FGDC *Working Draft* Wetland Mapping Standard

FGDC Wetland Subcommittee and

Wetland Mapping Standard Workgroup

Submitted by:
Margarete Heber
Environmental Protection Agency
Office of Water

Date: August 6, 2007

Table of Contents

1 INTRODUCTION

1.1 Background

Historically, the U.S. Fish and Wildlife Service (FWS) has had the responsibility for mapping wetlands in the United States. Those mapped products are currently held in the National Wetlands Inventory (NWI). As time has passed, more local and state and non-governmental organizations have become interested in mapping their wetlands, and at a more refined scale than has been available from NWI. For consistency, it has become increasingly important to develop a wetland mapping standard that everyone can use to map and share wetland data in a digital format. It is highly desirable to be able to reprocess dataset output from the NWI to support multiple mapping applications and digital products. It is also important for mapped wetland data to be "seamless" with other water data such as the features represented in the National Hydrography Dataset (NHD), so that wetlands can be mapped, coordinated, and understood in a more holistic environmental context, whether at the watershed, ecosystem, or regional level.

Historically, geographic data were stored as polygons and lines. In early edition wetlands maps, small wetland features were represented as points. These points were an artifact of the scale limitations of the cartographic technology used to map the wetlands at the time. The use of modern digital technology and on-screen mapping of wetlands allows interpretation to be done at a much larger scale. Features previously represented as points are now able to be delineated as polygons.

The intent of this standard is to support a consistent/seamless transition from traditional paper-based map products to technology-based mapping products and serve as the national standard for mapping wetland inventories for inclusion into the National Spatial Data Infrastructure (NSDI).

1.2 Objective

While this standard cannot change the National Wetlands Inventory Data produced prior to its implementation, this standard specifies a core set of data quality components necessary to add to the National Wetlands Inventory in a way that is consistent and supports multiple uses of the data, while meeting the requirements of the National Spatial Data Infrastructure (NSDI). This standard and is based largely on the existing draft standard used by U.S. Fish and Wildlife Service in support of the

NWI. The intent of the standard is to support current and future digital mapping capabilities of wetland data. The standard will provide specification of minimum data quality components for wetland mapping activities for inclusion into the NSDI that are funded or conducted by the Federal government. The National Wetlands Inventory digital wetland data serves as the foundation for the wetlands data layer of the NSDI. The standard balances the burden on the end-user community with the need for consistency and documented quality of digital mapping products. Additionally, this standard is created to coordinate wetland mapping with the National Hydrography Dataset, a national geospatial framework recognized by the Federal Geographic Data Committee (FGDC). Although this standard is structured to be extensible over time, the standard is deliberately developed with a forward-looking perspective to accommodate technology and map scale enhancements, assure its long-term usability, and minimize the need for revisions and updates over time.

1.3 Scope

The Wetland Mapping Standard supports the incorporation of federally-funded wetland mapping data into the national wetland geospatial database (under direction of the Fish and Wildlife Service) and the National Spatial Data Infrastructure (NSDI). This standard provides minimum requirements and guidelines for wetlands inventory mapping. Implementation guidelines and technical recommendations have been included to facilitate the vetting process, and are included in Appendix C. Specific cartographic, photogrammetric, and classification conventions where applicable have been identified and are represented by other Federal standards. Exemptions from these mapping requirements include:

1. Use of this standard for wetlands inventory mapping activities that are not federally-funded are strongly encouraged but not required. The NSDI will not incorporate non-compliant data from any source except National Wetlands Inventory maps created prior to the implementation of this standard (note these past NWI maps may be provided as scanned images only, for historical purposes only).
2. This standard exempts National Wetlands Inventory mapping and other federally-funded projects that began prior to the standard's effective date. Also exempt are federally-funded projects for which contract execution occurred prior to the standard's effective date, even if the actual work had not begun prior to that date.
3. This standard exempts change detection efforts that seek to extrapolate the amount of change in wetland area, type, functionality, value, integrity or quality, from samples. An intermediate step in these change detection efforts may include mapping individual wetlands in sample plots. This standard does not prevent Federal funding for this intermediate step.

4. The standard is neither designed, nor intended, to support legal, regulatory, or jurisdiction analyses of wetland mapping products, nor does it attempt to differentiate between regulatory and non-regulatory wetlands.
5. The standard is designed to support polygonal wetland datasets and does not apply to plot/point transects, and linear datasets.
6. This standard exempts data collected for site-specific wetland assessments for scientific research, environmental assessments (EAs) and environmental impact statements (EIS), and wetland determinations for regulatory purposes, when these site-specific activities necessitate the use of definitions and classifications which are incompatible with the FGDC wetland classification standard.
7. Certain mapping products are used as ancillary data in the development of wetland mapping; these mapping activities may remain independent of wetlands inventory mapping efforts and include:

    - *Deepwater substrate types*
    - *Vegetation Types*
    - *Soil types (including hydric soil units)*
    - *Topography*
    - *Geology*
    - *Forest Cover Maps*
    - *Hydrography*
    - *Navigation or bathymetry*

Other mapping activities may include wetlands or deepwater as a subset. Any new, updated or revised wetland mapping shall conform to this standard. More general mapping activities may use an existing compliant wetlands inventory to incorporate a wetlands subset rather than conducting new wetland mapping. Mapping activities of which wetlands may be a subset include but are not limited to:

- *Land Use Land Cover (LULC) classifications*
- *Forest cover maps*
- *Floodplains*

1.4 Applicability

This standard is intended for all Federal or federally-funded wetlands inventory mapping including those activities conducted by Federal agencies, states, and federally recognized tribal entities, non-governmental organizations, universities, and others. Specifically, if Federal funding is used in support of wetlands inventory mapping activities, then use of this standard is mandatory. The adoption of the standard for all other wetlands inventory mapping efforts (non-federally funded) is strongly encouraged to maintain and expand the wetland layer of the NSDI.

1.5 FGDC Standards and Other Related Practices

The following standards and applications are listed as core components to the Wetlands Mapping Standard effort. Some of these standards are included because the Wetlands Mapping Standard was developed in consideration and conformance with their requirements and intent.

The related FGDC standards include:

? Classification of Wetlands and Deepwater Habitats in the United States, FGDC-STD-004 http://www.fws.gov/stand/standards/cl_wetl.html
? Content Standard for Digital Geospatial Metadata (version 2.0) FGDC-STD-001-1998, http://www.fgdc.gov/metadata/geospatial-metadata-standards
? Geospatial Positioning Accuracy Standards Part 3. National standard for spatial data accuracy. FGDC-STD-007.3-1998
? *National Vegetation Classification Standard*, FGDC-STD-005
? *Soil Geographic Data Standard*, FGDC-STD-006

Other related practices include:

? *Canadian Wetland Inventory* maintained by Agriculture and Agri-Food Canada (AAFC) at http://www.cwi-icth.ca/
? *National Hydrography Database* (NHD) maintained by the USGS at http://nhd.usgs.gov/
? *Fish and Wildlife Service National Standards and Quality Components for Wetlands, Deepwater and Related Habitat Mapping*, http://www.fws.gov/stand/standards/dl_wetlands_National%20Standards.doc
? *Draft FGDC Riparian Standard* maintained by FGDC at http://www.fgdc.gov/standards/projects/FGDC-standards-projects/riparian-mapping/index_html
? *Guidance for Benthic Habitat Mapping: An Aerial Photographic Approach* maintained by the U.S. NOAA Coastal Services Center. Available for download at http://www.cschttp://www.csc.noaa.gov/benthic/mapping/pdf/bhmguide.pdf.noaa.gov/benthic/mapping/pdf/bhmguide.pdf
? Nature Serve's *Coastal/Marine Systems of North America: Framework for an Ecological Classification Standard at http://www.natureserve.org/publications/coastal_marine_classification.pdf*

- *RAMSAR Classification for Wetland Type* maintained by Convention on Wetlands (Ramsar, Iran, 1971) at http://www.ramsar.org/ris/key_ris_types.htm
- Primary Indicators Method. Tiner, R.W. 1993. *The primary indicators method - a practical approach to wetland recognition and delineation in the United States*. Wetlands 13(1): 50-64. (This method is typically used for verifying NWI wetlands on the ground).

1.6 Standard Development Procedures and Representation

Stakeholder representation from the Federal, State, non-profit, and private sectors was included in the development of this standard to ensure that the end-user information requirements are reflected in the final product. Technical development of the content of this standard began in June 2006 with a 3-day meeting of the workgroup comprised of members representing multiple Federal agencies and stakeholder groups. It was emphasized again that the standard would benefit from a wide vetting process targeting diverse members of the end-user community. Workgroup members and vetting participants, as well as workgroup activities are listed in Appendix H.

The development of this standard generated findings for minor revisions to other existing FGDC standards, including an expansion of the FGDC Wetlands and Deepwater Habitat Classification System (see Appendix A), additional tools for handling wetland unique identifiers, and publishing new FGDC standards for related wetland habitat types.

1.7 Maintenance Authority

The maintenance authority for the *Wetland Mapping Standard* resides with the FGDC Wetland Subcommittee. This workgroup recommends review of this standard at five-year intervals.

2 FGDC REQUIREMENTS AND QUALITY COMPONENTS

The sections below delineate the specification for the technical components of the Wetlands Mapping Standard. To further the Information Quality Act and conform to NWI Quality Review Procedures, all image-interpretation will receive a first level of 100% quality control review by a technically skilled person other than the person doing the original image interpretation and producers must provide an opportunity for review by other interested agencies and stakeholders prior to submission to the Service for inclusion in the NSDI. Names and affiliations of the reviewers of the data must be included in the metadata.

2.1 Source Imagery

The minimum requirement for this standard is that all source imagery must have a true spatial resolution and scale based on the geographic context of the mapping effort (Table 1).

NWI will conduct data verification, quality control, and quality assurance to meet current Quality Review Procedures before including data in the NSDI.

