NEW ENGLAND WETLAND FUNCTIONAL ASSESSMENT

Draft User Guide

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The development and application of the New England Wetland Functional Assessment (NEWFA) method is detailed in this document.

The Draft User Guide consists of the following sections:

Introduction and Background (Chapter 1)
Approaches to Aquatic Resource Assessment (Chapter 2)
NEWFA Overview (Chapter 3)
Data Sheet Instructions (Chapter 4)
Variables (Chapter 5)
Functional Capacity Models (Chapter 6)
Data Sheet (Appendix A)

Additional appendices will be added (see list in table of contents).

This method is designed for use with the USACE Section 404 Regulatory Program, with specific use requirements determined by the New England District. The New England Wetland Functional Assessment Method is not mandatory for all permit applications. This method may be used by other entities, but each such entity will need to decide independently whether or not to formally adopt or require this method.

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Chapter 1: Introduction and Background

Functional Assessment in the Regulatory Context

Assessing functions of aquatic resources has long been a basic element of the regulatory programs authorized by the Federal Water Pollution Control Act Amendments of 1972, more commonly known as the Clean Water Act (CWA). Section 404 of the Clean Water Act **(33 U.S.C. 1344),** which authorizes the regulation of permits for the discharge of dredged or fill material into aquatic resources, including wetlands, is jointly administered by the U.S. Army Corps of Engineers (USACE) and the U.S. Environmental Protection Agency (U.S. EPA). USACE and U.S. EPA define wetlands as "areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas." **(33 CFR 328.3 and 40 CFR 230.3**)

The Clean Water Act specifies that no Section 404 permit can be issued by USACE which will have an unacceptable adverse effect on the aquatic environment as determined by criteria established by the U.S. EPA, known as the 404(b)(1) Guidelines. (**40 CFR 230.1**) The goal of the Guidelines is "to restore and maintain, the chemical, physical, and biological integrity of waters of the United States (WOTUS) through the control of discharges of dredged or fill material". The regulations set forth in 40 CFR Section 230 are the substantive criteria issued by the U.S. EPA, used in evaluating whether a discharge of dredged or fill material into waters of the United States will have any unacceptable adverse impact on the aquatic ecosystem. No permit may be issued under Section 404 of the Clean Water Act which does not meet the conditions of the Guidelines.

The original Guidelines, published in 1980, use the term *environmental value* somewhat interchangeably with the term *function*. For example, Subpart A uses the term *values* in explaining the organization of the Guidelines:

> Subparts D through F detail the special characteristics of particular aquatic ecosystems in terms of their values, and the possible loss of these values due to discharges of dredged or fill material. **(40 CFR 230.4)**

Later, under Subpart B, term *function* is used in outlining the factual determinations that must be made under the Guidelines:

> Determine the nature and degree of effect that the proposed discharge will have, both individually and cumulatively, on the structure and function of the aquatic ecosystem and organisms. **(40 CFR 230.11(e))**

HIGHWAY METHODOLOGY WORKBOOK SUPPLEMENT

In 1993, USACE New England District (USACE-NAE) established a procedure to expedite review of large projects which would require full National Environmental Policy Act (NEPA) review, as well as USACE permit authorization through Section 404 of the CWA. This procedure was called the Highway Methodology, since most large projects at the time were highway projects. **(USACE, 1993)**. The method included a functional assessment tool, formally titled the Highway Methodology Workbook Supplement which was a descriptive, qualitative method for evaluating wetland functions and values. This method documents evidence of 13 functions and values (see Figure 1), plus an additional category for Other Value. This method continues to be actively used and has not changed since minor modifications (to include increased ratio of aquatic resource replacement) in 1999. **(USACE, 1999)**

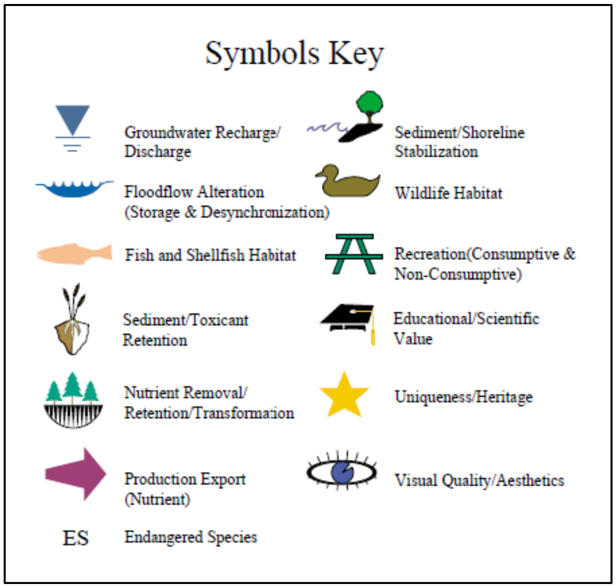

Figure 1: Highway Methodology Symbols

2008 Mitigation Rule

In 2008 a rule was published titled Compensatory Mitigation for Losses of Aquatic Resources under CWA Section 404 and added to the Guidelines as Subpart J. This regulation, commonly referred to as the Mitigation Rule, clarified the requirements for compensatory mitigation of unavoidable impacts. **(33 CFR 332).**

