ancillary data for indications of potential missed wetlands.
- For drier wetland types (ephemeral and cultivated wetlands), available historic imagery should be consulted. The general rule for this program is that if the wetland appears in 6 out of 10 years with available imagery, then it should be delineated.
- Proceed with the wetland classification step using the key presented in section 6 of this document.

## 6. Feature Classification

After delineation, wetland and upland features are classified. There are thirteen land cover classes and two wetland modifiers (Table 6.1). In addition, there are three subclasses for the emergent wetland class.

In general, use the 30% rule to classify heterogeneous wetland polygons (additional guidance on the 30% rule provided in Appendix A). If a class of plants (e.g. trees, shubs, emergents, etc.) occupies more than 30% of the polygon, then the wetland classification should be based on the presence of this vegetation. In the case, where more than one class of vegetation exists, the taller plant class takes precedence. For, example if a wetland polygon contains 20% emergent vegetation, 40% scrub-shrub, and 40% trees, then it should be classified as forested.

**Table 6.1: Cover classes for the wetland status and trends monitoring program**

| *System* | *Code* | *Habitat Name* | *General Description* |
|---|---|---|---|
| **Deepwater** | DW | Deepwater | Lakes, reservoirs, rivers, streams |
| **Wetland** | FO | Forested wetland | Forested swamp |
| | SS | Shrub swamp | Woody shrub or small tree marshland |
| | EM | Emergent wetlands | Marshes, wet meadows, and bogs |
| | AB | Aquatic bed | Wetlands with floating and submerged aquatics* |
| | UB | Unconsolidated bottom | Open water wetland, shore beaches and bars |
| | CW | Cultivated wetland | Wetlands in agricultural fields |
| **Wetland modifiers** | *m* | Manmade | DW, UB, AB or EM of artificial origin |
| | *af* | Artificially flooded | Aquaculture, sewage treatment, wetland treatment systems |
| **Upland** | U | Urban | Cities, incorporated developments |
| | R | Rural development | Non-urban developed areas, infrastructure |
| | A | Agricultural | Cultivated lands and managed upland pasture |
| | S | Silviculture | Managed wooded lands |
| | N | Natural | All natural upland including forested and wooded land as well as grassland, prairies, old fields, state and federal agricultural setaside lands. |
| | O | Other | All uplands not otherwise classed |

* Submerged aquatic vegetation may not be readily apparent on aerial photos.

Land cover is dynamic. Classifications are based primarily upon the cover classed observed at the time of spring imagery and the most contemporaneous summer image available. For, example, a previously forested wetland that has been harvested should be classified according to the dominant remaining cover type (e.g. scrub-shrub or emergent).

## 6.1. Deepwater (DW)

Deepwater habitats are permanently flooded features with non-vegetated open water areas of 20 acres or larger. It also includes wetlands with open water areas less than 20 acres if they have a windswept shoreline or a maximum depth more than 6.6 feet at low water.

Deepwater habitat features are typically situated below the deepwater boundary of wetlands. These features include lakes, reservoirs, and streams featuring extensive non-vegetated "open water" at least 20 acres in extent.

If the substrate is visible, or there is other evidence suggesting water is shallow (such as vegetated beds), the polygon will not be classified as deep water. Instead, it will be classified as a wetland. Rivers, streams, or artificial channels wider than 16 ft with periodic or continuous flow will be classified as deepwater (DW) unless summer imagery clearly indicates the presence of vegetated beds or visible substrate.


Figure 6.1: Deepwater (DW) signatures from spring 2006 natural color imagery.

## 6.2. Forested Wetlands (FO)

Forested wetlands include wetlands dominated (>30% crown cover) by trees or shrubs over 20 feet tall. Also included are wetlands with vegetation less than 20 feet tall, but having central "trunks" that are clearly trees.

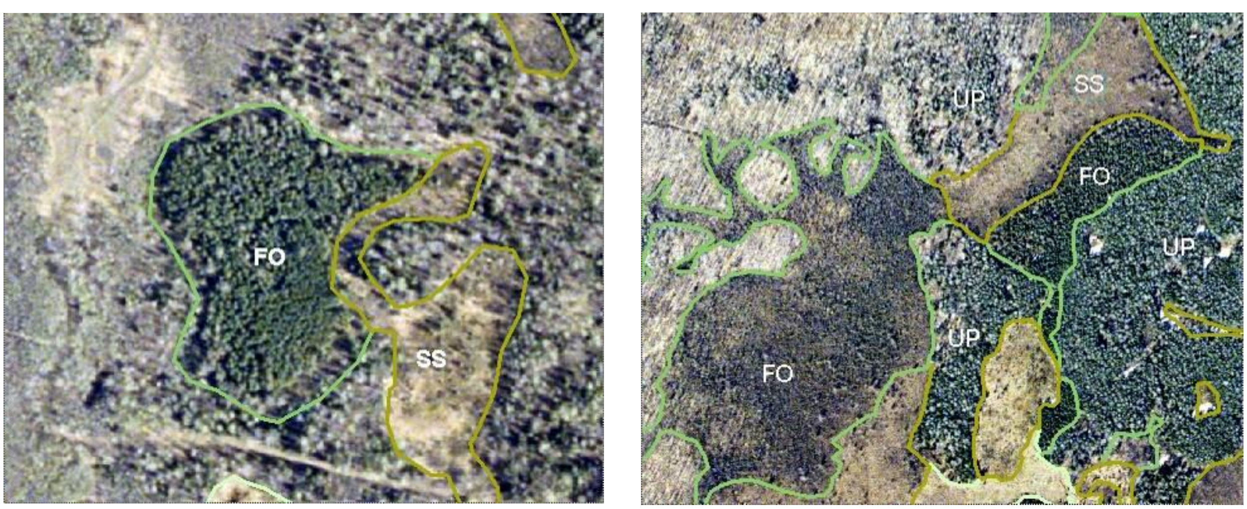



Figure 6.2: Forested (FO) wetland signatures from spring 2006 natural color imagery.

## 6.3. Scrub-shrub (SS)

Scrub-shrub wetlands are wetlands dominated (>30% short woody vegetation crown cover) by woody vegetation under 20 feet tall and typically having multiple stems.

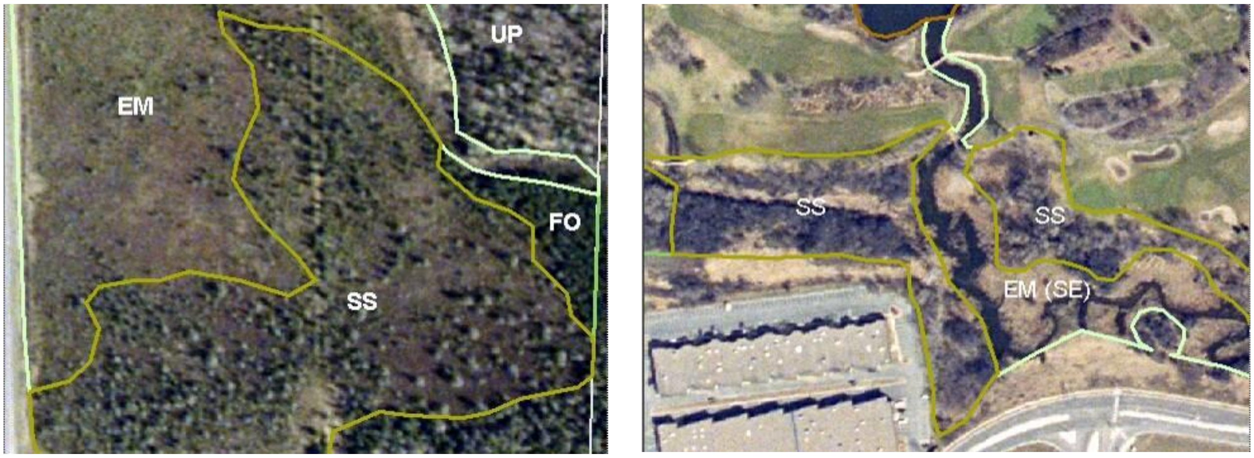



Figure 6.3: Scrub-shrub (SS) wetland signatures from spring 2006 natural color imagery.

## 6.4. Emergent (EM)

Emergent wetlands are wetlands dominated (>30% crown cover) by erect, rooted herbaceous plants (included mosses) emerging above surface water most of the growing season such as cattails, bulrushes, and grasses. Emergent classifications have three sub-classifications (additional guidance provided in Appendix B):

### *6.4.1. Saturated (SA)*

The saturated water regime for emergent wetlands includes wetlands where the soil is typically saturated to the surface for extended periods during the growing season, but extensive surface water is rarely present. When surface water is evident, it usually occurs in random scattered small "pockets" or pools. Various herbaceous plants like sphagnum mosses, grasses, sedges or wetland wildflowers dominate vegetation in emergent class wetlands with a saturated water regime. Emergent class wetlands with saturated water regimes include: bogs, wet meadows, and wet prairies.


Figure 6.4: Saturated emergent (EM-SA) wetland signatures from spring 2006 natural color imagery.