Table 1. Spatial Resolution Requirements of Source Imagery

	Lower 48 States and Hawaii*	**Alaska**	**In-Shore Deepwater**	**Off-Shore Deepwater**
Resolution	1m**	5m	3m	N/A***
Scale	1:12,000**	1:63,360	1:24,000	N/A***

*Includes the lower 48 states, Hawaii, District of Columbia and Trust Territories. In-shore and deepwater habitats are excluded. Alaska is also excluded.
**When imagery is not available at this scale or resolution; 1:24,000 or 3m is sufficient.
***Imagery is not suitable for bottom analysis for off-shore deepwater habitats.

Incorporation of any one or more of the following imagery source(s) will enhance data quality:

? Near-infrared wavelength imagery
? Stereoscopic imagery
? Multi-seasonal imagery

In some environments, especially those with low contrast, interpretation of these imagery sources may be necessary to achieve the completeness and accuracy requirements specified in this standard.

2.2 Classification

This standard is based upon classification using the FGDC Wetlands and Deepwater Habitat Classification System. The minimum standard for wetland classification is: ecological system, subsystem (where applicable), class, subclass for forested, scrub-shrub, and emergent classes, water regime, and special modifiers. The minimum standard for deepwater habitat classification is: system, subsystem, class, and the water regime. Table 2 on the next page represents required classifications based on habitat type. Further recommendations for classification are discussed in appendices B & C.

Table 2. Classification Levels Required Based on Habitat Type

	System	Subsystem	Class	Subclass☞	Water Regime	Special Modifiers
Lower 48 States and Hawaii*	Yes	Yes	Yes	Yes	Yes	Yes**
Alaska	Yes	Yes	Yes	Yes	Yes	Yes**
In-Shore Deepwater Habitat	Yes	Yes	Yes***	Yes****	Yes	No
Offshore Deepwater Habitat	Yes	Yes	Yes***	Yes****	Yes	No

☞Users should include Subclass for forested, scrub-shrub, and emergent Classes.
*Includes the lower 48 states, Hawaii, District of Columbia and Trust Territories. In-shore and deepwater habitats are excluded. Alaska is also excluded.
**Farmed wetlands need only include system and farmed modifier; cultivated cranberry bogs may be classified as PSSf.
***Unconsolidated bottom unless data indicates otherwise for inshore and deepwater habitats.
****Users should include Class and Subclass when data are available for inshore and offshore deepwater habitats; for other areas Class will suffice.

2.3 Accuracy

For wetland mapping, accuracy may be dependent upon several factors affecting identification including:

? Scale of imagery
? Mapping scale or base map scale
? Quality of imagery
? Season of imagery (leaf-off or leaf-on)
? Type of imagery or emulsion of imagery

- ? Environmental conditions when imagery was captured
- ? Difficulty of identifying particular types of wetlands
- ? Availability and quality of ancillary data sources

Accuracy is a function of data quality and technology as well as proper training of the image interpreter. Classification accuracy of the final map product should be measured by two metrics: Target Mapping Unit (TMU) and Producer's Accuracy (PA). This standard presents no requirement for User's Accuracy (UA). Implementation recommendations for UA are presented in Appendix C.

- ? **The Target Mapping Unit (TMU)** is an estimate of the size class of the smallest wetlands that can be consistently mapped and classified at a particular scale of imagery, and that the image-interpreter attempts to map consistently. The size of a TMU is based on a simple square or a circle shape (a polygon with significant interior area relative to its perimeter) and not a long, narrow rectangle (i.e., a linear feature with little or no discernable interior area at the scale of interest). Therefore, wetlands which appear long and narrow (less than 15 feet wide at a scale of 1:12,000), such as those following drainage-ways and stream corridors, are excluded from consideration when establishing the TMU, and such wetlands may or may not be mapped, depending on project objectives.
- ? **Producer's Accuracy (PA)** measures the percentage of features that are correctly classified on the imagery.
- ? **User's Accuracy (UA)** measures the percentage of reference sites on the ground (field-check) sites that are correctly classified on the map.

Spatial accuracy is a function of two metrics: Horizontal Accuracy (HA) and Vertical Accuracy (VA). This standard presents no requirement for Vertical Accuracy; however, implementation recommendations are included in Appendix C.

- ? **Horizontal Accuracy (HA)** refers to a features spatial relationship to the source imagery.
- ? **Vertical Accuracy (VA)** measure of the positional accuracy of a dataset with respect to a specified vertical datum.

Requirements for these accuracy metrics are presented in the following sub-sections.

2.3.1 Target Mapping Unit and Producers Accuracy

Ninety-eight percent of all wetlands visible on an image, at the size of the TMU or larger must be mapped regardless of the origin (natural, farmed, or artificial). The minimum technical requirements are specified in Table

3. Habitat changes that have occurred between the date of the source imagery and the date of field observation/groundtruthing are not considered errors because the wetland was correctly classified on the source imagery. Wetland data that exceed the minimum TMU requirements will be accepted for submission to the NSDI.

Table 3. TMU and Producer Accuracy Requirements

	Lower 48 States and Hawaii*	Alaska	In-Shore Deepwater	Off-Shore Deepwater
TMU	0.5 acres (0.2 ha)	5.0 acres (2.0 ha)	1.0 acre (0.4ha)	N/A
Producer's Accuracy	98%	98%	98%	N/A

*Includes the lower 48 states, Hawaii, District of Columbia and Trust Territories. In-shore and deepwater habitats are excluded. Alaska is also excluded.

For the lower 48 states and Hawaii and the Trust Territories, features that are at least 0.5 acre would be mapped with a demonstrated Producer Accuracy (PA) of 98% or higher documented, through external quality assessment of samples. The actual TMU and PA for the project area must be declared in the metadata, along with an associated justification.

2.3.2 Horizontal Accuracy

When the requirement states that the Horizontal Accuracy must be 5m root mean square error (RMSE) then the features must fall within 5m of the location of the features on the source imagery at least 68% of the time. This nominal positional accuracy conforms to FGDC Digital Ortho Quarter Quadrangle requirements used by many Federal agencies. This standard requires a nominal horizontal root mean square error (RMSE) commensurate with the context of the mapping as specified in Table 4.

Table 4. Horizontal Accuracy (RMSE) Requirements

	Lower 48 States and Hawaii*	Alaska	In-Shore Deepwater	Off-Shore Deepwater
Horizontal Accuracy (RMSE)	5m	25m	15m	N/A

*Includes the lower 48 states, Hawaii, and the District of Columbia. In-shore and deepwater habitats are excluded. Alaska is also excluded.

2.4 Data Verification

The overall guiding principle is that the wetlands data generated are added to the wetlands layer of the NSDI. To ensure quality control, the following verification checks outlined in this section (2.4) should be followed prior to submission for inclusion in the NSDI. Additional quality control recommendations are found in Appendix C.

2.4.1 Logical Consistency

Logical consistency refers to the internal consistency of the data structure, and particularly applies to topological consistency. This standard's intent is to ensure the ability to generate seamless digital mapping products within a project area. Tests for logical consistency must be performed that verify topology validity for submission to NSDI.

The minimum requirement for topological verification includes:

? Polygons intersecting the border of a project area must be closed along the border.
? Segments making up the outer and inner boundaries of a polygon tie end-to-end to completely enclose the area.
? Line segments are a set of sequentially numbered coordinate pairs.
? No duplicate features exist nor duplicate points in a data string.
? Intersecting lines are separated into individual line segments at the point of intersection.
? All nodes are represented by a single coordinate pair which indicates the beginning or end of a line segment.

Additional discussion on topology verification is presented in Appendix C.

2.4.2 Edge Matching

Edge-matching of wetland interpretation is required for a seamless wetland database. There are two types of edge-matching: 1) internal ties along the borders of source images and 2) external ties to pre-existing wetland data immediately adjacent to the project area.

The standard requires that in all cases, internal edge-matching shall be performed. Wetland mapping units lying along the outer borders of source images within a project area, whenever practical shall be edge-matched with interpretations on all adjacent images within the project area. All linear and polygon features shall be edited to ensure an identical or coincident transition across images in the entire project area. At a minimum, features located on the outer edge of the project area will be closed exactly at the border of the project area.

2.4.3 Attribute Validity

This standard requires that all polygons have a valid attribute code to depict wetland habitat type. To avoid attribute errors, all data submissions must be run through attribute verification checks prior to submission to FWS for inclusion in the NSDI. Implementation recommendations for ensuring attribute validity reside in Appendix C.

The USFWS Attribution Tools have been constructed to attribute map features that may depict wetlands, riparian areas, uplands or other natural resource features. These tools can also serve as a reference for uncommon or rarely used codes or to assist users who are not familiar with the alphanumeric wetland mapping codes. The main Attribution Tool contains the entire hierarchical scheme for the classifying wetlands and deepwater habitats (Cowardin *et al*, 1979). Additional information regarding the USFWS Attribution Tools is presented in Appendix C.

2.5 Datum and Projection

In accordance with the NWI and NSDI, the standard requires all data to be re-projected to Albers Equal-Area projection prior to submission. The standard requires the datum to be North American Datum 1983 (NAD83).

2.6 Metadata

Metadata must be provided and conform to the most recent FGDC Content Standard for Digital Geospatial Metadata (CSDGM). Adherence to the standard requires metadata to be produced for all the core accuracy requirements listed in this standard.

All metadata for derived wetland classifications must contain a reference to the FGDC-STD-004 Wetlands and Deepwater Habitat Classification System.