The preamble to the Mitigation Rule **(73 FR 19594)** states:

> The agencies have a long-standing policy of achieving no overall net loss for wetland acreage and function. Simply requiring one-to-one acreage replacement may not adequately compensate for the aquatic resource functions and services lost. Presently, there are methods that can be used by district engineers to assess aquatic resource functions or conditions, such as hydrogeomorphic assessment methods and indices of biological integrity. There are efforts being undertaken to develop methods to assess ecosystem services, such as those that use indices of wetland function to reflect the services provided by wetlands.

The Mitigation Rule deliberately uses the term *services* instead of *values*:

> [W]e have eliminated the term ''values'' from the final rule because the term ''services'' is currently being used in the ecological literature to relate to the human benefits that are provided by an ecosystem. The concept of ecosystem services provides a more objective measure than ''values'' of the importance of the functions performed by the ecosystem to human populations.

It is also noted in the preamble that "with this rule, we are moving towards greater reliance on functional and condition assessments to quantify credits and debits, instead of surrogates such as acres and linear feet."

The 2008 Mitigation Rule demonstrated a clear need for a quantitative method of functional assessment. The Highway Methodology Workbook Supplement, a narrative and qualitative methodology, could not meet this need. USACE-NAE recognized the need for an updated wetland functional assessment method to identify and quantify impacts to wetland functions and to help determine appropriate compensatory mitigation.

Development of a New Functional Assessment Method

In 2013, USACE New England District convened an interagency workgroup to identify requirements for a quantitative functional assessment method to be used throughout New England by the Regulatory Program and EPA Region 1. The team reviewed a number of wetland assessment tools, including the hydrogeomorphic (HGM) approach, to identify any potential candidates for regional application, however there was no method which could easily be modified to meet the needs of the team.

The workgroup determined that it would be necessary to create a new functional assessment method calibrated to the glaciation-affected geomorphology and the unique climate and landscapes of New England. The New England region is located in the extreme northeastern United States, and is comprised of the states of Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont. It is located wholly within the USACE Northcentral and Northeast wetland delineation region. This is a region that was under considerable ice during the most recent glaciation event (Wisconsonian stage of the Pleistocene). The geomorphology is strongly affected by this glacial activity, leaving a landscape covered with glacial till, outwash, drumlins, kame terraces, eskers, kettle holes, and other glacial features. Additionally, the New England region experiences "abundant rainfall, low evapotranspiration, and varied topography" making it a region "rich in perennial, intermittent, and ephemeral streams, natural lakes, and wetlands." **(USACE, 2012)**

The challenge was to develop a regionally applicable method that is both scientifically sound and met the needs of USACE/U.S. EPA to assess impacts to wetlands, within the constraints of the regulatory framework.

Design Objectives

- Quantitative method for assessment of wetland function (not condition or services)
- Assess intrinsic capacity of a wetland to perform individual functions
- Applicable regionally: consistent results in all six New England states
- Rapid data collection (Level 2 Assessment), cost-effective and user-friendly for trained individuals
- Objective and repeatable results
- Scientifically supported (based on the best available scientific information)
- Calibrated so that slight variations in input will not cause meaningful changes in output
- Account for unique geomorphological characteristics and climate of this region

Chapter 2: Aquatic Resource Assessments

Throughout the history of the CWA Section 404 Regulatory Program, various types of assessment tools have been developed locally, regionally, and nationally. The goal of conducting an assessment must be defined before initiating any analysis. The assessment objective determines which method will provide the most useful analysis.

The primary objective of any aquatic resource assessment typically falls into one of three categories:

1) To document existing conditions
2) To compare different resources at the same point in time (e.g., alternatives analysis)
3) To evaluate the same resource at different points in time (e.g., impacts analysis or restoration monitoring)

Comparing Wetland Assessment Methods

Assessments in the regulatory context are most commonly utilized in the context of evaluating impacts to aquatic resources beyond simply calculating the area affected. Variations in vegetation, hydrology, soil chemistry, and landscape context mean that the loss of two similarly sized resources may have markedly different effects on the surrounding environment. There are many approaches to wetland and other aquatic resource assessments, which can be compared by describing differences in four areas: 1) input, 2) evaluation type, 3) method structure, and 4) output.