### 6.4.2. Seasonal (SE)

The seasonal water regime for emergent wetlands include wetlands where water is present for extended periods (typically 6 weeks), especially early in the growing season. Surface water is absent during most years late in the growing season. Prominent mudflats associated with ponded or flowing water are typical in mid-summer. When surface water is absent, the water table is usually near the surface. Emergent hydrophytic plants dominate vegetation. Typical wetlands with seasonal water regime include floodplains and shallow temporarily flooded marshes. Floodplains are associated with adjacent rivers or streams. Shallow temporarily flooded marshes often will have ponding of water in areas inside of mudflats during spring or midsummer. The plant community may be dominated by an overstory of trees or shrubs with herbaceous understory. Hydrophytic plants such as grasses, sedges, water plantains, smartweeds, or cattails usually dominate shallow temporarily flooded marshes.


Figure 6.4: Seasonal emergent (EM-SE) wetland signatures from spring 2006 (above) and summer 2008 natural color imagery (below).

### 6.4.3. Inundated (IN)

The inundated water regime for emergent wetlands includes wetlands where water covers the land surface throughout the growing season in at least most years (6 out of 10 growing seasons). When surface water is not present throughout the growing season, the water table is at or near the surface. Typical wetland types include shallow and deep marshes with prominent “bands” or “beds” of persistent emergent hydrophytic plants such as cattails, bulrushes, various grasses, spike rushes, arrowheads, and smartweeds or shallow open water dominated more by floating and submergent vegetation such as water lilies, pondweeds, duckweeds, or watery celery.


Figure 6.5: Inundated emergent (EM-IN) wetland signatures from spring 2006 (above) and summer 2008 natural color imagery (below).

## 6.5. Aquatic Bed (AB)

Aquatic bed wetlands are wetlands dominated (>30% crown cover) by plants growing below or floating on the surface most of the growing season, such as pondweed, duck weed and water-lily. Classification of these wetlands usually relies on growing season (summer) imagery. Not all submerged vegetation is visible on aerial photographs and this many of these areas may be classified as unconsolidated bottom.

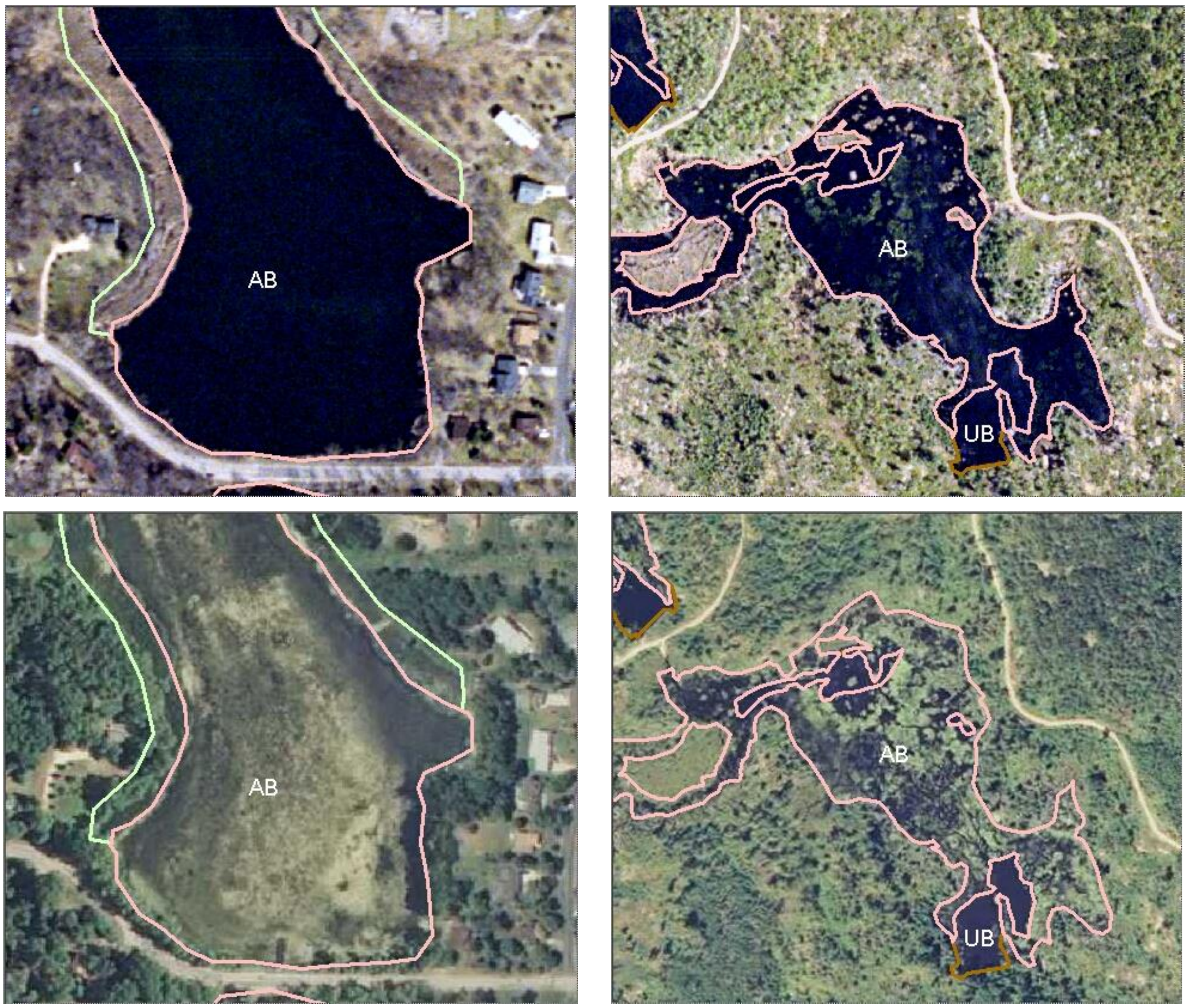



Figure 6.6: Aquatic bed (AB) wetland signatures from spring 2006 (above) and summer 2008 natural color imagery (below).

## 6.6. Unconsolidated Bottom (UB)

Unconsolidated wetlands are wetlands that are smaller than 20 acres, have maximum water depths less than 6.6 ft deep at low water, and lack of wave-formed or bedrock shorelines. Less than 30% of the surface of these wetlands is covered by vegetation of any kind, including un-vegetated shore-lands and bars. Unconsolidated bottom wetlands may include aquatic bed wetlands with submerged vegetation that is not visible on aerial photos.


Figure 6.7: Unconsolidated bottom (UB) wetland signatures from spring 2006 (above) and summer 2008 natural color imagery (below).

## 6.7. Cultivated Wetland (CW)

Cultivated wetlands are wetlands that are ineffectively drained wetland in fields under cultivation, where hydrophytes would re-establish if farming were discontinued. Delineation of these wetlands usually relies on growing season imagery, not spring imagery. Cultivated wetlands do not include areas where water presence is believed to be ephemeral (7 or less days).


Figure 6.8: Cultivated wetland (CW) signatures from spring 2006 (above) and summer 2008 natural color imagery (below).

## 6.8. Urban (U)

Urban lands include city and town land uses that have a network of streets or roads and a mixture of commercial/industrial, residential, or park areas.


Figure 6.9: Urban land (U) signatures from spring 2006 natural color imagery.

## 6.9. Rural Development (R)

Rural lands include human developed areas without a network of streets or roads and found outside the limits of cities and towns. These areas include linear upland features (roads and power lines) at least 33 feet wide (including right of ways), recreational features, mining sites, and isolated commercial/industrial facilities.

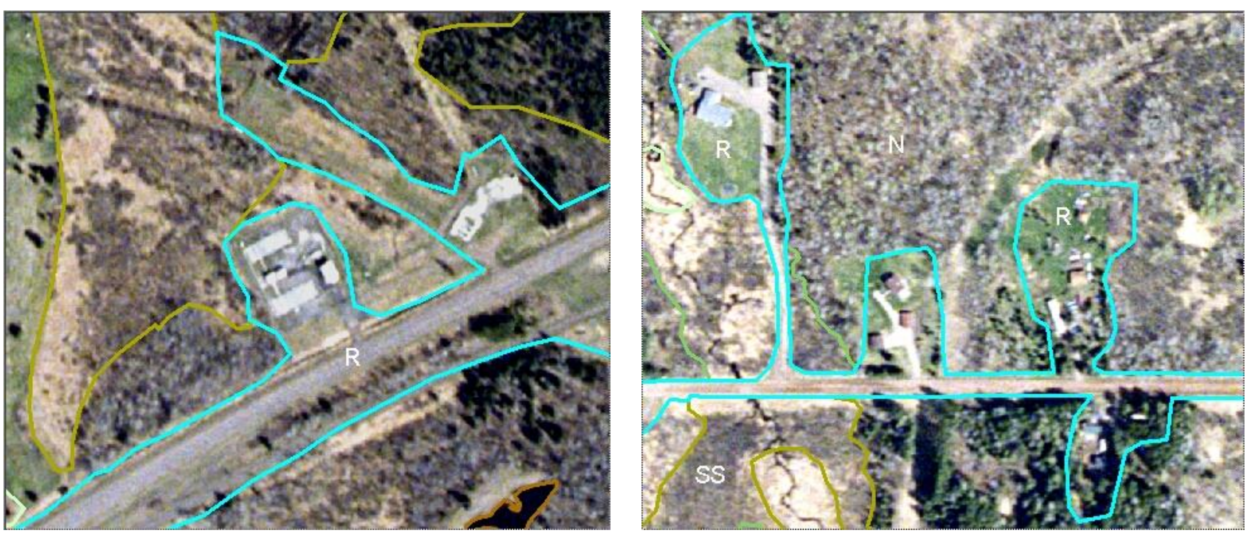



Figure 6.10: Rural (R) development signatures from spring 2006 natural color imagery.