References

Classification of Wetlands and Deepwater Habitats in the United States, FGDC-STD-004 http://www.fws.gov/stand/standards/cl_wetl.html

Content Standard for Digital Geospatial Metadata (version 2.0) FGDC-STD-001-1998, http://www.fgdc.gov/metadata/geospatial-metadata-standards

National Hydrography Database (NHD) maintained by the USGS at http://nhd.usgs.gov/

Draft FGDC Riparian Standard maintained by FGDC at http://www.fgdc.gov/standards/projects/FGDC-standards-projects/riparian-mapping/index_html

Fish and Wildlife Service National Standards and Quality Components for Wetlands, Deepwater and Related Habitat Mapping, http://www.fws.gov/stand/standards/dl_wetlands_National%20Standards.doc

Geospatial Positioning Accuracy Standards Part 3. National standard for spatial data accuracy. FGDC-STD-007.3-1998

Guidance for Benthic Habitat Mapping: An Aerial Photographic Approach maintained by the U.S. NOAA Coastal Services Center. Available for download at http://www.csc.noaa.gov/benthic/mapping/pdf/bhmguide.pdf

National Vegetation Classification Standard, FGDC-STD-005 http://biology.usgs.gov/npsveg/classification/sect2.html

RAMSAR Classification for Wetland Type maintained by Convention on Wetlands (Ramsar, Iran, 1971) at http://www.ramsar.org/ris/key_ris_types.htm

U.S. Geological Survey. 2001. Standards for revised primary service quadrangle maps. Part 2 specifications. National Mapping Technical Instructions. U.S. Department of the Interior, U.S. Geological Survey, Reston, VA. 76p. plus appendices.

Primary Indicators Method. Tiner, R.W. 1993. *The primary indicators method - a practical approach to wetland recognition and delineation in the United States*. Wetlands 13(1): 50-64.

Appendix A: Workgroup Recommendations to the FGDC

1) FGDC Riparian Standards

Riparian habitats are integrally related to and/or highly interspersed with many wetland types. To exclude them from wetland maps would likewise be ecologically unsound and technically impractical. Inclusion of riparian habitat mapping in the NWI provides additional values in the western U.S. since wetlands are so limited in arid/semi-arid regions, and riparian habitats there are so critical to providing some of those limited functions; political, environmental and land-management concerns are at issue.

The developers of this standard recommend that the current *Draft FGDC Riparian Standard* be updated and expanded to align with the efforts of this wetland mapping standard. Riparian methodologies for classifying and mapping specific riparian habitat types that include wetland habitats need to be investigated further. More information regarding riparian habitat classification and mapping can be found in Appendix C.

2) Marine Benthic Standards

Marine benthic habitats are integrally related to and/or highly interspersed with many wetland types. Methodologies for mapping and classifying marine benthic habitat types need to be investigated further. NOAA maintains guidance for mapping benthic habitats, *Guidance for Benthic Habitat Mapping: An Aerial Photographic Approach* and classifying benthic habitats, *Coastal and Marine Ecological Classification Standard (CMECS).*

Through the development of this standard, it is encouraged that a FGDC committee be established to create and seek Federal approval for a new mapping standard that addresses marine and benthic habitat mapping activities. The committee should use the existing NOAA guidance for benthic habitat mapping as a baseline for creating an official FGDC standard. Additional informative information pertaining to marine and benthic habitat mapping resides in Appendix C.

3) Proposed Future Tools for Unique Identifiers and Tracking

The history of an individual feature in a geodatabase is referred to as a feature's "lineage." Geodatabases allow a user to query historical versions of a data layer and inspect the history of an individual feature. The ability to track wetland feature lineage becomes increasingly important as the national wetlands geodatabase grows and matures, especially when frequent edits are necessary. "Unique identifiers" are attributes which uniquely identify each mapped feature. Stable unique identifiers for wetland features would also be helpful for associating wetland data with other data sets (such as water quality and monitoring data), expanding the possibilities for analysis. The proposed National Wetland Mapping Standard endorses the adoption of technical standards for tracking polygons. Until such technical guidelines are developed, see Appendix E for technical implementation guidance regarding polygon lineage and unique identifiers.

Appendix B: Attributes for Wetland Classification

The following keys provide a list of other descriptors that have been developed by the U.S. Fish and Wildlife Service to describe other wetland properties not currently addressed in Cowardin et al. 1979 wetland classification system. When added to existing NWI wetland classifications, the expanded wetland database becomes a more powerful analytical tool allowing users to predict wetland functions for large geographic areas, to better characterize wetlands (e.g., palustrine wetlands associated with lakes, rivers, streams, and ponds), and to generate information of interest to policymakers and others (e.g., how many and how much of the wetland resource is isolated or connected to waters of the United States and how many and what kind of ponds are being created). When the Cowardin et al. classification is reviewed in the future, it is likely that these attributes in whole or part will be added to the classification. This operational draft system is referred to informally as LLWW (for Landscape, Landform, Water Flow path, and Waterbody type).

The following keys in Figures 1 and 2 provide a list of codes for writing alpha-numeric designations for wetland and deepwater habitats as defined by the wetland classification system developed by the U.S. Fish and Wildlife Service (Cowardin et al. 1979).

Figure 1

WETLANDS AND DEEPWATER HABITATS CLASSIFICATION

(Levels: SYSTEM – SUBSYSTEM – CLASS – Subclass)

M - MARINE

1 - SUBTIDAL

- RB – ROCK BOTTOM
  - 1 Bedrock
  - 2 Rubble
- UB – UNCONSOLIDATED BOTTOM
  - 1 Cobble-Gravel
  - 2 Sand
  - 3 Mud
  - 4 Organic
- AB – AQUATIC BED
  - 1 Algal
  - 3 Rooted Vascular
  - 5 *Unknown Submergent*
- RF - REEF
  - 1 Coral
  - 3 Worm
- OW - *OPEN WATER/ Unknown Bottom*

2 - INTERTIDAL

- AB – AQUATIC BED
  - 1 Algal
  - 3 Rooted Vascular
  - 5 *Unknown Submergent*
- RF– REEF
  - 1 Coral
  - 3 Worm
- RS – ROCKY SHORE
  - 1 Bedrock
  - 2 Rubble
- US - UNCONSOLIDATED SHORE
  - 1 Cobble-Gravel
  - 2 Sand
  - 3 Mud
  - 4 Organic

E - ESTUARINE

1 - SUBTIDAL

- RB - ROCK BOTTOM
  - 1 Bedrock
  - 2. Rubble
- UB – UNCONSOLIDATED BOTTOM
  - 1 Cobble-Gravel
  - 2 Sand
  - 3 Mud
  - 4 Organic
- AB – AQUATIC BED
  - 1 Algal
  - 3 Rooted Vascular
  - 4 Floating Vascular
  - 5 *Unknown Submergent*
  - 6 *Unknown Surface*
- RF – REEF
  - 1 Mollusc
  - 2 Worm
- OW - *OPEN WATER/ Unknown Bottom*

2 - INTERTIDAL

- AB – AQUATIC BED
  - 1 Algal
  - 3 Rooted Vascular
  - 4 Floating Vascular
  - 5 *Unknown Submergent*
  - 6 *Unknown Surface*
- RF– REEF
  - 1 Mollusc
  - 2 Worm
- SB – STREAMBED
  - 1 Cobble Gravel
  - 2 Sand
  - 3 Mud
  - 4 Organic
- RS - ROCKY SHORE
  - 1 Bedrock
  - 2 Rubble
- US – UNCONSOLIDATED SHORE
  - 1 Cobble-Gravel
  - 2 Sand
  - 3 Mud
  - 4 Organic
- EM -EMERGENT
  - 1 Persistent
  - 2 Nonpersistent
- SS – SCRUB-SHRUB
  - 1 Broad-Leaved Deciduous
  - 2 Needle-Leaved Deciduous
  - 3 Broad-Leaved Evergreen
  - 4 Needle-Leaved Evergreen
  - 5 Dead
  - 6 *Deciduous*
  - 7 *Evergreen*
- FO – FORESTED
  - 1 Broad-Leaved Deciduous
  - 2 Needle-Leaved Deciduous
  - 3 Broad-Leaved Evergreen
  - 4 Needle-Leaved Evergreen
  - 5 Dead
  - 6 *Deciduous*
  - 7 *Evergreen*

R - RIVERINE

SUBSYSTEM: 1 – TIDAL; 2 – LOWER PERENNIAL; 3 – UPPER PERENNIAL; 4 – INTERMITTENT; 5 – *UNKNOWN PERENNIAL*

- RB – ROCK BOTTOM
  - 1 Bedrock
  - 2 Rubble
- UB – UNCONSOLIDATED BOTTOM
  - 1 Cobble-Gravel
  - 2 Sand
  - 3 Mud
  - 4 Organic
- *SB – STREAMBED
  - 1 Bedrock
  - 2 Rubble
  - 3 Cobble Gravel
  - 4 Sand
  - 5 Mud
  - 6 Organic
  - 7 Vegetated
- AB – AQUATIC BED
  - 1 Algal
  - 2 Aquatic Moss
  - 3 Rooted Vascular
  - 4 Floating Vascular
  - 5 *Unknown Submergent*
  - 6 *Unknown Surface*
- RS – ROCKY SHORE
  - 1 Bedrock
  - 2 Rubble
- US – UNCONSOLIDATED SHORE
  - 1 Cobble-Gravel
  - 2 Sand
  - 3 Mud
  - 4 Organic
  - 5 Vegetated
- **EM – EMERGENT
  - 2 Nonpersistent
- OW – *OPEN WATER*

** STREAMBED is limited to TIDAL and INTERMITTENT SUBSYSTEMS, and comprises the only CLASS in the INTERMITTENT SUBSYSTEM.*

** EMERGENT is limited to TIDAL and LOWER PERENNIAL SUBSYSTEMS.

Classification of Wetlands and Deepwater Habitats of the United States

Cowardin ET AL. 1979 as modified for National Wetlands Inventory Mapping Convention

Figure 2

WETLANDS AND DEEPWATER HABITATS CLASSIFICATION

SYSTEM: L- LACUSTRINE

SUBSYSTEM: 1 - LIMNETIC

CLASS	B – ROCK OTTOM	UB – UNCONSOLIDATED BOTTOM	AB – AQUATIC BED	OW – *OPEN WATER/ Unknown Bottom*
Subclass	Bedrock Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Algal 2 Aquatic Moss 3 Rooted Vascular 4 Floating Vascular 5 *Unknown Submergent* 6 *Unknown Surface*	