INPUT (DATA TYPE AND SCOPE OF COLLECTION)

All assessment methods require the collection of data which describe the physical, chemical, and biological characteristics of the resource being evaluated. However, there is wide variation between which characteristics are documented and how those features are measured or described. Some methods may focus on site-level data while other methods consider data about the surrounding landscape. Data may be collected during one or more site visits and/or through remote sensing.

Assessment methods can be categorized by the intensity and time required for data collection and analysis. The U.S. EPA Core Elements Framework **(U.S. EPA, 2023b)** describes three tiers of assessments:

LEVEL 1: LANDSCAPE ASSESSMENT	relies on coarse, landscape scale inventory information, typically gathered through remote sensing and preferably stored in, or convertible to, a geographic information system (GIS) format
LEVEL 2: RAPID ASSESSMENT	at the specific wetland site scale, using relatively simple, rapid[1] protocols which can be similar methods that can be carried out in a matter of hours, rather than days
LEVEL 3: INTENSIVE SITE ASSESSMENT	uses intensive research-derived, multi-metric indices gathering direct and detailed measurements of biological taxa and/or hydrogeomorphic functions

[1] Fennessey et al. (2007) explain the definition of "rapid" as "taking no more than two people a half day in the field and requiring no more than a half day of office preparation and data analysis to come to an answer. We also considered the relative ease of collecting field data required by each method."

Landscape level assessments (Level 1) typically provide information at the watershed level and may be used to identify broad trends or set priorities for future site-specific assessments. Because Level 1 assessments rely on GIS data or other remote sensing methods, they are a good option when there are limited resources for field work or restricted site access.

Rapid assessments (Level 2) provide site-specific information which may be necessary for regulators and other decision-makers. Level 2 assessments are often used when there are multiple resources which need to be evaluated within a relatively short time frame, such as when conducting an alternatives analysis for a permit application.

Intensive site assessments (Level 3) are useful for in-depth analysis of a single site. Level 3 assessments may be used as the baseline analysis for a longitudinal study or for developing reference criteria for future analyses.

NEWFA is considered a **Level 2 (Rapid)** wetland assessment method.

Evaluation Type: Function vs. Condition

Terms such as function, condition, service, and value all refer to different ways to assess and compare resources, but these terms are not interchangeable. Most wetland assessments are designed to evaluate either function or condition, although some methods are a hybrid of both. Some assessment methods also consider the resulting benefits to human populations (services).

An assessment of condition evaluates the current state of the resource, and the presence/absence of stressors as compared to a least-disturbed example of a similar wetland. Condition assessments, such as U.S. EPA's National Wetland Condition Assessment **(U.S. EPA, 2023a),** measure the level of degradation of a wetland and may be used to monitor the changing "health" of the wetland over time.

An assessment of function evaluates the individual physical, chemical and biological processes that occur in an aquatic ecosystem as a result of the characteristics of the resource and the surrounding landscape. Function assessments, use various indicators within the wetland to predict which functions are likely to occur and the level of those functions, but measurement of actual function would be beyond the scope of a rapid assessment. Functional assessment methods can vary widely in the number and types of functions that they evaluate, but they will generally include at least one hydrologic function, one biogeochemical function, and one biological function. It is important to note that condition should never be used as a proxy for function; a heavily degraded system may still have high functional capacity for specific functions. Some methods also evaluate services, such as recreation or aesthetic value.

CONDITION	the relative ability of an aquatic resource to support and maintain a community of organisms having a species composition, diversity, and functional organization comparable to reference aquatic resources in the region (the health of the resource)
FUNCTIONAL CAPACITY	the degree to which an aquatic resource can provide a specific function
FUNCTIONS	the physical, chemical, and biological processes that occur in ecosystems
SERVICES	the benefits that human populations receive from functions that occur in ecosystems
VALUES	the importance to the human population (this term is outdated; current methods refer to services rather than values)

> NEWFA assesses **functional capacity**. The method does not evaluate condition or services (values).

Effectiveness (Potential Function) vs. Opportunity (Current Function)

Wetland functional assessment methods also vary in the consideration of potential function vs. current function. Potential function (sometimes referred to as effectiveness) considers the characteristics of the resource being assessed and how effective those intrinsic characteristics are for supporting specific functions, whether or not they are actively performing that function at any given moment. Current function (sometimes referred to as opportunity) considers the current availability of circumstances that would facilitate the occurrence of specific functions. **(Adamus et al., 1987; Adamus et al., 1991)**

EFFECTIVENESS	the capability of a wetland to perform a function because of its physical, chemical, or biological characteristics; the intrinsic or potential functional capacity of a wetland.
OPPORTUNITY	the capability of a wetland to perform a function in response to current circumstances; current function.