## 6.10. Agricultural (A)

Agricultural lands include uplands and drained lands managed for food or fiber production, cropland, actively managed/grazed pasture, orchards, or nurseries. This class includes farmsteads and farm buildings. Due to legacy impacts of past practices, abandoned agricultural lands should be classified as agricultural land unless it is clear that land is intended to mature toward a natural condition. When in doubt, err toward the natural class.

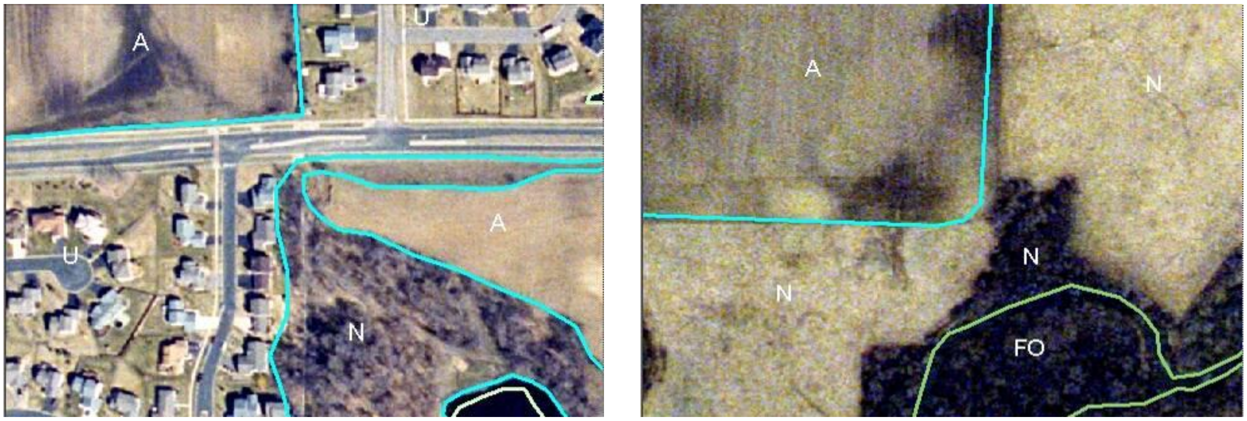



Figure 6.11: Agricultural (A) and natural upland (N) signatures from spring 2006 natural color imagery.

## 6.11. Natural Upland (N)

Natural upland includes all natural land that is not wetland. This includes land such as forested or wooded land that is not planted and actively managed as well as grasslands, prairies, long-term fallow lands, and upland conservation lands (e.g. CRP, RIM, CREP). This class does not include planted and actively managed lands such as silviculture or agricultural lands (See side-table issues in Appendix D). For illustration of the natural upland class see the figure in section 6.10.

## 6.12. Silviculture (S)

Silviculture includes upland wooded lands with 30% closed canopies that are actively planted, harvested, and otherwise managed for the production of wood and wood products. (See side-table issues in Appendix D)


Figure 6.12: Silviculture (S) signatures from spring 2006 natural color imagery.

## 6.13. Other (O)

All other upland classes not falling in one of the above classes shall be classified in the “other” class. This class includes barren land and indeterminate transitions between land uses.

## 6.14. Modifiers

### *6.14.1. Manmade Modifier (m)*

The manmade modifier denotes a wetland with a basin that is either entirely created by or substantially modified by humans. The modifier may be applied to deepwater, unconsolidated bottom, aquatic bed, or emergent wetlands. This modifier includes all types of “artificial ponds”, whether they were created by excavation of upland where wetland had previously not existed or if they appear by their landscape context to have been intentionally constructed by excavation, damming or obvious detention of storm flows or water table surface exposure in previously natural wetlands or waterways. Wetlands that appear to have resulted from unintentional or incidental linear feature detention as result from roadbeds or railroad beds should not be flagged as “manmade”. A few examples, though not all inclusive, of wetlands which should be denoted as “manmade” include: livestock ponds, storm water catchment basins, aquaculture ponds, golf course ponds (if graded and contoured as water traps), aesthetic or reflection ponds, wildlife dugout ponds and wastewater treatment ponds.

If a polygon shows evidence of being created by humans, attach the “m” modifier to the class code. For example, if an unconsolidated bottom (UB) polygon is bounded by straight sides and/or the water is clearly contained by concrete berms, the correct classification would be UBm. There are a number of clues that a polygon is manmade, including:

- Straight or regular sides (squares, rectangles, nearly perfectly circular)
- Mechanically built up sides (concrete or dirt containment berms)
- Located in a golf course, in the middle of a housing development, or next to a farmstead
- Presence of engineered structures such as rip-rap shorelines and storm sewer inlets and outlets

### *6.14.2. Artificially Flooded Modifier (af)*

The artificially-flooded modifier denotes wetland areas where the frequency or depth of inundation is artificially manipulated by addition or removal of water. Features attributed with the manmade modifier will sometimes be classified artificially flooded as well. This modifier may be added to unconsolidated bottom, aquatic bed, and emergent classifications.

Some examples of this modifier are: animal feedlot operation treatment ponds, active mining facilities, excavated aquaculture ponds, constructed wetland treatment systems, sewage ponds, industrial treatment ponds, and swimming ponds. The artificially flooded modifier will be used in unison with the manmade modifier in some conditions; this will be determined by whether or not its water source is artificial or not. Artificial sources of water include water from any municipal or industrial source. Tailings discharge from active mining operations is considered an industrial source. Water derived from precipitation or runoff are not considered artificial sources regardless of whether the runoff is from urban or agricultural drainage systems.

Visual indicators for the artificially flooded modifier may include, but are not limited to:

- Regularly shaped wetlands or ponds with multiple cells
- Water bodies within agro-industrial or mineral extraction settings with evidence of recent industrial activity
- Associated pipes and appurtenances

The “af” modifier may be removed from a feature over time if the facility becomes inactive for some period of time; such as in the case of abandoned gravel mines.

# *7. Change Detection*

The Minnesota Wetland Survey aims to quantify and report real wetland changes. Many types of wetland changes are expected to occur within the sample plots including:

- Deletion of drained/filled wetlands (i.e., wetland to upland)
- Addition of new/restored wetlands (i.e., upland to wetland)
- Changes in wetland classification
- Changes in wetland and intra-wetland community extent (borders increasing or decreasing) often due to weather or climate patterns.
- Changes in non-wetland classes: [DW (Deepwater); U (Urban); R (Rural Development); A (Agricultural); F (Forested); G (Grassland); O (Other)] will only be made when they involve associated changes in a wetland feature.

*Note: The guidance for mapping non-wetland classes for the 1st cycle interpretation included DW (Deepwater); U (Urban); R (Rural Development); A (Agricultural); S (Silviculture); N (Natural); O (Other).*

Land cover change is delineated using a heads-up, on-screen process. In this process, the most recent imagery is converted to a digital image and geo-referenced, if necessary. The image analyst display a copy of the baseline land cover data as an overlay to the updated imagery using ArcGIS. The land cover data are then edited as needed, primarily by using the split polygon tool and then entering the updated land cover attribute into a new field. The structure of the data is described further in section 8.1.

## 7.1. Avoiding False Change

Change detection will be based on differences in **wetland area** and **classification** over time ($T_1$ = time 1 and $T_2$ = time 2). All changes in wetland area should be mapped regardless of their cause; however, care should be taken to avoid making false changes.

Examples of false changes include:

- Minor adjustments to the polygon boundaries due to imagery registration issues between $T_1$ and $T_2$. Image analysts should consider the horizontal positional accuracy of the source imagery when determining whether to make a boundary change. As a rough guideline, a boundary shift of less than 10 meters should not be delineated as change.
- Short-term changes in water level or extent due to abnormal weather patterns or other ephemeral water conditions (e.g. sheet water) immediately prior to image acquisition (e.g. drought or flooding). Longer-term climate induced changes should be mapped.

Image analysts should consult local weather data for the period preceding the image date and look for other visual cues in the image that conditions are normal before mapping area changes. Short-term weather patterns are defined as patterns that occur over a period ranging from days to a couple of months.

  - Consult maps showing weekly precipitation and departure from normal precipitation (Figure 8.1). http://climate.umn.edu/doc/weekmap.asp
  - Visual clues to abnormal water conditions may include standing water on parking lots, roads, or in areas planted with crops (Figure 8.2).

- Drier-end, cultivated wetlands that may not be apparent during dry cycles. Due to the fact that this wetland class is very difficult to interpret, and trends in cultivated wetlands may have significant direct policy implications, particular attention needs to be taken to evaluate all available imagery and ancillary information to correctly reinterpret these features and avoid false changes.
  - Consult maps showing weekly precipitation and departure from normal precipitation. http://climate.umn.edu/doc/weekmap.asp
  - Also see water year precipitation summary maps prepared by the DNR State Climatologist. http://climate.umn.edu/doc/hydro_yr_pre_maps.htm
  - Also consult any other recent imagery that may be available such as that from the Farm Service Agency.
  - If the wetland is present in 6 out of 10 of the previous years with available imagery, it should not be removed unless there is clear visible evidence of hydrologic alteration (ditch or drain tile) or unless consideration of additional years of imagery decreases the frequency of wetland presence below the 6 out of 10 year rule.
- Deepwater or other wetlands being drawn down or diverted for management reasons

Analyzing imagery from multiple years and from different seasons is one of the strongest sources of evidence to help distinguish between false (short-term) change and true wetland change.