SUBSYSTEM: 2 - LITTORAL

CLASS	RB – ROCK BOTTOM	UB – UNCONSOLIDATED BOTTOM	AB – AQUATIC BED	RS – ROCKY SHORE	US – UNCONSOLIDATED SHORE	EM – EMERGENT	OW – *OPEN WATER/ Unknown Bottom*
Subclass	1 Bedrock 2. Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Algal 2 Aquatic Moss 3 Rooted Vascular 4 Floating Vascular 5 *Unknown Submergent* 6 *Unknown Surface*	1 Bedrock 2. Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic 5 Vegetated	2 Nonpersistent	

SYSTEM: P - PALUSTRINE

CLASS	RB – ROCK BOTTOM	UB – UNCONSOLIDATED BOTTOM	AB – AQUATIC BED	US – UNCONSOLIDATED SHORE	ML – MOSS-LICHEN	EM – EMERGENT	SS – SCRUB-SHRUB	FO – FORESTED	OW – *OPEN WATER/ Unknown Bottom*
Subclass	1 Bedrock 2. Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Algal 2 Aquatic Moss 3 Rooted Vascular 4 Floating Vascular 5 *Unknown Submergent* 6 *Unknown Surface*	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic 5 Vegetated	1 Moss 2 Lichen	1 Persistent 2 Nonpersistent	1 Broad-Leaved Deciduous 2 Needle-Leaved Deciduous 3 Broad-Leaved Evergreen 4 Needle-Leaved Evergreen 5 Dead 6 *Deciduous* 7 *Evergreen*	1 Broad-Leaved Deciduous 2 Needle-Leaved Deciduous 3 Broad-Leaved Evergreen 4 Needle-Leaved Evergreen 5 Dead 6 *Deciduous* 7 *Evergreen*	

MODIFIERS

In order to more adequately describe the wetland and deepwater habitats one or more of the water regime, water chemistry, soil or special modifiers may be applied at the class or lower level in the hierarchy. The farmed modifier may also be applied to the ecological system.

WATER REGIME	WATER CHEMISTRY	SOIL	SPECIAL MODIFIERS
A Temporarily Flooded B Saturated C Seasonally Flooded D *Seasonally Flooded/ Well Drained* E *Seasonally Flooded/ Saturated* F Semipermanently Flooded G Intermittently Exposed H Permanently Flooded J Intermittently Flooded K Artificially Flooded W Intermittently Flooded/Temporary Y Saturated/Semipermanent/ Seasonal Z Intermittently Exposed/Permanent U *Unknown* K *Artificially Flooded* L Subtidal M Irregularly Exposed N Regularly Exposed P Irregularly Flooded *S Temporary -Tidal *R Seasonal-Tidal *T Semipermanent-Tidal *V Permanent-Tidal U *Unknown* *These water regimes are only used in tidally influenced, freshwater systems.	1 Hyperhaline 2 Euthaline 3 Mixohaline *(Brackish)* 4 Polyhaline 5 Mesohaline 6 Oligohaline 0 Fresh 7 Hypersaline 8 Eusaline 9 Mixosaline 0 Fresh a Acid t Circumneutral i Alkaline	g Organic n Mineral	b *Beaver* d *Partially Drained/Ditched* f Farmed h *Diked/Impounded* r Artificial Substrate s *Spoil* x Excavated

NOTE: Italicized terms were added for mapping by the National Wetlands Inventory program.

The following keys provide a list of other descriptors that have been developed by the U.S. Fish and Wildlife Service to describe other wetland properties not currently addressed in Cowardin et al. 1979 wetland classification system. When added to existing NWI wetland classifications, the expanded wetland database becomes a more powerful analytical tool allowing users to predict wetland functions for large geographic areas, to better characterize wetlands (e.g., palustrine wetlands associated with lakes, rivers, streams, and ponds), and to generate information of interest to policymakers and others (e.g., how many and how much of the wetland resource is isolated or connected to waters of the United States). When the Cowardin et al. classification is reviewed in the future, it is likely that these attributes in whole or part will be added to the classification. This operational draft system is referred to informally as LLWW (for Landscape, Landform, Water Flow path, and Waterbody type).

Simplified Keys for Classifying Tidal and Nontidal Wetlands by Landscape Position, Landform, and Water Flow Path (Adapted from Tiner 2003)

Landscape Position

1. Wetland borders a river, stream, lake, reservoir, in-stream pond, estuary, or ocean……..2
1. Wetland does not border one of these waterbodies; it is surrounded by upland or borders a pond that is surrounded by upland………………………………………….Terrene
2. Wetland lies along an ocean shore and is subject to tidal flooding………………………Marine
2. Wetland does not lie along an ocean shore or if oceanside, it is not subject to tidal flooding...3
3. Wetland lies along an estuary (salt-brackish waters) and is subject to tidal flooding……Estuarine
3. Wetland does not lie along an estuary or if along the estuary, it is not subject to tidal flooding………………………………………………………………………………..4
4. Wetland lies along a lake or reservoir or within its basin (i.e., the relatively flat plain contiguous to the lake or reservoir)…………………………. ………………………..Lentic
4. Wetland lies along a river or stream, or in-stream pond, or borders a marine or estuarine wetland or associated waters but is not flooded by tides (except episodically)……….....5
5. Wetland is associated with a river or stream…………………………………………..6
5. Wetland is not associated with a river or stream; it is a freshwater nontidal wetland bordering a marine or estuarine wetland or associated waters.…………………………Terrene
6. Wetland is the source of a river or stream and this watercourse does not flow through the wetland………..…………………………………………………………………Terrene
6. A river or stream flows through or alongside the wetland ……………………………...7
7. Wetland is periodically flooded by river or stream ………..……………………………Lotic[1]
7. Wetland is not periodically flooded by the river or stream ………..…………….………...Terrene

[1] Lotic wetlands are separated into river and stream sections (based on watercourse width - polygon = Lotic River vs. linear = Lotic Stream at a scale of 1:24,000) and then divided into one of five gradients: 1) high (e.g., shallow mountain streams on steep slopes), 2) middle (e.g., streams with moderate slopes), 3) low (e.g., mainstem rivers with considerable floodplain development and slow-moving streams), 4) intermittent (periodic flows), and 5) tidal (hydrology under the influence of the tides).

Landform

1. Wetland occurs on a slope >2%..Slope
1. Wetland does not occur on a slope>2%..2
2. Wetland forms an island completely surrounded by water………………………….……..Island
2. Wetland does not form an island…….…………………………………………….…….3
3. Wetland occurs in the shallow water zone of a permanent nontidal waterbody, the intertidal zone of an estuary with unrestricted tidal flow, or the regularly flooded (daily tidal inundation) zone of freshwater tidal wetlands…………….………………..Fringe
3. Wetland does not occur in these waters or in estuarine intertidal zones with unrestricted tidal flow……………………………………………………..……..4
4. Wetland occurs in a portion of an estuary with restricted tidal flow due to tide gates, undersized culverts, dikes of similar obstructions………………………………………Basin
4. Wetland does not occur in such location……...…………………………………………5
5. Wetland forms a nonvegetated bank or is within the banks of a river or stream…….….Fringe
5. Wetland is a vegetated river or stream bank or not within the banks……..…….………6
6. Wetland occurs on an active alluvial plain of a river (a polygonal feature)[2]……… Floodplain*
6. Wetland does not occur on an active floodplain…………………………………….…..7
7. Wetland occurs on a broad interstream divide (including headwater positions) associated with coastal or glaciolacustrine plains or similar plains………………....Interfluve*
7. Wetland does not occur on such a landform...…………………………………………..…8
8. Wetland occurs in a distinct depression…………………………………………….…...Basin
8. Wetland occurs on a nearly level landform……………………………………………..Flat

----

*Basin and Flat sub-landforms can be identified within these landforms when desirable.

[2] For practical purposes, floodplain is restricted to rivers (i.e., polygonal watercourses); similar areas along streams (i.e., linear watercourses) are designated as basins or flats.

Water Flow Path[3]

1. Wetland is typically surrounded by upland (nonhydric soil); receives precipitation and runoff from adjacent areas with no apparent outflow[4]…..……..………………Isolated**
1. Wetland is not geographically isolated……………..…………………..……….2
2. Water flow is mainly bidirectional from tides or lake/reservoir fluctuations…….….3
2. Water flow is essential one-directional (downstream)………………………....….4
3. Wetland is subjected to tidal flooding…………………………...………..Bidirectional-Tidal
3. Wetland is located along a lake or reservoir and not along a river or stream entering this type of waterbody; water levels are mainly affected by the rise and fall of lake or reservoir water levels ……………..…………..Bidirectional-Nontidal***
4. Wetland is a sink, receiving water from a river, stream, or other surface water Source and lacking surface-water outflow………..………………………………Inflow
4. Wetland is not a sink; surface water flows through or out of the wetland…………...5
5. Water flows out of the wetland, but does not flow into this wetland from another source……………………………………………………………………Outflow
5. Water flows through the wetland, often coming from upstream or uphill sources (typically wetlands along rivers and streams)….……………..…………..Throughflow

----

**Wetland is geographically isolated; hydrological relationship to other wetlands and watercourses may be more complex than can be determined by simple visual assessment of surface water conditions. If groundwater relationships are known can apply other water flow paths as appropriate, but add "groundwater" to the term (e.g., outflow-groundwater).

***Bidirectional-Nontidal flow should be expanded to reference the water flow path of the associated waterbody: BH – bidirectional-nontidal/throughflow, BN – Bidirectional-nontidal/inflow, BO – Bidirectional-nontidal/outflow, and BS – Bidirectional-nontidal/isolated.

Source: Tiner, R.W. 2003. Dichotomous Keys and Mapping Codes for Wetland Landscape Position, Landform, Water Flow Path, and Waterbody Type Descriptors. U.S. Fish and Wildlife Service, National Wetlands Inventory Program, Northeast Region, Hadley, MA. 44 pp.