Many methods contain assessment criteria that account for both potential and current function without necessarily making the distinction between the two. Some methods, such as the Wetland Evaluation Technique II, or WET II **(Adamus et al., 1987; Adamus et al., 1991)** assess each function for both effectiveness and opportunity as separate measures. WET II explains the distinction with the following example:

> The capability of a wetland to alter floodflow is dependent on several characteristics such as floodwater storage capacity, outlet discharge, and water velocity reduction. As a result of these characteristics, there may be a reduction of flooding downstream from the wetland.
>
> A wetland will probably be effective in terms of the floodflow alteration function if it has unrestricted physical space for floodwater expansion and/or physical obstructions that reduce water velocity (i.e., the presence of robust vegetation).
>
> A wetland will probably have the opportunity to perform the floodflow alteration function if it is in a watershed capable of producing flood conditions.

> NEWFA assesses **intrinsic/potential function (effectiveness)** only. The method does not consider opportunity.

METHOD DESIGN AND STRUCTURE

All assessment methods are designed for application in a specific geographic region and are only calibrated for use within that designated area (e.g. state, county, U.S. EPA Region, USACE District, specified eco-region, watershed, littoral cell, etc.).

> NEWFA is designed to be used in the **New England Region/District**. The method is not calibrated for use in other locations.

Some methods are only applicable to specific types of wetlands. For example, many methods use the hydrogeomorphic classification system developed by Brinson **(Brinson, 1993)** to identify a subset of wetlands for assessment. Other methods may be applicable to all wetlands in the geographic region.

> NEWFA can be **applied to all wetlands**. The method does not require establishing wetland class prior to analysis.

In some methods, wetland characteristics are described by a series of ecological models, which are mathematical equations or algorithms, using data – remote-sensed and field collected – as the variables in these equations. The basic tenet of these methods is that different wetlands naturally perform certain functions based on a variety of physical characteristics, such as hydrodynamics, landscape position, geology, and vegetation. These characteristics are indicators of the presence and level at which individual specific functions occur in each resource.

> NEWFA uses **models comprised of variables based on indicators** to determine the functional capacity of a wetland system.

Wetland assessments may use a similarity index for comparison with a reference wetland. Reference wetland sites representing the range of functional performance are established and monitored so that the type and level of function(s) typical of a particular wetland type can be assessed. While such methods using reference wetlands may develop robust data sets to support their models, the detailed evaluation and analysis of these sites is costly and time consuming.

> NEWFA uses **hypothetical reference standards** to evaluate function. The method does not use reference wetlands or a similarity index.

REFERENCE RESOURCES	a set of aquatic resources that represent the full range of variability exhibited by a regional class of aquatic resources as a result of natural processes and anthropogenic disturbances.
REFERENCE STANDARDS	characteristics that must be present in a wetland for it to score the highest for a function. Or conditions exhibited by a group of reference wetlands that correspond to least degraded reference sites of the regional wetland subclass.
SIMILARITY INDEX	a measure that quantifies the resemblance between two or more entities, in our contexts, typically wetland sites or data sets. It is often expressed as a percentage, with higher percentages indicating greater similarity.

OUTPUT: QUANTITATIVE VS. QUALITATIVE

The output is the end product or result of the assessment. Outputs can be quantitative (numerical) or qualitative (narrative). Many quantitative methods use an index from 0.0 to 1.0.

> NEWFA is a **quantitative** method. The output is an integer from 1-10.

Chapter 3: NEWFA Overview

Method Workflow

Every wetland has a unique set of characteristics which govern the functions performed by that wetland system. The characteristics of each wetland are documented by recording more than fifty unique data. The data recorded inform the scoring for one or more variables, which are indicators of the ability of the wetland to perform one or more functions. Every variable has a specific list or range of possible values, and every value is assigned a numeric score. The capacity to perform each function is assessed with ecological models, which use the variables in a mathematical (or simple logic) expression of that function. This expression produces a Functional Capacity Grade between 1 (lowest) and 10 (highest) for each individual function.