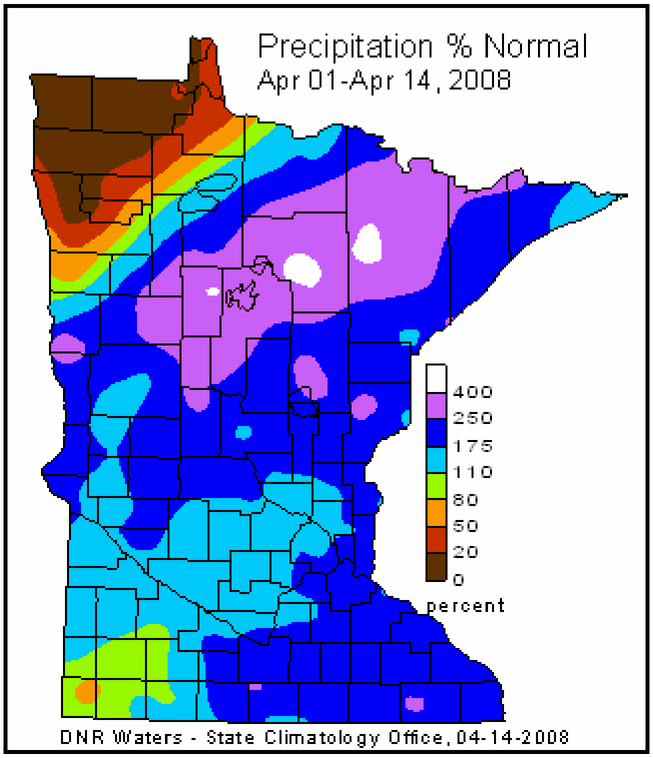



Figure 7.1: Precipitation that significantly departs from normal suggest that apparent changes in wetland boundaries may be temporary in nature. The white areas shown in the map (Itasca and St. Louis Counties) had four times the normal precipitation for the week.

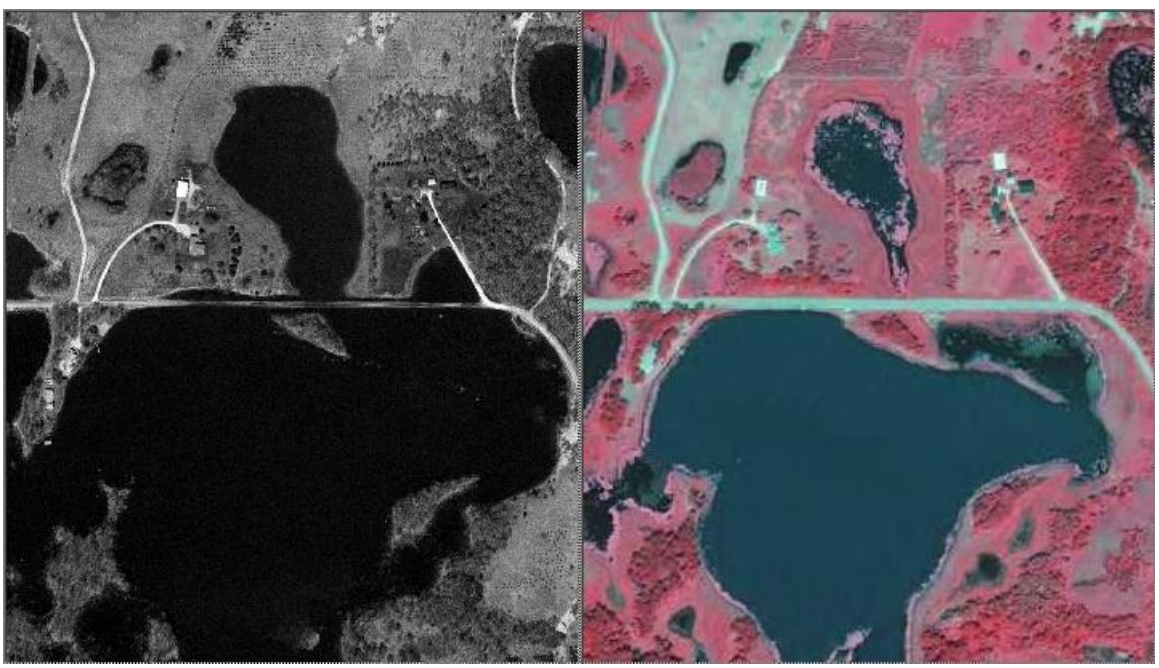


Figure 7.2: Plaisted Lake (Washington County) and the wetland just to the north of 140th Street are considerably larger in the aerial photo from 2000 (left) than they are in 2008 (right). Water can clearly be seen covering parts of 140th Street, which is evidence that this is an abnormal water condition.

## 7.2. External Boundary Changes

Revise external wetland polygon boundaries (boundaries between wetland and upland classes) to account for changes in wetland extent, including additions and deletions, regardless of size, as long as they do not represent a false change as described above. It is expected that the majority of individual wetland boundary changes may be less than an acre in size, but cumulatively their area can be significant and may result from small-scale activities that are exempted by the WCA.

## 7.3. Internal Boundary Changes

In wetland complexes that have more than one wetland class, only revise the internal classification boundaries (boundaries between wetland classes) when the change exceeds an area of 0.5 acre for wetland complexes smaller than 10 acres or 5% for wetland complexes larger than 10 acres. In the example presented in Figure 8.3, if the change in wetland classes from $T_1$ to $T_2$ for the EM/AB area was less than 0.5 acre (or less than 5% for wetlands larger than 10 acres), it would not be re-delineated or classified as a real change. Wetlands are very dynamic systems and their intra-wetland community composition varies naturally year-to-year depending on many factors, including herbivory, water level changes and/or plant community succession or maturation. Since wetland class can naturally be very dynamic, only larger changes should be noted and be revised. The intent is to avoid spending excessive time on large numbers of small intra-wetland community changes. Following this convention the apparent change from $T_1$ to $T_2$ in Figure 1B with the disappearance of the AB wetland class and expansion of the EM class is over 0.5 acre in area (and greater than 5%) and therefore should be delineated as a recordable change. An exception to this convention is if a single polygon wetland (not a complex) changes classification from $T_1$ to $T_2$ would be recorded as a "classification only" change.

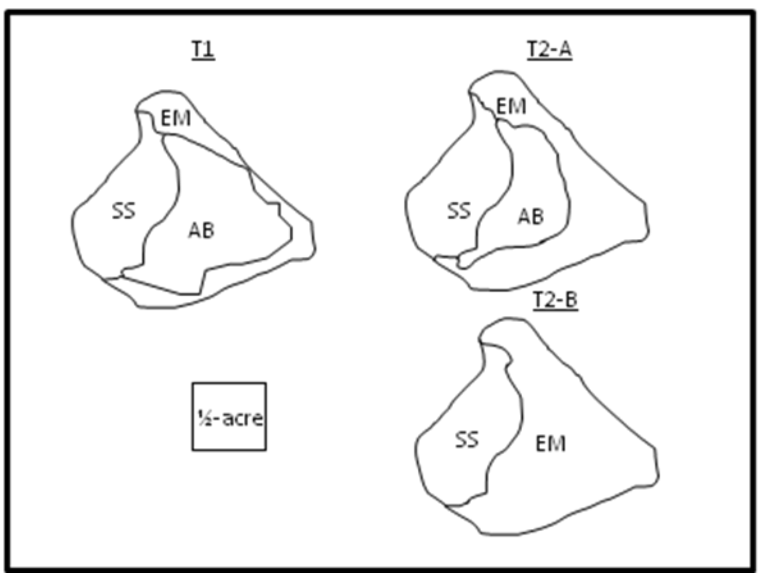



Figure 7.3: Change in wetland classification from time one (T1) to time two (T2) showing two scenarios A and B for T2.

Changes are documented in the attribute table in up to three separate fields: 'Cover_Code' documents a change in classification; 'Em_X Code' (if applicable) documents a change in water regime; and a new field '<u>DELTA</u>' should be used to document the type of change, "direct = D" or “indirect = I” that is observed. Record and attribute all polygon classification changes as either D (Direct) or I (Indirect) in the DELTA field. All changes in wetland extent and classification that are visually apparent at a zoom scale not smaller than 1:5000 should be delineated and attributed.

Some shifts in wetland community classification may lag behind the three year reporting cycle. The wetland photo interpretation guidance requires summer imagery used in concert with spring CIR imagery to interpret wetland classification. Currently, summer imagery is updated approximately every 5-years. This is less frequent than the 3-year reporting cycle and much less frequent than the interpretations for the annual plots.

To the extent possible questionable or disputable changes should be flagged and reviewed by field examination and/or with additional ancillary data and/or review by additional interpreters.

## 7.4. Attribution of Change

All true wetland changes will be mapped for both panel and common plots. Wetland changes will be attributed as either “D” for direct changes or “I” for indirect changes to differentiate between those changes where the cause is directly evident from the imagery and those changes where the cause is not clearly visible.