[3]Surface water connections are emphasized because they are more readily identified than groundwater linkages (see footnote below for paludified landscapes).

[4] Water flow path for some bogs and similar wetlands may be paludified; paludification processes occur in areas of low evapotranspiration and high rainfall, peat moss moves uphill creating wetlands on hillslopes (i.e., wetland develops upslope of primary water source).

Waterbody Types from Dichotomous Key

List of Estuary, Ocean, River, Stream, Lake, and Pond Types (with corresponding map codes assigned)

EY Estuary
- 1 drowned river valley estuary
  - a open bay (fully exposed)
  - b semi-enclosed bay
  - c river channel
- 2 bar-built estuary
  - a coastal pond-open
  - b coastal pond-seasonally closed
  - c coastal pond-intermittently open
  - d hypersaline lagoon
- 3 river-dominated estuary
- 4 rocky headland bay estuary
  - a island protected
- 5 island protected estuary
- 6 shoreline bay estuary
  - a open (fully exposed)
  - b semi-enclosed
- 7 tectonic
  - a fault-formed
  - b volcanic-formed
- 8 fjord
- 9 other

Note: If desired, you can also designate river channel (rc), stream channel (sc),and inlet channel (ic) by modifiers. *Examples*: EY1rc = Drowned River Valley Estuary river channel; EY2ic= Bar-built estuary inlet channel. If not, simply classify all estuarine water as a single type, e.g., EY1 for Drowned River Valley or EY2 for Bar-built Estuary.

OB Ocean or Bay
- 1 open (fully exposed)
- 2 semi-protected oceanic bay
- 3 atoll lagoon
- 4 other reef-protected waters
- 5 fjord

RV	River		
	1	low gradient	
	a		connecting channel
	b		canal
	2	middle gradient	
	a		connecting channel
	3	high gradient	
	a		waterfall
	b		riffle
	c		pool
	4	intermittent gradient	
	5	tidal gradient	
	6	dammed gradient	
	a		lock and dammed
	b		run-of-river dammed
	c		other dammed

ST	Stream		
	1	low gradient	
	a		connecting channel
	2	middle gradient	
	a		connecting channel
	3	high gradient	
	a		waterfall
	b		riffle
	c		pool
	4	intermittent gradient	
	5	tidal gradient	
	6	dammed	
	a		lock and dammed
	b		run-of-river dammed
	c		beaver dammed
	d		other dammed
	7	artificial	
	a		connecting channel
	b		ditch

LK	Lake		
	1	natural lake (*see also Pond codes for possible specific types*)	
	a		main body
	b		open embayment
	c		semi-enclosed embayment
	d		barrier beach lagoon

	2	dammed river valley lake	
	a		reservoir
	b		hydropower
	c		other
	3	other dammed lake	
	a		former natural
	b		artificial
	4	other artificial lake	
PD	Pond		
	1	natural	
	a		bog
	b		woodland-wetland
	c		woodland-dryland
	d		prairie-wetland (pothole)
	e		prairie-dryland (pothole)
	f		playa
	g		polygonal
	h		sinkhole-woodland
	i		sinkhole-prairie
	j		Carolina bay
	k		pocosin
	l		cypress dome
	m		vernal-woodland
	n		vernal-West Coast
	o		interdunal
	p		grady
	q		floodplain
	r		other
	2	dammed/impounded	
	a		agriculture
	a1		cropland
	a2		livestock
	a3		cranberry
	b		aquaculture
	b1		catfish
	b2		crayfish
	c		commercial
	c1		commercial-stormwater
	d		industrial
	d1		industrial-stormwater
	d2		industrial-wastewater
	e		residential
	e1		residential-stormwater
	f		sewage treatment
	g		golf
	h		wildlife management

i		other recreational
o		other
3	excavated	
a		agriculture
a1		cropland
a2		livestock
a3		cranberry
b		aquaculture
b1		catfish
b2		crayfish
c		commercial
c1		commercial-stormwater
d		industrial
d1		industrial-stormwater
d2		industrial-wastewater
e		residential
e1		residential-stormwater
f		sewage treatment
g		golf
h		wildlife management
i		other recreational
j		mining
j1		sand/gravel
j2		coal
o		other
4	beaver	
5	other artificial	

Appendix C: Implementation Recommendations in Support of Section 2.0

In developing Section 2, "FGDC Requirements and Quality Components," this standard acknowledges the need for additional implementation recommendations above and beyond the existing minimum technical requirements. This appendix provides technical recommendations for implementing the Wetland Mapping Standard.

1) Classification *(Standard Section 2.2)*

A. Riparian Habitats

Riparian habitats are plant communities that are contiguous to rivers, streams, lakes or drainage ways. Riparian areas are usually transitional between aquatic and upland, or wetland and upland. In addition to providing a vertical transition between aquatic and terrestrial ecosystems, riparian areas also possess a distinct horizontal structure. Drainage patterns form an extensive, dendritic network throughout the country. The associated riparian zones form corridors that extend within and into different regions. The general spatial pattern of riparian areas thus forms a gradient of height and width and becomes a network within an overall matrix (Malanson 1993).

Current mapping standards for riparian habitats are based both on vegetation and the geomorphology of the channel. Riparian habitats in the U.S. may be broken down into two distinct categories: Arid (including Hyper-Arid, Semi-Arid and Dry-Subhumid) and Humid. Arid riparian habitat occurs in areas where mean annual evaporation exceeds mean annual precipitation, primarily WEST of the Mississippi River. Humid riparian habitat occurs in areas where mean annual precipitation exceeds mean annual evaporation, primarily EAST of the Mississippi River. Using current technology, riparian habitats can only be readily mapped only from aerial imagery in the Western U.S. where evaporation exceeds precipitation and where the habitats are therefore distinct from the surrounding vegetation. Since humid riparian habitats cannot currently be mapped as easily as arid riparian habitats, they are not considered further in this version of the mapping standard. However, it is recommended that efforts be undertaken to develop technology to map humid riparian habitats for possible inclusion in updates of the Wetland Mapping Standard.

Arid riparian habitats are currently mapped/included within the NWI geospatial data layers. "Arid Riparian Habitat" is defined based on FWS guidance entitled "A System for Mapping Riparian Areas in the Western United States" (USFWS 1997 [and draft revision 2007])[5].

Arid Riparian areas, including Hyper-Arid, Semi-Arid and Dry-Subhumid, are the non-wetland and non-aquatic plant communities contiguous to and affected by surface and subsurface hydrologic features of perennial or intermittent lotic and lentic water bodies (rivers, streams, lakes or drainage ways). Arid Riparian areas have one or both of the following characteristics: 1) distinctively different vegetative species than adjacent areas, and 2) species similar to adjacent areas but exhibiting more vigorous or robust growth forms.

Arid riparian habitats are defined in the mapping system as being "non-wetland and non-aquatic" to separate wetlands in a riparian landscape position from riparian areas. This prevents the overlap of polygons and allows mapping of these features in the same data layer with wetlands and other aquatic habitats. However, in practice, arid riparian habitats may include unintentional inclusions of wetland and other aquatic habitat.

B. Upland Areas

This standard recommends against labeling Upland areas. However, if these features must be mapped to maintain topology or for quality control, the "U" symbol should be used. For the wetland data layer for the National Spatial Data Infrastructure (NSDI), the "U" or "upland" features/polygons are eliminated for several reasons, one of which is these areas may contain undetectable wetlands given the limitations of the Service's wetlands data collection methods. Another important reason for the elimination of the "U" or upland features relates to the sheer size of the database.

C. Wetland and Deepwater Attribute Parsing

The classification attribute table should be designed such that the code for each level of the classification scheme is placed in a separate field (or column) in the table (i.e., SYSTEM, SUBSYSTEM, CLASS, SUBCLASS, WATER_REGIME, SPECIAL_MODIFIER, etc.), in order to better facilitate incorporation and analysis of the data.

When separate fields are used for the classification levels, additional fields may be created to hold the concatenated codes in order to simplify labeling. For example, a data field "Label _1" may contain all the Cowardin classification levels put together (e.g.,"PFO1Fh"), and likewise another field "Label_2" might contain all the LLWW classification levels put together.

This standard does not recommend using "mixed codes". However, two (or rarely three) codes may, in unusual instances, be needed to attribute a particular level of the classification (for example, in a wetland with a mixture of scrub-shrub and emergent covers which are inseparable at the interpretation scale used, and that has a resulting Class code of "SS1/EM1"). This situation is informally referred to as "mixed codes" or "split classes". In very rare instances, three classes may be mixed, but the NWI database is not designed to accept this level of data at this time.

Mixed codes (or split classes) should not be used unless at least one of the following conditions is met: (1) the wetland contains two or more distinct cover types, each encompassing at least 30% aerial coverage, but the wetland is too small in size to allow separate delineation of each cover type; OR (2) the wetland contains two or more classes or subclasses, each compromising at least 30% aerial coverage, which are so evenly interspersed that separate delineation is not possible. If it is necessary to use mixed codes, the class covering greater area within the polygon is considered the dominant class, and the other class is sub-dominant (listed second). For example, PFO1/SS1C is a wetland where FO1 (broad-leaved deciduous forested wetland) covers more of the wetland polygon than the SS1 (broad-leaved deciduous scrub-shrub) component.

Where mixed codes are possible within a classification level, additional attribute fields may be utilized for each level of the classification to facilitate analysis of the data (e.g. CLASS_1 and CLASS_2, or SPECIAL_MODIFIER_1 and SPECIAL_MODIFIER_2); however the NWI database is not designed to accept this level of data at this time. Slashes are used to separate mixed codes (as is done in the existing NWI data) when the codes are concatenated for labels (e.g., PSS1/EM1Hh).

The implementation of parsing rules and procedures will be pursued as a result of this standard.