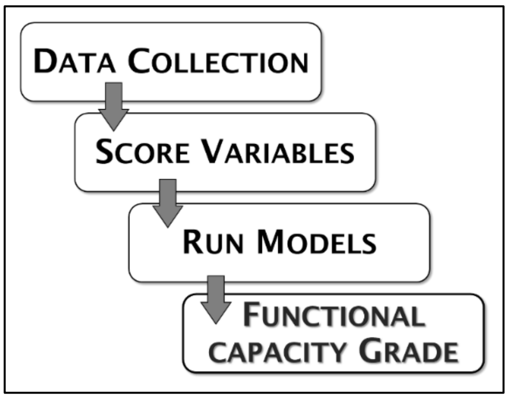

Figure 2: Method Workflow

Functions Assessed

Wetland functions can generally by grouped into three categories: hydrology, water quality maintenance, and biota support. The 14 functions assessed by NEWFA are listed in the table below.

Table 1: Functions Assessed

Hydrology	Water Quality Maintenance	Biota Support
(1) Surface Water Detention	(7) Particulate Retention	(12) Production Export
(2) Groundwater Recharge	(8) Nitrogen Transformation	(13) Plant Community Integrity
(3) Streamflow Maintenance *	(9) Phosphorus Retention	(14) Wildlife Habitat Integrity
(4) Storm Surge Reduction *	(10) Removal/Sequestration of Heavy Metals	
(5) Bank Stabilization *	(11) Carbon Sequestration	
(6) Shoreline Stabilization *		

* Resource Specific Functions – these functions are only applicable to some wetland systems

RESOURCE SPECIFIC FUNCTIONS (RSF)

While many functions potentially occur at some level in all wetlands, there are others which will only occur in certain types of wetlands. Some methods, such as HGM, simply omit any functions which do not apply to the specific class of wetland being assessed. However, because NEWFA is designed to assess all wetland regardless of type, certain functions are designated as Resource Specific Functions

(RSF). RSF are not assessed in every scenario. Each RSF has specific criteria which are used to determine the applicability of that function for an individual wetland. For example, wetlands with no connection to a stream cannot provide bank stabilization. This does not adversely affect the assessment of the system's capacity to perform other functions; however, because Bank Stabilization is not applicable, the wetland is simply not evaluated for that function. See Appendix G for detailed applicability criteria for each of the four resource specific functions.

> **RESOURCE-SPECIFIC FUNCTIONS:** functions which are only applicable to some wetlands systems; there must be a stream or open water body associated with the wetland for these functions to be assessed.

1) **Streamflow Maintenance** requires the presence of a stream which is positioned to potentially receive flow at least periodically from the wetland system of interest.
2) **Storm Surge Reduction** requires proximity to a water body which is subject to storm surge and at an elevation such that that the wetland system of interest will potentially receive some of that surge.
3) **Bank Stabilization** requires the presence of a streambank within or abutting the wetland system of interest which has enough elevation above the stream that it might be subject to erosion.
4) **Shoreline Stabilization** requires the presence of a water body subject to shoreline erosion by wave or tidal energy which is abutting the wetland system of interest.

Identification of the Assessment Unit (AU)

> **ASSESSMENT UNIT:** The unit of evaluation; the area in which functional capacity is being assessed for one or more wetland functions. The assessment unit may be an entire wetland or a portion of a wetland system.

The extent and location of the AU can strongly influence findings of the functional assessment, so it is critical to properly identify and delimit the AU boundaries. There are many different approaches to defining and identifying the assessment unit. Some methodologies use hydrogeomorphic classification, vegetation community classifications, changes in hydrologic regime, mapped soil series or human-made boundaries such as roads, fences or land use zones**. In this method, assessment units are primarily identified based on hydrologic continuity.** The logic and rationale for deciding when to separate a wetland system into two or more AUs is documented in Part A of the data sheet and detailed criteria can be found in Appendix D.

Generally, each entire wetland system will be evaluated as one Assessment Unit, including systems consisting of multiple wetland types. In most circumstances the system will be evaluated as one single AU, and the AU boundary will match the wetland edge. Changes in HGM class, plant community, or soil series alone do not meet the criteria for dividing a system into multiple AUs.

Adjacent freshwater and saltwater wetlands should be evaluated as separate AUs. The effects of salinity on the plant community and in particular, the water chemistry and its overall effects on the wetland system require that those areas be evaluated separately. Areas where ocean-derived salts measure 0.5 ppt or higher during the period of average annual low flow should be evaluated separately from areas where salinity is less than 0.5 ppt.

Wetland systems bisected by a flowing water body (e.g., stream or river) which is 3m or wider are separated into multiple AUs. Each non-contiguous wetland on either side of the stream is evaluated as a separate AU. When the system is bisected by a river/stream less than 3m wide, the AU includes the entire stream segment from the inlet to the outlet of the wetland. The stream area from the intersection with the upstream wetland edge to the downstream edge is labeled as a Non-Wetland Sub-Unit (see identification of Assessment Sub-Units). Appendix D contains detailed criteria and examples.