**Direct** changes **(D)** are those changes that have a directly visible cause in the source imagery or ancillary data. This includes all changes where there is clear and logical visual evidence of human influence, such as:

- A restored wetland often with an adjacent vegetated buffer appearing where a wetland had not previously existed,
- Wetland filling or drainage actions that has reduced the wetland extent and is able to be confirmed by collateral visually apparent evidence such as ditches or new tiles which allow development or agricultural encroachment,
- Wetland excavation or inundation which apparently results from damming or obvious detention of water flow or water table exposure and meeting the criteria for a modified (*m*) wetland where one had not previously been modified.

The direct change category also includes changes resulting from visually apparent natural cause such as those from beaver activities, or mixed human and natural causes such as landslides, stream accretion or movement.

**Indirect** changes **(I)** include changes in wetland extent or classification that are visually apparent, but there is no clear visual evidence of the cause. Indirect changes may include changes due to long term climate change, subsurface tile drainage (if it is not visually evident), and lowering of the groundwater table from pumping. It is anticipated that the majority of wetland polygon boundary changes will be due to indirect effects.

A modifier for **natural** changes **(n)** will be added to the direct change category for those causes that are directly visible, but clearly from a natural source, such as beavers. Most of the direct changes will be due to human activities; however, things such as beaver activity (i.e. dams) may be classified as direct change with a natural modifier **(Dn)**. For causes that may have mixed natural and human sources, such as stream accretion or movement will not be coded with the “n” modifier.

### 7.5. Corrections

Corrections to previous interpretations: Errors from previous interpretations should be corrected given new imagery and ancillary data and these corrections should not be marked as changes. Thus no entry would be made in the Delta field. Corrections may include: classification changes, missed wetlands, areas incorrectly delineated as wetland, boundary adjustments to previous delineations of wetland or upland classifications.

## *8. GIS Standards*

ArcGIS is the primary software tool for displaying digital imagery, digitizing wetland boundaries, and classifying wetlands.

### 8.1. Data format and management

All mapped features and feature changes will be managed within a geodatabase. Individual panel results within a cycle and yearly results in the annual plots represent "Eras". Each Era will be saved as an independent feature class. A new geodatabase copy will be created for each era. It will include all the past eras and will append the new era as a new feature class in the geodatabase. All geodatabases will contain the same attribute fields and definitions:

***OBJECTID*****:** Automatically produced when polygons are added to the data set.

***SHAPE*****:** Automatically produced and gives the geometry of data.

***SHAPE_Length*****:** Automatically produced perimeter length (meters) of a particular polygon.

***SHAPE_Area*****:** Automatically produced area (square meters) of a particular polygon.

***Panel:*** Identifies which sampling panel for the polygon. In all cases, only one panel will reside in each geodatabase.

***County:*** Name of the county that contains the polygon.

***Gridcode:*** Unique number for the PSU that contains the polygon.

***Cover_Code_[year]:*** Contains the cover class of the feature. The field name includes the year of the interpretation (e.g. Cover_Code_2006, Cover_Code_2007, etc.)

***Remarks:*** Free text field for any additional information on any particular polygon.

***Em_XCode:*** This column is used for water regime classification of emergent class, used only in the base years of 2006, 2007, and 2008.

***Em_Remarks:*** Provides space for interpreter(s) to add any additional information on any particular polygon concerning the water regime classification.

***Delta_[year]:*** This field is used to indicate an indirect or direct change. The field name includes the year of the assessment.

***Acres_[year]:*** Area of the polygon in acres. If a polygon is cut out of a larger polygon due to change, it will retain the acre amount for the prior year, and will be updated to the amount for the change. The field name includes the year of the assessment.

## 8.2. Data naming and data storage

To prevent duplicates and data loss, only one master copy of the geodatabase for each era and base year is available for interpretation. In addition, there is a check in check out procedure set in place for the data at RAP to ensure data integrity.

Geodatabase names for the initial three eras will start with "wetlands" followed by an underscore with the year, and underscore, and the word "baseline (e.g. wetlands_2006_baseline).

Geodatabase names for all subsequent change detection eras will begin with "era" with an underscore follow by the two year (four digits) in comparison with an underscore and the word "change" (e.g. era_2006_2009_change). The annual change will also start with "era" followed by an underscore with the two year (last two digits) comparison followed by the word "annual" (e.g. era_06_07_annual).

Copies of the final geodatabase for each year will be sent to the Wetland Monitoring Coordinator for analysis and permanent data archive. A copy of the final data for each year will be stored on the Network Attached Storage (NAS) device located in the DNR Central Office (St. Paul, MN) device known as "*Heron"* [ ABERNAS (156.98.35.103)], under the directory "*wstmp*".

The RAP office (Grand Rapids, MN) will also maintain a permanent archive copy of the final data for each year on the "P" server, under the "Wetlands" directory.

## 8.3. Topology rules

The data should provide wall to wall coverage of each PSU without any gaps between polygons or overlaps of polygons. These conditions can be satisfied by using the topology tools in ArcGIS. A topology should be established for the geodatabase with rules for each PSU "Must be covered by" (polygons) and polygons "Must not overlap". After the photo-interpreter has completed the interpretation on a PSU, they should verify the topology and fix any errors.

## 8.4. Editing procedures

All editing procedures will be accomplished using ArcGIS

- Adding polygons will be completed by using tools such as create new feature or auto complete polygon. The "create new feature" tool is used to make independent polygons. The auto complete tool is used to create adjacent polygons sharing the same boundary, and preventing overlap.
- Deleting polygons can be done in a variety of ways. First, the polygon can be selected, and deleted due to a misinterpretation or a change. Second, typically, if a change occurs, the polygon is not deleted; it will be redrawn to coincide with the change. The polygon could also be merged with adjacent polygons, or cut\clipped to suit the changes of the wetland.
- Reshaping polygons are usually done by cutting, merging, or simply deleting the polygon and redrawing it. This method is preferred to prevent any overlap or gaps in the data, consequently decreasing topology errors.
- Cutting polygons are done by selecting the existing polygon and merely drawing what needs to be cut out, or if the polygon needs to be cut in to two different classes.

- Border polygons are delineated outside of the PSU boundary to ensure full coverage and eliminate gaps. When all editing is complete, a clip to boundary process snaps all boundary polygons to the PSU.

Upon creation or modification of any and all polygons, they are properly classified, saved frequently, and the dataset is backed up to prevent data loss.

## 9. Data Analysis

This section summarizes basic data analysis processing steps. Further details of specific analyses will be provided in wetland status and trends data reports.

The percentage of wetland cover class is summarized for each PSU by first concatenating the PSU identification number (GridCode) with the cover class (CoverCode) to create a new field using ArcGIS (Figure 9.1). The new field is then summarized to calculate the total area of each cover class in each PSU (Figure 9.2).

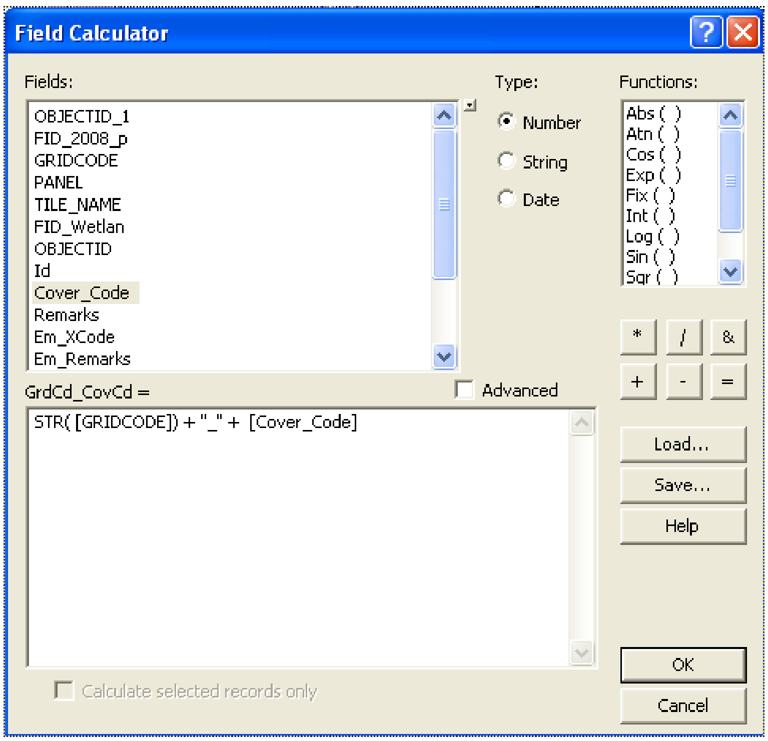



Figure 9.1: Concatenate the ID number for the PSU (GridCode) with the cover code.