D. Adding Additional Classification Descriptors

The producer may add additional descriptors including subclass, water chemistry modifiers, special modifiers and other descriptors such as LLWW descriptors (e.g., landscape position, landform, water flow path, and waterbody type) to satisfy regional or local needs. This standard recommends the use of LLWW descriptors to enhance characterization of wetlands and to predict wetland functions.

2) Accuracy *(Standard Section 2.3)*

A. User's Accuracy (UA)

This standard recommends use of field accuracy assessment techniques to assess UA and the documentation of these results in the metadata. Field accuracy can be determined by applying the primary indicators approach to field-checked wetlands (Tiner 1993).

B. Quality Control

The *Wetland Mapping Standard* seeks to ensure the consistent identification of a specified percentage of wetlands that are above a specified size in the submission of digital data by all users, in order to support and document the data quality requirements of the national data layer. To this end, the contractual requirements established for the use of Federal funding when mapping in accordance with this standard do require the demonstration of TMU, PA and/or UA. Prior to NSDI inclusion, all products are subject to being verified by either general inspection, 100% inspection, or inspection by sampling. Inspection of the digital wetlands data will involve both visual and software evaluation procedures. The inspections are intended to satisfy compliance with file format, content completeness, positional accuracy, attribute accuracy, topological fidelity, and edge matching.

3) Data Verification *(Standard Section 2.4)*

A. Logical Consistency and Edge Matching

The standard recommends tying new polygons to existing polygons in adjacent areas in the NSDI to maintain a seamless national wetlands database. To maintain a seamless national wetlands database, it is advisable to tie the interpretations for the project area to adjacent pre-existing wetland data in the national database. Such external edge-matching should be performed if the age, scale, and emulsion of the source images are compatible. In some cases, this will not be possible, such as where the project area is a watershed, county, State, reservation or any other area of interest and funds or source imagery are not available for external ties, where changes in wetland boundaries or types have occurred during the intervening time period, or where wetlands were inaccurately delineated on the original maps. The standard encourages producers to tie their new data to pre-existing national wetlands data and include plans and costs for doing so in project proposals. This will expedite data posting in the national database and aid efforts to maintain a seamless database. Implementation of this recommendation would likely require considerable overlap of both source imagery and map production with adjacent mapping efforts.

B. Attribute Validity

The USFWS Topology and Attribute Verification Tools have been constructed to automate (to the extent possible) the quality control functions necessary to ensure the data are cartographically accurate. This suite of functions has been designed to address cartographic errors, digital anomalies, and some logic checks that make use of the power of geographic information system technology. The verification tools will flag potential problems but provides the image interpreter the option of editing or ignoring the feature. This is to accommodate the image interpreter's ability to ultimately determine the best ecological portrayal of the data. For example, a small lake that is only 18 acres has been identified during the data verification process as a potential problem based on its size (18 acres) and classification (lacustrine). The interpreter has information that the lake depth exceeds 90 feet and determines that lacustrine is the best ecological descriptor for this feature.

The verification tools allow the user to easily find attribute problems with the wetlands polygons. There are two types of procedures involved. The first procedure is a non-interactive, intensive process that checks all the attribute codes, repairs some of them and flags others for subsequent checks. The second type of procedure is an interactive process where the interpreter uses the interactive mapping capabilities of the GIS application to visually identify specific topological and attribute features that may need adjustment.

The tools incorporate the following:

? Allows the image interpreter to perform a series of verification tests and optionally visualize the results of those tests through the use of "graphic elements."?

? Stores and manages results of the tests in a special field added to the layer's attribute table.?

? Provides the image interpreter with a count of the number of errors found by a particular test.?

? Provides the image interpreter with an estimate of the processing time remaining until completion of a verification test through the use of a "progress bar.?

? Provides a function that runs the most critical tests and produces either a "pass" or "fail" assessment of the QA/QC procedure.?

Appendix D: Known Issues with Existing Wetlands Mapping Data

During the development of this standard, several wetland mapping issues have been discussed and presented. This appendix describes known technical issues related to wetland mapping and data collection.

1) Nominal Scale Issues

Wetland maps produced using data from the wetlands layer of NSDI as thematic or topical data using U.S. Geological Survey topographic maps, digital raster graphics (DRG) or digital orthophotography as a base will comply with the standard for USGS digital spatial wetlands for maps produced from data[5] with a nominal scale of 1:24,000 or 1:63,360 (Alaska).

Organizations engaged in producing wetlands data are encouraged to exceed this nominal scale as source materials (e.g., Digital Ortho Quarter Quads) and technology capabilities allow.

2) Completeness and Errors

Every mapping project has errors of omission and commission. For wetland mapping, omission errors are wetlands that are not shown on the map. Wetlands may be omitted due to several factors that preclude their identification or delineation including scale and emulsion of imagery, mapping scale or base map scale, quality of imagery, environmental conditions when imagery was captured, and difficulty of identifying particular types of wetlands. Commission errors are errors related to misclassification or limits of scale. For wetland mapping, commission errors include: 1) misclassification (e.g., nonwetland areas mapped as wetlands or misidentification of the wetland type), 2) small uplands included within a large wetland mapping unit, and 3) small wetlands of different type included within a larger wetland unit of another type (e.g., a small scrub-shrub wetland within a palustrine forested wetland mapping unit) simply because they are too small to map (below the target mapping unit). The latter two situations are commonly referred to as "inclusions." Habitat changes that have occurred between the date of the source imagery and date of field observation/groundtruthing are not considered errors as the wetland was correctly classified on the source imagery.

NWI maps and geospatial data tend to err more by omission than by commission. This means that if a NWI map indicates the presence of a wetland in a given area, it is highly likely that a wetland is there. Yet, if a NWI map does not show a wetland, one would usually not be there, but users should be aware that small

[5] U.S. Geological Survey. 2001. Standards for revised primary service quadrangle maps. Part 2 specifications. National Mapping Technical Instructions. U.S. Department of The Interior, U.S. Geological Survey, Reston, VA. 76p. plus appendices.

unmapped wetlands on the ground may exist, particularly in landscape positions favoring wetland formation (e.g., floodplains, flat areas along streams, in depressions, and along drainageways). The following section "NWI Mapping Limitations" discusses some causes of omissions in NWI mapping.

3) NWI Mapping Limitations

1. Target Mapping Unit (TMU) – A TMU is an estimate of the minimum sized wetland that the NWI is attempting to consistently map. It is not necessarily the smallest wetland shown on the maps. The TMU for wetlands generally varies with the scale of the source imagery used, wetland type, project design, and funding.

2. Spring imagery - Where spring imagery is used, aquatic beds and nonpersistent emergent wetlands are usually undermapped. These areas are classified as open water, unless vegetation was observed during field investigations. In a few cases, scrub-shrub wetlands are submerged, avoiding imagery-detection; they too are included within mapped open waterbodies.

3. Summer (leaf-on) imagery - This imagery makes it difficult to identify many forested wetlands as well as seasonal wetlands. For example, the presence of a leafy canopy makes it extremely difficult to separate all but the wettest forested wetlands from upland forests. The wetness of the forest floor is obscured, except where canopy openings exist. In some areas, such as the Pacific Northwest, spring imagery is difficult to acquire due to cloud cover so leaf-on imagery was used for wetland mapping. In Alaska, most of the source imagery is acquired in mid-summer. In both these examples, the NWI Project is conservative in mapping forested wetlands. Also, summer imagery makes it more difficult to recognize seasonal wetlands that are flooded in winter and spring, but dry out before the imagery is acquired.

4. Forested wetlands - These are among the more difficult types to interpret. Consequently, these types are conservatively mapped. Forested wetlands on glacial till are often difficult to interpret, so many of these wetlands do not appear on NWI maps. The location of temporarily flooded or seasonally saturated forested wetlands are among the most difficult to identify on the ground as well as through imagery interpretation, so many of these wetlands do not appear on the NWI maps. This limitation is common along the Coastal Plain and perhaps in glaciolacustrine plains such as the Ontario Plain (New York). In areas where 1:80,000 black and white imagery was used, many forested wetlands were not interpretable. Consulting USDA soil survey maps and locating

undeveloped portions of hydric soil map units may help identify locations where more of these wetlands may be found.

5. Upland inclusions - Small upland areas may occur within delineated wetlands due to target mapping unit size. Field inspections and/or use of larger-scale imagery may be used to refine wetland boundaries when necessary.

6. Estuarine and tidal waters - Delineation of estuarine and riverine (tidal) systems and the oligohaline (slightly brackish) segment of estuaries should be considered approximate based on available reports or limited field checking.

7. Intertidal flats - Since imagery is not always captured at low tide, all intertidal flats are not visible; boundaries of these nonvegetated wetlands are often approximated from coastal and geodetic survey maps and topographic maps.

8. Coastal wetlands - Identification of high marsh versus low marsh in estuarine wetlands is often approximated, since the imagery of these zones is not distinctive in many instances.

9. Water regimes - Water regimes are identified based on imagery coupled with limited field verification; they should be considered approximate. Long-term hydrologic studies are required to accurately describe the hydrology of any particular wetland.

10. Linear wetlands - Wetlands which appear long and narrow (less than 50 feet wide at a scale of 1:24,000), and follow drainage-ways and stream corridors, may or may not have been mapped, depending on project objectives. Such linear wetlands may be relatively short or miles in length. The categorization of wetlands as linear features depends on the specific project objectives as well as on the limitations of the imagery and scale used. On the ground, linear wetlands may be found to be wider in places than what is shown on the map due to seasonal vegetation patterns and hydrologic conditions at the time the image was acquired. Most NWI maps identify at least some of these linear features. In most cases, no attempt was made to map all linear wetlands. Users can infer the possible occurrence of linear wetlands by looking for pertinent topographic features on the NWI maps.

11. Farmed wetlands - In general, only five types of farmed wetlands are shown on NWI maps: cranberry bogs, prairie potholes, pothole-like depressions, playa lakes, and seasonally flooded diked former tidelands in California. This is based on technical considerations and an interagency agreement between the

U.S. Fish and Wildlife Service and the U.S.D.A. Natural Resources Conservation Service, developed in the 1970s.