Wetland systems contiguous with an open water body (e.g., lake or pond) which is 4ha or larger are separated into multiple AUs. Each non-contiguous wetland which is abutting the water body is evaluated as a separate AU. Water bodies smaller than 4 ha are considered part of the AU and labeled as a Non-Wetland Sub-Unit (see identification of Assessment Sub-Units).

Wetland systems containing disruptions in hydrologic connectivity may need to be separated into multiple AUs. Natural or human-made discontinuities, such as uplands, berms, roads, etc. may constitute an AU boundary. However, where hydrology is essentially continuous between the divisions of a formerly whole wetland (e.g., through an appropriately sized culvert), these segments would be considered part of the same AU. Shifts in hydrologic regime (i.e. from permanently flooded to seasonally flooded) are not considered disruptions in continuity as long as hydrologic continuity is not severed completely.

Upland areas which are entirely surrounded by wetland should remain part of the AU. Upland inclusions which are 0.2 hectare or larger should be identified as Non-Wetland Sub-Units (see below) and recorded in Section G2b of the data sheet. Smaller upland inclusions may also be mapped and identified as Non-Wetland Sub-Units at the investigator's discretion.

Property boundaries and/or project footprint should not be used to define the AU. Even though the investigator may not be able to access the AU outside the project footprint, the AU should be identified following the same guidelines regardless of field access. The AU does not have to be entirely field-accessible if adequate remote sensing data are available.

> NOTE: There may be circumstances where AU identification/delineation requires project specific criteria. For situations where AU identification or delineation may be difficult, discussion of the specific case with USACE–NAE before beginning the functional assessment is recommended.

Assessment Unit Subdivisions

While some wetlands may be relatively homogenous, many AUs have considerable variation between different areas of the site. **Assessment units which are heterogeneous and structurally complex must be sub-divided for data collection purposes in order to accurately capture the variability of the system**. Sub-divisions based on changes in vegetation structure are referred to as Assessment Sub-Units (ASU) and sub-divisions based on changes in soil type, surficial geology and/or landscape position are referred to as Soil Examination Areas (SEA).

Identification of Assessment Sub-Units (ASU)

> **ASSESSMENT SUB-UNIT:** Sub-division of an assessment unit for data collection purposes; based on changes in vegetation structure. An AU with structurally diverse and heterogeneous vegetation must be sub-divided into units within which the vegetation structure is homogeneous.

Assessment units may be sub-divided into both Vegetated Wetland Sub-Units and Non-Wetland Sub-Units. A Vegetated Wetland Sub-Unit must meet the definition of a wetland and have at least 5% vegetative cover during the peak vegetated period. Non-Wetland Sub-Units include areas with less than 5% vegetative cover, all non-wetland aquatic resources, and areas of upland which are fully enclosed by the AU.

VEGETATED WETLAND SUB-UNITS

Vegetated Wetland Sub-Units are distinguished by changes in vegetation cover and/or structure and are classified as Forested, Scrub-Shrub, or Emergent (see definitions below). A complex site may have more than one ASU of the same type, if there are two adjacent areas that have different strata distribution and areal cover, they must be sub-divided into separate ASUs.

Divisions are not made for differences in assemblages of species. Areas that are adjacent and have different species composition, but similar structural values are considered part of the same ASU. See Appendix E for examples.

Vegetated Wetland Sub-Unit types are determined using a modified Cowardin classification system. Vegetated "Cowardin" classes are distinguished based on the tallest layer of vegetation (forest, shrub, etc.) that provides more than 30% surface cover. **(Cowardin et al., 1979)**

FORESTED WETLAND SUB-UNIT	an area with at least 30% cover by trees (defined as woody plants 6m or greater in height).
SCRUB-SHRUB WETLAND SUB-UNIT	an area with at least 30% cover by scrub-shrub plants (defined as woody plants less than 6m tall).
EMERGENT WETLAND SUB-UNIT	an area dominated by emergent (herbaceous) vegetation, including aquatic bed vegetation, even when submerged. Emergent plants include all non-woody species, regardless of height.

NON-WETLAND SUB-UNITS

Non-Wetland Sub-Units consist of all areas located within the AU which are not classified as Vegetated Wetland Sub-Units. Non-Wetland Sub-Units are classified as Standing Water, Flowing Water or Other. All upland inclusions should be delineated as Non-Wetland Sub-Unit: Other.