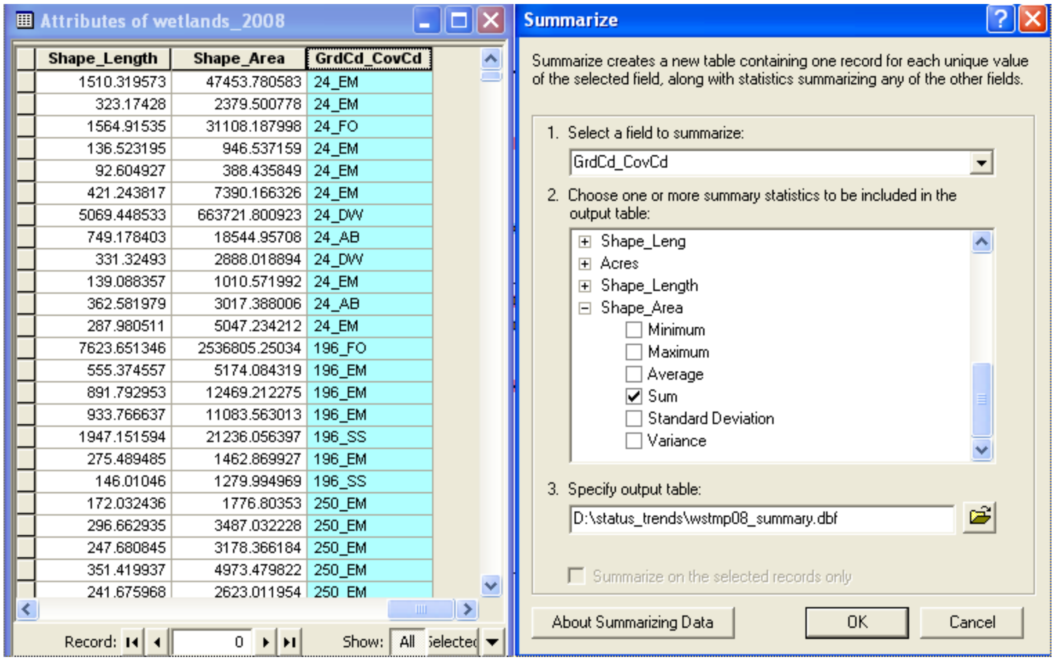



Figure 9.2: Summarize the feature area using the concatenated field.

The summary table is exported from ArcGIS and then imported into Microsoft Excel, where the concatenated field is parsed back into it original components (GridCode and CoverCode) and then a pivot table is created where each row (record) is a unique PSU identification number and the area for each cover class is in its own column (field). The sums of the columns are checked against the expected total (typically 1 square mile). The columns are then transformed from total area to the fractional area for the PSU. No data values are assigned a value of zero. These data are then joined to a spreadsheet of geographic attributes for the centerpoints of each PSU that include the ecological classification section, the county name, and the major watershed ID number (Figure 9.3). The database join is performed using Microsoft Access.

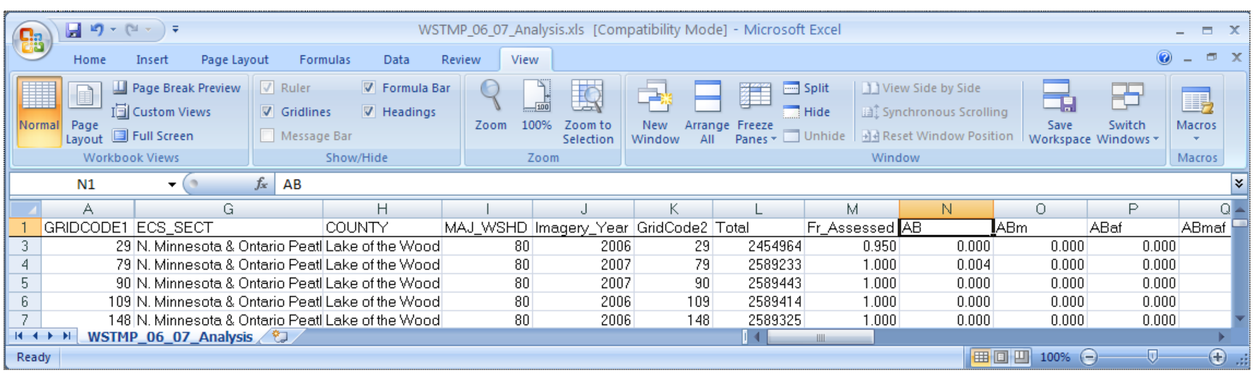



Figure 9.3: The data analysis spreadsheet includes a unique record for each PSU with the fractional area of each cover class (upland and wetland) in addition to geographic attributes and the year of the assessment that can be used to group the data.

## 10. Quality Control

Differences in wetland delineation and classification can arise due to the inherently subjective nature of the human perception that is the basis for photo-interpretation. In an effort to promote consistency and decrease errors, a strict quality control program has been implemented that includes documentation of standard operating procedures, consistent training of photo-interpreters, in-office secondary review by senior photo-interpreters, and field verification of wetland maps.

## 10.1. Photo-interpretation training

The initial wetland interpretation and classification is conducted by trained college interns. Training is provided by DNR-RAP personnel. All photo-interpreters are trained to adhere to the standard operating procedures for wetland delineation and classification for this project. Primary photo-interpreters are given practice interpreting PSUs from various landscape settings around the state, and must be certified prior to performing production work.

In addition, the training program also includes field experience as an aid to improve consistency and accuracy of interpretation of landscape features. All interpreters complete a number of field visits to see a variety of wetland types. They examine soil types and vegetation associated with wetlands and view aerial photos to compare what is on the ground and photo.

The main goal of training is to improve the consistency of interpretation between interpreters as well as over time.

## 10.2. Secondary review

After the initial interpretation by student photo-interpreters, all imagery and wetland delineations are checked by senior photo-interpreters from DNR-RAP. The purpose of the second interpretation is to ensure overall quality and consistency, to ensure that primary photo-interpreters are following standard procedures, and to implement corrective action when needed. Lastly, the second interpreters will correct any delineation errors entered by the first interpreters.

## 10.3. Field verification

The field verification process is employed to gauge consistency and accuracy of the wetland interpretation. Wetlands near roadways are randomly selected throughout the state, with a goal of having at least 30 polygon observations of each wetland type. Error rates for omission, commission, and overall error rates will be calculated using an error matrix (Table 10.1) following procedures described in Congalton and Green (1999).

Four main objectives will be met through the field review process:

- Quantitatively assess accuracy of photo interpretation results.
- Review features in areas with known rapid changes to the wetland resource such as developing urban fringes.
- Resolve interpretation problems, including specific wetland classes or features known to be difficult to interpret.
- Provide additional field exposure to RAP personnel for the wetland and landscape features they are interpreting.

**Table 10.1: Error Matrix for 2006 Wetland Status and Trends Monitoring Program**

| Photointerpreted Wetland Class | Ground Reference Wetland Class | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DW | UB | AB | EM | SS | FO | CW | N | S | A | R | U | Totals | Commission |
| DW | **31** | 1 | | 1 | | | | | | | | | 33 | 6% |
| UB | 1 | **45** | | 1 | | | | | | | | | 47 | 4% |
| AB | | 2 | **26** | 2 | | | | | | | | | 30 | 13% |
| EM | | 2 | | **90** | 3 | | | 4 | | 3 | | 2 | 104 | 13% |
| SS | | | | 3 | **28** | 2 | | | | 1 | | | 34 | 18% |
| FO | | | | | | **28** | | 4 | | | | | 32 | 13% |
| CW | | | | 6 | | | **22** | | | 3 | | | 31 | 29% |
| N | | | | 1 | 6 | 6 | | **39** | 1 | 2 | 2 | 2 | 59 | 34% |
| S | | | | | | | | | **23** | | | | 23 | 0% |
| A | | | | 1 | | | | 4 | | **44** | | 1 | 50 | 12% |
| R | | | | | | | | | | | **35** | 1 | 36 | 3% |
| U | | | | | | | | | | | | **18** | 18 | 0% |
| Totals | 32 | 50 | 26 | 105 | 37 | 36 | 22 | 51 | 24 | 53 | 37 | 24 | 497 | |
| Omission | 3% | 10% | 0% | 14% | 24% | 22% | 0% | 24% | 4% | 17% | 5% | 25% | | |

| | |
|---|---|
| Overall Accuracy | 86% |
| Khat | 85% |

* Class codes in this table reflect the classes that were in use in 2006. The natural class (N) has been split into natural forested (F) and natural grassland (G). Silviculture class (S) has been incorporated into the agricultural class (A).

### 10.4. Review and Updates to Procedures

Procedures for the WSTMP will be reviewed on an annual basis. The procedures presented in this document may have to change over time to keep up with critical changes in technology. Some potential changes include:

- Switching from true-color film imagery to 4-band (or CIR) digital imagery
- Addition of other ancillary sources of imagery as they become available
- Changes in software and hardware

Every effort will be made to conduct method comparison studies whenever materially significant changes are made to the procedures, so as to ensure that the results of the trend monitoring are not skewed by method changes.

## *11. References*


APSRS. 1997. Manual of Photographic Interpretation, 2nd edition. ASPRS Press, Washington, DC. 700 p.

Congalton, R.G. and K. Green. 1999. Assessing the accuracy of remotely sensed data: principles and practices. CRC/Lewis Press, Boca Raton, FL. 137 p.

Cowardin L., V. Carter, F. Golet, and E. LaRoe. 1979. Classification of wetlands and Deepwater Habitats of the United States. U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC. 79 p.

Dahl, T.E. 2000. Status and Trends of Wetlands in the Conterminous United States 1986 to 1997. U.S. Department of Interior, Fish and Wildlife Service. Washington, D.C. 82 pp.

Dahl, T.E. and M.T. Bergeson. 2009. Technical Procedures for Conducting Status and Trends of the Nation's Wetlands. www.fws.gov/wetlands 75 pp.

Parker, M., Tuggle, B.N., Cooper, J.W., Dahl, T.E. 2004. Technical Procedures for Wetland Status and Trends: Operational Version. U.S. Department of Interior, Fish and Wildlife Service. Washington, D.C. 62 pp.