12. Partly drained wetlands - Partly drained wetlands are mapped based on recognizable image signatures. Many of these wetlands may have been missed. Consulting USDA soil survey maps and locating hydric soil map units not mapped as wetlands by NWI may help identify locations where more of these wetlands may be found.

13. Tundra - Moist tundra (usually wetland) is often difficult to separate from dry upland tundra due to lack of definitive image signatures. This is especially true where wide transition zones exist between the two types.

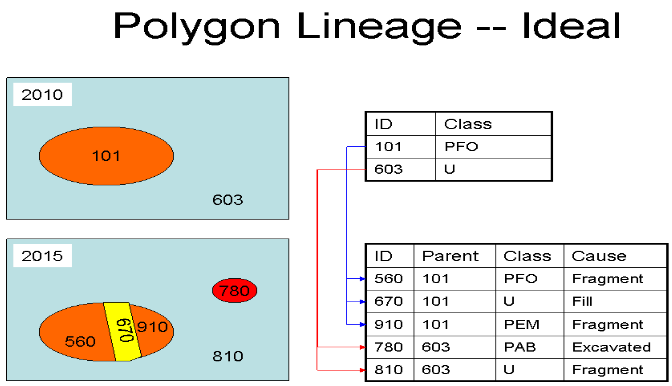
14. Date of wetlands geospatial data – The dates of the NWI geospatial map data are based on the dates of the source imagery. Data does not show losses or gains in wetlands since that date.

15. Submerged Aquatic Beds in Tidal Waters. NWI maps may show some of these beds – where they were visible on the aerial photography used by NWI. A more complete survey of these habitats, however, requires capturing special photography (e.g., larger scale, low tide, clear water, and no wave action) to maximize their identification and delineation.

Appendix E: Polygon Lineage and Unique Identifiers

Changes in wetlands either in spatial extent or physical characteristics will be maintained through feature lineages and versioning without losing any legacy data on the original polygon. Moreover, technologies that allow direct association of feature metadata with individual features have simplified maintenance of documentation. In the case of wetland inventories derived from previous inventories (i.e., where original data are edited through GIS), the GIS systems can track changes automatically (See Figure 1 for ideal Polygon Lineage).

Figure 1.

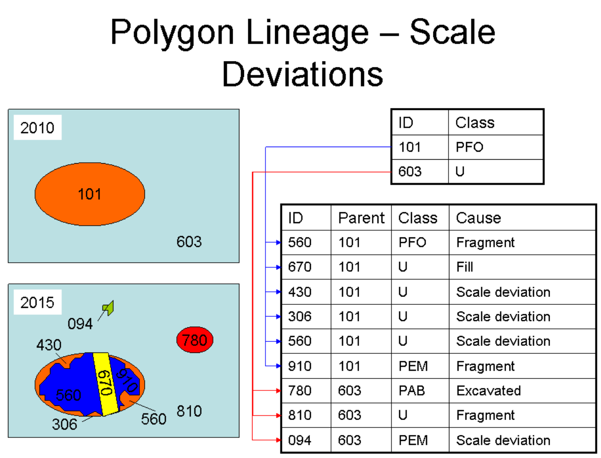


ID	Class
101	PFO
603	U

ID	Parent	Class	Cause
560	101	PFO	Fragment
670	101	U	Fill
910	101	PEM	Fragment
780	603	PAB	Excavated
810	603	U	Fragment

However, attributing the cause for the wetland changes requires additional editing and the development of change code descriptors (See Figure 2 for Polygon Lineage Scale Deviations).

Figure 2.



ID	Class
101	PFO
603	U

ID	Parent	Class	Cause
560	101	PFO	Fragment
670	101	U	Fill
430	101	U	Scale deviation
306	101	U	Scale deviation
560	101	U	Scale deviation
910	101	PEM	Fragment
780	603	PAB	Excavated
810	603	U	Fragment
094	603	PEM	Scale deviation

It is anticipated that the effort to develop these codes and other detailed Technical Guidelines for implementing the standard in practice will take place after the adoption of the FGDC National Wetland Mapping Standard.

Until such Technical Guidelines are developed, it is recommended that in lieu of attributing the reason for changes in every polygon, wetland mappers should consider focusing on attributing "new wetlands" - wetlands that were not there (in time one) and separating these wetlands into three categories. These categories are "newly established", "re-established" and "pre-existing." This would require re-examination of the source imagery from the prior inventory to determine whether the wetland was actually present at that time. For example, if an area classified as forested wetland in time two, was observed as a forest on the aerial image for time one, it is likely that the area was a forested wetland in time one; the area should be added as forested wetland to the time one wetland acreage. It is not a "newly established wetland," but rather a "pre-existing wetland." The situation is not as clearcut for agricultural areas where an area may appear as dryland during a drought or dry year (and even be cultivated) and later "reappear" as an emergent wetland in a wet year. While it is a "new" wetland in one sense, the wetland was always there, but undetectable during dry conditions. This wetland should also be added to the time one wetland acreage statistics. If, however, the area was drained in time one, and in time two, ditches were blocked and a wetland formed, then this wetland should be considered a "newly re-established wetland," and it would not be added to the time one base acreage since it was not a wetland at that time. This may not be as easy to interpret as one might think, so appropriate cautions, concerns, and limitations should be referenced in the metadata for the inventory.

After doing this comparative analysis, the recalculated wetland acreage summaries for the prior period (time one) will better reflect actual conditions for that era and can then be compared with the more recent data (i.e., the "missing" wetlands will have been added to the time one base).

In the interim, historic NWI data will be made available for use. Polygon lineage may be accomplished where NWI data are edited, however, in most cases; new NWI data are derived from better imagery and completely replace the older data. This complicates the issue of polygon lineage since the polygon is replaced and not simply edited; alignment and configuration may be quite different due to scale and image quality differences. In any event, polygon lineage issues identified in this appendix should be further examined and a practical solution developed for possible inclusion in future versions of NWI.

Appendix F: Questions and Answers

Q: What is a wetland and why map it?
A: Wetland Maps are essential to view a complete and accurate picture of wetland resources in the US, calculate (not estimate) wetland loss and gain, see wetland geospatial distribution, and complete the watershed picture on the National Map. Once wetlands are mapped, many types of assessments can be performed. Wetland assessments are critical to: monitor wetland health, make permit decisions, target volunteer wetlands restoration, maintain biodiversity, restore species, measure mitigation success, undertake watershed management, protect water supplies, and better community planning.

Q: What is the geographic area covered by features stored in the Geodatabase?
A: Five discrete geographic areas were designated as wetland mapping areas. These were named CONUS (conterminous United States), Alaska, Hawaii, PR-VI (Puerto Rico and the U.S. Virgin Islands), and Pac Trust (Pacific Trust Territories). Alaska contains the state of Alaska including the Aleutians. Hawaii contains the principle islands of Hawaii, including Hawaii, Maui, Kahoolawe, Lanai, Molokai, Oahu, Kauai and Niihau. CONU contains the 48 conterminous states. PR - VI contains the islands of Puerto Rico and the U. S. Virgin Islands. Pac Trust contains the U.S. island possessions and trust territories of the south Pacific.

Q: What is the background on the development of the Wetlands Mapping Standard?
A: There is currently no FGDC-approved (Federal Geographic Data Committee) standard for wetland mapping. USFWS (U.S. Fish & Wildlife Service) will never have will never have the resources to undertake wetland mapping and updating alone, especially on a continual basis – a partnership (Fed, State, Tribal, Local and others) can accomplish this. The mapping standard is essential the production of compatible data .

Q: Why develop a national standard?
A: A Wetland Mapping Standard will:
- streamline mapping efforts for greater consistency and efficiency,
- enable any entity to map using the standard and construct or update the National Wetlands Inventory (NWI) Geodatabase and the National Map,
- facilitate consistent mapping layers that can be used across geopolitical and watershed boundaries, and

- ensure that Federal funding for wetland mapping produces data for improving and updating the NWI Geodatabase and the National Map.

Q: What Was Proposed to and Approved by the FGDC in February 2006?

A: The Wetlands Subcommittee proposed to base development of a FGDC wetland mapping standard on the existing FWS wetlands mapping standard and coordinate with other pertinent standards: NHD, NOAA classifications, FGDC classification standards, etc.; coordinate with stakeholders; and propose draft for comment in February 2007.

Q: What if you use old data to create new maps?

A: This is acceptable provided old data are suitably registered to the new map base and data are updated to reflect more current conditions. Existing data may also be portrayed on new base maps such as digital ortho quarter-quads, so users can identify areas of change, but such data are not considered a new map as no new digital data will be generated for inclusion in the NSDI.

Q: Can this standard support traditional mapping?

A: Yes, conventional photointerpretation techniques using aerial photography and traditional cartographic techniques may still be employed, but such techniques will require that maps be digitized to create geospatial data for inclusion in the NSDI.

Q: What classifies wetlands as Pf (palustrine farmed)?

A: Farmed wetlands are wetlands that are cultivated to grow one or more crops (e.g., corn, soybeans, or cranberries) and are still wet enough to meet the definition of wetlands; they are not former wetlands that are effectively drained and planted with crops. Cultivated cranberry bogs should be mapped as PSSf (palustrine scrub-shrub farmed).

Q: What is the difference between "inshore deepwater" and "offshore deepwater"?

A: <u>Inshore deepwater:</u> includes nontidal waters (e.g., rivers and lakes) deeper than 2m (at annual low water) and subtidal waters below the extreme spring low tide mark in estuaries and tidal freshwater rivers: "deepwater" excludes shallow waters of upper perennial mountain streams, other wadable rivers and streams, and lakes (lacustrine littoral wetlands) as well as intermittent rivers and streams.

Offshore deepwater: includes subtidal waters lying below the extreme spring low tide mark in the marine ecosystem (ocean and embayments); these waters lie seaward of the break between estuarine and marine waters. Deepwater excludes the intertidal zone (tidal wetland).