STANDING WATER SUB-UNIT	an enclosed area (4 ha or less) of semi-permanent standing water.
FLOWING WATER SUB-UNIT	a body of water (3m or narrower) with a detectable current (at least periodically), confined within a bed and banks.
OTHER NON-WETLAND SUB-UNIT	any non-wetland area within the AU which does not meet definitions of a Standing Water or Flowing Water sub-unit (e.g. mud flats, beach/dune, bedrock, cobble, upland, etc.).

NOTE: Throughout the remaining sections of this document, the abbreviation "**Sub-Unit**" (or "ASU") will be used to **refer to Vegetated Wetland Sub-Units only**.

The longer terms, "Vegetated Wetland Sub-Units" or "Vegetated Wetland ASU" will be used in contrast to the terms "Non-Wetland Sub-Unit" or "Non-Wetland ASU" for clarification when the distinction is necessary.

Identification of Soil Examination Areas (SEA)

> **SOIL EXAMINATION AREAS**: Sub-division of an assessment unit for data collection purposes; based on changes in soil map unit, surficial geology and/or landscape position.

Each location where soil and substrate data are recorded is referred to as a Soil Examination Area or SEA. A relatively small and homogeneous site will require only one SEA. However, more complex sites will require multiple SEAs in order to depict the degree of site heterogeneity.

A soil map unit is a collection of areas with soil components or miscellaneous areas that are both defined and named the same. Each map unit differs in some respect from all others in a survey area and is uniquely identified by a symbol on a soil map. Each individual area (polygon) on the map is a "delineation". When a site consists of multiple soil types, each soil map unit is a separate SEA.

Landscape position refers to the geomorphic setting or location of a wetland in the landscape. Landscape position may be defined by topographic location, hydrologic inputs, and/or relationship to a water body. While some assessment units may span multiple landscape positions, there should be at least one SEA for each landscape position.

Surficial geology refers to the unconsolidated deposits located closest to the earth's surface, above bedrock. These layers are sometimes referred to as Quaternary geology because they were formed and deposited during or after the last glaciation. Surficial geology units may be classified by the method of deposition and/or the size, type, composition, and sorting of materials in each layer. These characteristics strongly influence the way water moves through the sub-surface. There should be at least one SEA for each individual surficial geology deposit type underlying the assessment unit.

There will be one SEA for each unique combination of soil map unit, surficial geology, and landscape position. Each SEA should be a homogenous sub-division, no SEA should consist of more than one soil map unit, landscape position or surficial geology deposit. Soil and substrate data will be recorded at one point within each SEA.

Data Collection

NEWFA uses a combination of desktop data (documented in the office using orthophotography and geospatial tools) and field data (collected during the site visit). Desktop data includes reconnaissance data, which are recorded in advance of the site visit, as well as measurements of area, distance and buffer analyses, which occur after the site visit. Field data collected during the site visit includes information about the soils, vegetation, hydrology, habitat, landscape, and stressors.

LEVEL OF EXPERTISE AND RESOURCES REQUIRED

The method is designed for use by individuals with a strong background in wetland science. At a minimum, the level of expertise needed to collect and record the data accurately and consistently should be similar to that needed to delineate wetlands. All of the tools required for field data collection are commonly used by wetland professionals, no specialized equipment is required for this method.

- Materials such as aerial photographs and soil maps provide important information about what to expect at the site and saves time and effort during the site visit.
- NEWFA is designed to be applied regionally, and digital data requirements are limited to datasets which are available regionally. However, higher resolution data may be available at the state or local level and can be helpful when planning the site visit.

Required Mapping Information (see Appendix J for data source details)

- ✓ ORTHOPHOTOGRAPHY — use most recently available imagery at the highest possible resolution for most accurate advance determination.
- ✓ TOPOGRAPHIC MAPS — digital topographic map layers are available for download from USGS.
- ✓ SURFICIAL GEOLOGY — if available, use NEWFA Surficial Geology GIS layer
- ✓ LULC LAYER – use most recent layer available, or if available, use NEWFA LULC GIS layer.
- ✓ SOIL SURVEYS — use WebSoilSurvey or other soil survey source.

Additional Helpful Information

- ✓ National Wetland Inventory (NWI) maps (use most recent version)
- ✓ State Wetland Maps
- ✓ Local Wetland Inventory Maps
- ✓ Local Land Use Maps
- ✓ Stream Connectivity Reports

Materials and Equipment Needed

This is not an all-inclusive list.