Stevens, D.L. and Olsen, A.R. 2004. Spatially balanced sampling of natural resources. Journal of the American Statistical Assoc. 99:465:262-278.

Wilen, B.O., V. Carter, and J.R. Jones. 1996. Wetland mapping and inventory. In National Water Summary of Wetland Resources. Fretwell, J.D., J.D. Williams, and P.J. Redman *Eds*. Water Supply Paper 2425. U.S. Geological Survey, Reston, VA. Pp. 73-78.

# 12. Appendix A – 30% Rule for Classifying Heterogeneous Polygons

Does the wetland polygon support 30 % or greater coverage of mature trees (average height typically exceeding 6 meters (20 feet)) having primarily single trunks, or vegetation which has the potential to grow to over 6 meters?

Yes → FO –Forested wetland

No ↓

Does the wetland polygon contain shrubs (average height les than 6 meters) that typically have multiple ramets and occupy 30% or greater polygon coverage?

Yes → SS – Shrub swamp

No ↓

During the growing season, does the wetland polygon contain emergent vegetation which occupies 30% or greater coverage of the polygon?

Yes → EM – Emergent wetland

No ↓

During the growing season, does the wetland polygon contain plants floating on the surface or submergent plants which comprise 30% or greater coverage of the wetland polygon?

Yes → AB – Aquatic bed

No ↓

During the growing season, does the wetland polygon contain less than 30% actively growing aquatic vegetation and is dominated by water?

Yes → UB - Unconsolidated bottom[2]

No ↓

Is water present in spring imagery indicating a wetland condition, but there is evidence the wetland polygon has been actively cultivated, and during the growing season of most years supports agricultural crops?

Yes ↓

CW[3] – Cultivated wetland

[1]Any wetland polygon, regardless of class, having regular geometric shapes or other evidence of an artificial origin the manmade should have the *(m)* modifier attached.

[2]Note, the UB class includes unconsolidated shores and any wetland area with consolidated shore areas devoid of vegetation

[3]Note, if there is evidence such as a ditch outlet, or evident tile network indicating the wetland has been effectively drained then it is considered to be non-wetland

## *Appendix B – Interpretation Guidance for Water Regime Classification*

The water regime of emergent wetlands can be very difficult to interpret as it is a complex function of time and various other environmental variables. Accurately interpreting wetland water regime with confidence, requires more data and imagery than will typically be available. Therefore, professional judgment must be used in making interpretations.

Short-term seasonal water changes are used primarily for differentiating seasonal wetlands from saturated and inundated wetlands. However, interpreting short-term water status requires an understanding of the longer-term water status. Longer term changes such as drought-flood cycles typically occur roughly every ten years or more. Long term imagery and climate data, if available, will best differentiate seasonal wetlands from temporary wetlands. Another complicating factor is that short and long term hydrologic status can vary considerably across the state. Spatial summaries of precipitation records across Minnesota will be helpful ancillary data and are available online from the Minnesota Climatology Working Group at http://climate.umn.edu/doc/weekmap.asp. The geographic region and the landscape context of the wetland should also be considered when making this classification. For example;

- Bogs including floating mat situations are best classified as saturated (SA)
- Lowland flats with little topographic gradient are most likely saturated
- Wetlands associated with ground water seepage faces located on slopes are also most likely saturated.
- In cases where beaver activity is suspected inundated (IN) will be the most common water regime.
- Inundated (IN) emergent wetlands are usually larger than 3 acres and are frequently associated with other fringing wetland classes or water regimes in the transition to upland habitats
- Seasonal (SE) water regime will be most typical in glaciated depressional basins or are frequently associated with inundated emergent wetlands or stream systems.

The frequency and regional distribution of various wetland water regimes has been described in detail elsewhere by the Minnesota Department of Natural Resources[1] and is briefly summarized here.

Based on the National Wetland Inventory data, approximately 70.5% of the emergent wetlands (EM) statewide by area will have a saturated water regime. Most of these occur in the North Central and North East regions of Minnesota as peat lands and other associated lowland habitats. An estimated 28% of the statewide emergent wetlands by area will likely have a seasonal water regime. Though this water regime is found in wetlands statewide it is most typical in the Central Morainal region and throughout the North Central Glaciated Plains and Red River Valley regions of Minnesota. Only an estimated 2% of the emergent wetlands by area are likely to have an inundated water regime. Wetlands with this water regime are most common in the Aspen Parklands, Hardwood Hills, Minnesota River Prairie, Southeast Plateau regions of MN though

[1] Minnesota Wetlands Conservation Plan, Version 1.0, 1997, Minnesota Department of Natural Resources, St. Paul, MN. Pp 32, 34. http://files.dnr.state.mn.us/ecological_services/wetlands/wetland.pdf

they clearly occur statewide.  These regional patterns are very general and in fact any water regime may occur in any part of the state. Therefore, imagery and ancillary data should guide interpretation.

It is difficult to develop a simple "cookbook" method for interpreting wetland water regime.  It will be most helpful to first read and understand the concepts expressed in the following emergent wetland water regime descriptions and then to use the general matrix of water regime indicators described in Table 1.

Emergent Wetland Water Regime Descriptions

*Inundated* - (permanent and semi-permanently flooded) water regime:  Water covers the land surface throughout the growing season in most years (6 out of 10 growing seasons).  During droughts surface water may not be present throughout the growing season, however the water table will typically remain at or near the surface and may appear as dark soil mottles during extended dry periods.  Inundated wetlands frequently grow-in significantly with emergent plants and water levels may decrease as the growing season progresses such that only 70% of the water extent visible during spring may be evident in summer imagery.  Inundated emergent wetlands will frequently occur adjacent to or as part of a complex with aquatic bed (AB) or unconsolidated bottom (UB) wetlands as well as deepwater (DW) habitats.  Typical wetland types include shallow and deep marshes with prominent "bands" or "beds" of persistent[2] emergent aquatic plants such as cattails, bulrushes, various grasses, sedges, spike rushes, arrowheads and smartweeds.  Inundated wetlands are typically at least 3 acres in size.

Seasonal (includes temporarily flooded wetlands) – In most years surface water is present for extended periods (typically at least 6 weeks), especially early in the growing season, but is usually absent by late in the growing season in most years (6 out of 10 growing seasons).  Prominent mudflats associated with small pockets of ponded or flowing water are typical in mid-summer.  When surface water is absent in summer imagery the water table is usually near the surface.  Significant precipitation events in summer or fall can result in "rewetting".  Vegetation is dominated by emergent aquatic plants which will frequently fill the entire (100%) area of the wetland by mid-summer unless the water level drops rapidly resulting in extensive mudflats which may be unvegetated.  Typical wetlands with seasonal water regime include floodplains and shallow depressional marshes.  Floodplains are adjacent to rivers or streams are usually dominated by an overstory of trees or shrubs with an herbaceous understory.  Seasonal water regime is typical of marshes situated in shallow depressions are usually dominated by aquatic plants such as grasses, sedges, water plantains, arrowhead, smartweeds or cattails.  Wetlands with seasonal water regime can also occur in poorly drained shallow depressions in agricultural, grassland and forested land cover types.

*Saturated* - In wetlands with saturated water regimes the soil is typically saturated to the surface for extended periods during the growing season, but extensive surface water or water column is rarely present.  When surface water is evident it usually occurs in random scattered small "pockets" or pools of small scale depressions such as hummocks in pastures.  These water pockets may be difficult to see from remote imagery.  The water table is usually at or near the surface.  Saturated water regime also includes mat (e.g., sedge, cattail) and other bog

[2] Persistent means plants that normally remain standing as prominent herbaceous litter at least until the beginning of the next growing season for example cattails and bulrushes.

communities floating over the water column or unconsolidated bottom. Vegetation in emergent class wetlands with saturated water regime is dominated by various herbaceous plants like sphagnum mosses, grasses, sedges or wetland wildflowers such as Joe-Pye weed, goldenrods, various orchids or pitcher plants. Emergent class wetlands with saturated water regimes include: bogs, wet meadows, and wet prairies.

Delineating Water Regime Polygons

Each instance where emergent wetlands have distinct different water regimes should be delineated down to ½ acre in size. However, an area should not be delineated as separate water regime unless it comprises at least one quarter of the total wetland basin area. It is very unlikely a given emergent wetland basin will have more than three water regimes and more typically one or two.

Table 1. Emergent Wetlands – Interpreting water regime

| Water Regime | Emergent Code | Spring Imagery | Summer Imagery | Fall Imagery | Change in WATER PRESENCE |
|---|---|---|---|---|---|
| Saturated | SA | Open water normally absent. | Open water normally absent.<br>Litter or actively growing wetland vegetation present throughout the wetland. | Open water normally absent. Lush vegetation. | Little change |
| Seasonal | SE | Open water normally present except in dry years. | Open water normally absent (6 out of 10 years). Open water may be present during wet years (≤4 out of 10 years).<br>Litter or active growing zone of wetland vegetation typically present throughout ≥70% of the wetland. Mudflats are common. | Open water normally absent, but may be present due to recent local precipitation events. | Marked wet/dry change with more open water during wet periods and less dry during droughts |
| Inundated | IN | Open water normally present (6 out of 10 years) except in drought conditions. | Open water normally present (≥5 out of 10 years), although extent of open water may change from spring. Emergent vegetation extent may change by up to 50% from spring. | Open water normally present. Open water extent similar to summer. | Significant change can occur, but open water is usually present. |

# 14. *Appendix C – Interpretation Guidance for Pond Modifiers*

September 29, 2009

The national wetland status and trends program, conducted by the U.S. Fish and Wildlife Service, has identified a trend of increasing frequency of occurrence of constructed ponds and pond-like wetlands. To better understand this trend, the USFWS has proposed to track ponds by type and as such they have identified several different types of ponds including ponds created or modified for use in aquaculture, waterfowl production, industrial processes, "natural" landscaping, farming, recreation, and urban water management.