Q: What is the difference between internal vs. external edge matching?

A: Internal edge matching involves tying all linework within a project area to ensure that all polygons are closed and linears are connected, while external edge matching addresses ties to pre-existing wetland data outside, but contiguous to, the project area (e.g., matching a wetland polygon within project area to a continuation of it on an adjoining map outside the project area).

Q: What does federally funded mean?

A: Federal Funding Sources include both mandatory and discretionary funding. Mandatory funding is controlled by laws other than appropriations acts. Discretionary funds are controlled by appropriation acts. Examples of mandatory funds are Coastal Wetlands Planning, Protection, and Restoration Act funds and those collected from the sale of Duck Stamps. All appropriated funds are considered to be discretionary funds. All contracts, agreements, or grants, etc. funded fully or in part by Federal agencies either through mandatory or discretionary funds are federally funded sources.

Q: How will the standard be implemented?

A: The standard will be made widely published and it is will be written into Federal contracts, agreements and grants. Any entity receiving Federal money must use FGDC standard. The federal agencies will encourage others to adopt/use the standard and use grant money as seed money to encourage its use. The standard will facilitate states/tribes to establish wetlands mapping funding coalitions. .

Q: Why can't you just use publicly available, Web-based mapping products to map wetlands?

A: We currently are unable to use publicly available, Web-based mapping products to map wetlands because the features required for mapping are only available as layers in pc-based mapping software. In the future, wetlands data may be added to publicly available, Web-based mapping products if they conform to the standards requirements.

Appendix G: Definitions (Informative)

classification error -- commission errors are areas mapped as wetlands that are not in fact wetlands on the ground. For example, small uplands may be included within a large wetland mapping unit or small wetlands of a different type may be included within a larger wetland unit of another type (e.g., a small scrub-shrub wetland within a palustrine forested wetland mapping unit) simply because they are too small to map (below the target mapping unit). These types of situations are commonly referred to as "inclusions." Misclassification results in both omission and commission errors since one class is missing features while another has surplus features.

Cowardin classification system -- the U.S. Fish and Wildlife Service's official wetland and deepwater habitat classification system written by Cowardin, Carter, Golet, and LaRoe and published in 1979, approved by the FGDC as the National Standard in 1996.

deepwater habitats -- "Other Aquatic Habitats" are equivalent to "Deepwater Habitats" as defined by the FWS Wetlands Classification System (Cowardin *et al*, 1979):

> *Deepwater habitats are permanently flooded land lying below the deepwater boundary of wetlands. Deepwater habitats include environments where surface water is permanent and often deep, so that water, rather than air, is the principal medium in which the dominant organisms live, whether or not they were attached to the substrate.*
>
> The Wetlands Classification System further defines the limits of deepwater habitats:
>
> *The boundary between wetland and deepwater habitat in the Marine and Estuarine Systems coincides with the elevation of the extreme low water of spring tide; permanently flooded areas are considered deepwater habitats in these Systems. The boundary between wetland and deepwater habitat in the Riverine and Lacustrine Systems lies at a depth of 2 m (6.6 feet) below low water; however, if emergents, shrubs, or trees grow beyond this depth at any time, their deepwater edge is the boundary. The 2-m lower limit for inland wetlands was selected because it represents the maximum depth to which emergent plants normally grow (Welch 1952; Zhadin and Gerd 1963; Sculthorpe 1967).*

inshore deepwater – nontidal waters (e.g., rivers and lakes) deeper than 2m (at annual low water) and subtidal waters below the extreme spring low tide mark in estuaries and tidal freshwater rivers: "deepwater" excludes shallow waters of upper perennial mountain streams, other wadable rivers and streams, and lakes (lacustrine littoral wetlands) as well as intermittent rivers and streams.

offshore deepwater – subtidal waters lying below the extreme spring low tide mark in the marine ecosystem (ocean and embayments); these waters lie seaward of the break between estuarine and marine waters; "deepwater" excludes the intertidal zone (tidal wetland).

federally-funded -- financial support for the mapping project comes directly or indirectly from one or more federal agencies.

horizontal accuracy -- refers to a features spatial relationship to the source imagery.

logical consistency -- logical consistency refers to the internal consistency of the data structure, and particularly applies to topological consistency.

non-federally funded – financial support comes from state, local, or private funds with no contribution either directly or indirectly from Federal sources.

National Spatial Data Infrastructure (NSDI) -- consistent means to share geographic data among all users could produce significant savings for data collection and use and enhance decision making. Executive Order 12906 calls for the establishment of the National Spatial Data Infrastructure defined as the technologies, policies, and people necessary to promote sharing of geospatial data throughout all levels of government, the private and non-profit sectors, and the academic community.

The goal of this Infrastructure is to reduce duplication of effort among agencies, improve quality and reduce costs related to geographic information, to make geographic data more accessible to the public, to increase the benefits of using available data, and to establish key partnerships with states, counties, cities, tribal nations, academia and the private sector to increase data availability.

The NSDI has come to be seen as the technology, policies, criteria, standards and people necessary to promote geospatial data sharing throughout all levels of government, the private and non-profit sectors, and academia. It provides a base or structure of practices and relationships among data producers and users that facilitates data sharing and use. It is a set of actions and new ways of accessing, sharing and using geographic data that enables far more comprehensive analysis of data to help decision-makers chose the best course(s) of action. Much has been accomplished in recent years to further the implementation of the NSDI, but there is still much to be done to achieve the vision of current and accurate geographic data being readily available across the country.

producer's accuracy (PA) -- measures the percentage of features that are correctly classified on the imagery.

project area – a geographic area where wetland mapping is to be performed through some form of remote sensing (e.g., photointerpretation, satellite or other image processing). It may range in size from a region, state, county, or municipality to portion thereof. For purposes of this standard, a project area is not a site-specific area where construction, restoration, or similar actions are proposed or where on-the-ground wetland delineations are performed.

spatial resolution -- The detail with which a map depicts the location and shape of geographic features. The larger the map scale, the higher the possible resolution. As scale decreases, resolution diminishes and feature boundaries must be smoothed, simplified, or not shown at all; for example, small areas may have to be represented as points.

target mapping unit (TMU) -- is an estimate of the size class of the smallest wetlands that can be consistently mapped and classified at a particular scale of imagery, and that the image-interpreter attempts to map consistently.

upland **-- "**Upland" or "U" is the default classification for regions of the map that are not classified as wetlands or other aquatic habitats. As such, the designation "Upland" represents generalized terrestrial areas which have not been further subdivided or categorized by type. While "Upland" primarily includes terrestrial (non-wetland) areas and former wetlands that are effectively drained or filled, it may include unclassified wetlands such as human-modified areas (e.g., farmed wetlands), wetlands that are too small to be differentiated, wetlands that couldn't be detected on the type of imagery used (e.g., small wetlands under forest cover), and other unintentional wetland omissions (errors). According to the FWS Wetlands Classification System (Cowardin *et al*, 1979):

> *The upland limit of wetland is designated as (1) the boundary between land with predominantly hydrophytic cover and land with predominantly mesophytic or xerophytic cover; (2) the boundary between soil that is predominantly hydric and soil that is predominantly nonhydric; or (3) in the case of wetlands without vegetation or soil, the boundary between land that is flooded or saturated at some time during the growing season each year and land that is not.*

vertical accuracy – the measure of the accuracy of the vertical measure of a reference point.

wetland classification -- in support of maintaining an ecological perspective, wetlands are defined as below, based upon the FWS Wetlands Classification System (Cowardin *et al*, 1979). This definition is the national standard for wetland mapping, monitoring, and data reporting as recognized by the FGDC on December 17, 1996.

> *Wetlands are 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.

For purposes of this classification wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes, (2) the substrate is predominantly undrained hydric soil, and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year.

wetlands inventory mapping **–** more detailed mapping of wetlands beyond distinguishing between simple categories of forested and non-forested or vegetated and non-vegetated.

user's accuracy (UA) -- measures the percentage of reference sites on the ground that are correctly classified on the map.

Appendix H: Workgroup Members, Vetting Participants, and Workgroup Activities

Workgroup Members and Vetting Participants

? Environmental Protection Agency (EPA)
? National Oceanic and Atmospheric Administration (NOAA)
? United States Geological Survey (USGS)
? U.S. Fish and Wildlife Service (USFWS)
? Tennessee Valley Authority (TVA)
? Environmental Council of the States (ECOS)
? Indiana Department of Environmental Management (IDEM)
? Office of the Secretary of Defense (OSD)
? Advisory Committee on Water Information (ACWI)
? Association of State Wetland Mangers (ASWM)
? National States Geographic Information Council (NSGIC)
? National Water Quality Monitoring Council (NWQMC)
? Ducks Unlimited Inc. (DU)
? National Association of Counties (NACo)
? National Association of Home Builders (NAHB)
? River Network
? Army Corp of Engineers (COE)
? FEMA Floodplain Mapping Division

Workgroup Activities

The framework for a draft proposal for the Wetlands Mapping Standard was presented and discussed at the following meetings:

? Association of State Wetland Managers (ASWM) annual meetings in 2005 and 2006.
? Society of Wetland Scientists (SWS) annual meeting in 2005, *26th Annual International Wetlands Meeting, Coastal Plain Wetlands: Ecological, Landscape, and Regulatory Transformations.*
? National States Geographic Information Council (NSGIC) Annual Conference in Annapolis 2006.
? National Association of Counties (NACo) Winter meetings in February and March of 2006.
? 2006 Tennessee Valley Authority (TVA) Regional Natural Heritage Program's 11th Annual eMap User Meeting.
? Surface Water Monitoring and Standards (SWiMS) Region 5 meeting in 2007.
? 2007 Tennessee Federal and State GIS User Group Meeting
? 2007 Southeastern Wetlands Data Workshop, May 2007.
? Tennessee Geographic Information Council's 2007 Annual Conference, June 2007.
? ASWM Wetlands 2007 National Symposium, August 2007.