The Minnesota wetland status and trends monitoring program (WSTMP) relies on two modifiers for tracking these features. The two modifiers used in this program include the "*m*" modifier for artificially created or modified wetland basins and the "*af*" modifier for artificially flooded wetland basins. This document provides guidance on assigning these attribute modifiers for this program. The full definition of these modifiers is provided in the main body of the interpretation guidance for the WSTMP, but is repeated here with additional illustrations and details regarding criteria for application of the modifiers.

## Manmade Modifier (m)

The manmade modifier denotes a wetland with a basin that is either entirely created by or substantially modified by humans. The modifier may be applied to deepwater, unconsolidated bottom, aquatic bed, or emergent wetlands. This modifier includes all types of "artificial ponds", whether they were created by excavation of upland where wetland had previously not existed or if they appear by their landscape context to have been intentionally constructed by excavation, damming or obvious detention of storm flows or water table surface exposure in previously natural wetlands or waterways. Wetlands that appear to have resulted from unintentional or incidental linear feature detention as result from roadbeds or railroad beds should not be flagged as "manmade". A few examples, though not all inclusive, of wetlands which should be denoted as "manmade" include: livestock ponds, storm water catchment basins, aquaculture ponds, golf course ponds (if graded and contoured as water traps), aesthetic or reflection ponds, wildlife dugout ponds and wastewater treatment ponds.

If a polygon shows evidence of being created by humans, attach the "m" modifier to the class code. For example, if an unconsolidated bottom (UB) polygon is bounded by straight sides and/or the water is clearly contained by concrete berms, the correct classification would be UBm.

There are a number of clues that a polygon is manmade, including:

- Straight or regular sides (squares, rectangles, nearly perfectly circular)
- Mechanically built up sides (concrete or dirt containment berms)
- Located in a golf course, in the middle of a housing development, or next to a farmstead
- Presence of engineered structures such as rip-rap shorelines and storm sewer inlets and outlets

## Artificially Flooded Modifier (af)

The artificially-flooded modifier denotes wetland areas where the frequency or depth of inundation is artificially increased by the addition of artificial water sources. Features attributed with the manmade modifier will sometimes be classified artificially flooded as well. This modifier may be added to unconsolidated bottom, aquatic bed, and emergent classifications.

Some examples of this modifier are: animal feedlot operation treatment ponds, active excavated aquaculture ponds, constructed wetland treatment systems, sewage ponds, industrial treatment ponds, and swimming ponds. The artificially flooded modifier will be used in unison with the manmade modifier in some conditions; this will be determined by whether or not its water source is artificial or not. Artificial sources of water include water from any municipal or industrial source. Water derived from precipitation or runoff are not considered artificial sources regardless of whether the runoff is from urban or agricultural drainage systems.

Visual indicators for the artificially flooded modifier include:

- Regularly shaped wetlands or ponds with multiple cells and associated pipes and appurtenances.
- Water bodies within agro-industrial or mineral extraction settings with associated pipes and appurtenances

Other criteria (non-visual)

- Waterbodies lined with geo-textile fabrics, concrete or other such impermeable layers (this would include swimming pools).
- MPCA NPDES permit point GIS data layer associated with the facility (in most cases, except for aquaculture and wildrice pond facilities) (see Table 1). Other GIS data layers may be available to aid attribution of these facilities.

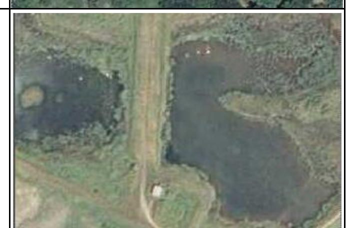
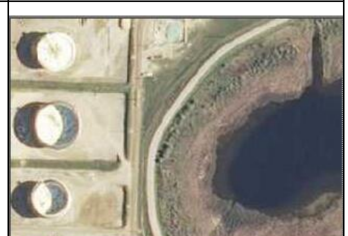
Adjacent land uses and the context of the waterbody or facility should also be taken into consideration when determining whether a waterbody should be attributed with an *m* or *af* modifier.

Table 1 lists examples of pond types and their associated modifiers.

Table 1. Various pond types and associated modifiers

| Pond types | Primary water source | Modifier | Modifier | NPDES point coverage | Water of the State | Hydrologic modification |
|---|---|---|---|---|---|---|
| Forest ponds | Natural | | | | Yes | No |
| [should not have "m" modifier] | | | | | | |
| Bog ponds | Natural | | | | Yes | No |
| [should not have "m" modifier] | | | | | | |
| Beaver Ponds | Natural | | | | Yes | Yes |
| [should not have "m" modifier] | | | | | | |
| Newly constructed wetlands | Natural | m | | | Yes | Yes |
| [Although construction may not always be apparent] | | | | | | |
| Excavated ornamental wildlife ponds | Natural | m | | | Yes | Yes |
| Diked or bermed wildlife ponds | Both (varies) | m | | | Yes | Yes |
| Excavated livestock ponds | Natural | m | | | Yes | Yes |
| Diked or bermed livestock ponds | Natural | m | | | Yes | Yes |
| Concentrated animal feedlot operation treatment ponds | Artificial | m | af | Yes | | |
| Diked or excavated aquaculture ponds | Both (varies) | m | af | | Yes | Yes |
| Active excavated mining or quarry ponds | Both (varies) | m | af | Yes | Yes | Yes |
| Abandoned mining or quarry ponds | Natural | m | | | Yes | Yes |
| Graded natural wetland aquaculture ponds | Natural | m | | | Yes | Yes |
| Diked wildrice ponds | Artificial | m | | | Yes | Yes |
| Excavated golf course ponds | Both (varies) | m | | | Yes | Yes |
| Natural wetland golf course ponds | Natural | m | | | Yes | Yes |
| Constructed wetland treatment system | Artificial | m | af | Yes | No | No |
| Abandoned mining pits (aggregate) | Natural | m | | | Yes | Yes |
| Created stormwater ponds | Artificial | m | | | No | Yes |
| Stormwater ponds excavated in natural wetlands | Natural | m | | | Yes | Yes |
| Sewage treatment ponds | Artificial | m | af | Yes | No | No |
| Created ornamentation ponds | Both (varies) | m | | | Yes | Yes |
| Excavated ornamental ponds | Natural | m | | | Yes | Yes |
| Excavated or bermed recreational ponds | Natural | m | | | Yes | Yes |
| Industrial treatment ponds | Artificial | m | af | Yes | No | No |
| Swimming ponds | Artificial | m | af | | No | No |

Table 2. Examples of features with manmade (*m*) and artificially flooded (*af*) characteristics

| Pond Type and visual features | Example aerial photos |
|---|---|
| Concentrated animal feedlot operation treatment ponds:<br>• Associated with multiple confinement structures<br>• Usually single cell<br>• Often off color-turbid water<br>• Usually in a rural landscape |  |
| **<u>Active</u>** excavated mining or quarry ponds:<br>• Light colored bare soil staging and access areas prominent<br>• Often off color-turbid water<br>➢ Inactive mines or quarries do not need to be tagged with the *af* modifier |  |
| Diked or excavated aquaculture ponds:<br>• Dikes are prominent<br>• Context typically rural<br>• One or more cells |  |
| Constructed wetland treatment system:<br>• Associated with small communities<br>• Color often light green<br>• One or more small cells<br>• Usually vegetated |  |
| Sewage treatment ponds:<br>• Associated with urban populations<br>• Usually multi-celled or with various pumps pipes or appurtenances<br>• Usually having well defined edges and a regular boundary<br>• Frequently off color-turbid water |  |
| Industrial treatment ponds:<br>• Usually associated with urban land cover, though not always population centers<br>• Frequently multi-celled<br>• Frequently off color-turbid water |  |
| Swimming ponds:<br>• Urban recreation facilities near population centers<br>• “Sand beaches” typical of adjacent upland<br>• Variously shaped<br>• Adjacent parking lots |  |

## 15. Appendix D – Side-Table Issues

1) There has been discussion about changing the feature precedence rules to give wetlands and deepwater habitat priority over all other coincident features. In particular, it is considered desirable by some TAC members to map wetland and deepwater areas that lie underneath bridges. In current practice the bridge is mapped and not the wetland or deepwater habitat. Changing this rule will require some re-interpretation of the data. The costs for this are not known at this time, but a cost-estimate for the effort will be developed.
2) There is some interest among the TAC for splitting the natural upland class into two classes: forested/wooded and grassland. The natural upland class would be eliminated. In addition, the silviculture class would be incorporated into the forested/wooded class. The costs for implementing this change are not known, but a cost estimate will be developed. Example definitions are as follows:

- **Forested/Wooded**: Forested includes upland wooded lands with >30% closed canopies. This includes harvested (regenerating) forest stands.
- **Grassland**: The grassland class includes upland areas with herbaceous land cover other than crops. This included prairies, non-forested conservation lands (e.g. CRP, RIM, CREP), pastures, and hay fields.