Table 2: Field Equipment

REQUIRED	OPTIONAL
Data sheet (Appendix A)	DBH measure
Field maps (see below)	Flagging Tape and marker
Clip board and writing implement	Auger
Invasive species list (see Appendix I)	Hand Lens
Munsell color book (or other equivalent color book)	Binoculars
Tape measure (50 meter)	Camera
Compass	Invasive species ID guide
Shovel/Spade	
Tile Probe	
User Guide – Chapter 4 (Data sheet instructions)	
Personal protection equipment (PPE)	

TIME NEEDED TO COLLECT DATA

> NOTE: Time estimates do not include the time required to delineate the wetland boundary if that has not already occurred. Please also note that identifying assessment units within a complex wetland system may be more time consuming than collecting the data in some cases.

Data collection time consists of both time in the office and time in the field. Variables that will affect the total time required for the site visit include the size and complexity of the wetland and ease of access to the interior of the site. Larger sites and sites with dense brush or deep standing water will require more time and effort. For relatively homogenous sites, it is only necessary to collect vegetation and soil data in one location. Assessment units that are more complex, with distinct changes in vegetation or multiple soil types, will require more time.

The field data sheet is designed so that data collection can be completed either by a single individual or by a field team with members working simultaneously on different sections. The size of the field team and degree of familiarity with the method will also affect the amount of time necessary to complete the site visit. Because NEWFA is a rapid assessment method, under most circumstances, all field data can be collected in one single site visit. Over three seasons of method field testing, most site visits were completed in 4 hours or less. The only scenarios where the field data collection could not be completed in one day, occurred at sites where the assessment unit was significantly larger and more complex on the ground than the preliminary assessment unit identified during pre-field/in-office reconnaissance.

In some cases, the field team may not be able to access portions of the site. If the inaccessible areas are relatively similar to the rest of the site, the results should still be valid.

> **IMPORTANT: Contact USACE-NAE for ANY scenario where documentation is incomplete due to access issues.**

Desktop data collection occurs both before and after the site visit. Variables that will affect the time required for desktop data collection include time required for digital data layer acquisition, level of expertise interpreting aerial photography and familiarity with geospatial software/tools. All desktop data can be acquired using ArcGIS Online, but users may prefer to use desktop GIS software if available. (See Appendix J for detailed instructions)

Guidelines for Applying NEWFA

Detailed instructions for data collection are located in Chapter 4.

> NOTE: This method assumes that the wetland edge has been identified, but a formal wetland delineation is not required in order to assess wetland function using NEWFA.

Step 1: Read and Understand Data Collection and Recording Protocol

- Review the NEWFA Data Sheet in Appendix A and the instructions in Chapter 4.

Step 2: Gather Site Information

- Thoroughly review any available topographic maps, natural light and infrared aerial photography, soil survey maps, LiDAR, wetland maps.
- See Appendix J for list of recommended data sources.

Step 3: Preliminary Identification of the Assessment Unit (AU)

- Identify the preliminary extent and boundary of the AU.
- Guidelines on dividing systems into multiple AUs are located in Appendix D.
- Documentation of preliminary AU identification is recorded in Section A-1 of the data sheet.
- See Chapter 4A for instructions on documentation.

Step 4: Preliminary Identification of Assessment Sub-Units (ASU)

- Determine if the AU consists of multiple Sub-Units and identify preliminary ASU divisions.

- Guidelines on ASU identification and classification are located in Appendix E.
- Documentation of preliminary ASU identification is recorded in Section A-2 of the data sheet.
- See Chapter 4A for instructions on documentation.

STEP 5: PRELIMINARY IDENTIFICATION OF SOIL EXAMINATION AREAS (SEAS)

- Determine if the AU requires multiple SEAs and identify preliminary SEA locations.
- Guidelines on ASU identification and location are located in Appendix F.
- Documentation of preliminary SEA identification is recorded in Section A-3 of the data sheet.
- See Chapter 4A for instructions on documentation.

STEP 6: DETERMINE APPLICABILITY OF RESOURCE-SPECIFIC FUNCTIONS (RSFS)

- Determine if any of the four RSFs are applicable.
- Guidelines on RSF applicability are located in Appendix G.
- Documentation of RSF applicability is recorded in Part B of the data sheet.
- See Chapter 4B for instructions on documentation.

STEP 7: SITE VISIT PREPARATION

- Print the data sheet located in Appendix A.
- Print at least one extra copy of Part C for each potential Vegetated Wetland Sub-Unit.
- Print at least one extra copy of Part D for each potential Soil Examination Area.
- Field maps showing preliminary AU boundary, ASU divisions and SEAs are required (can be printed or digital).
- List of Field Equipment found above.

STEP 8: COLLECT AND RECORD FIELD DATA

- Use preliminary ASU and SEA identification to guide initial site exploration.
- Field data is recorded in Parts C through F of the data sheet.
- Part C of the data sheet will be completed once for each Vegetated Wetland ASU.
- Part D of the data sheet will be completed once for each SEA.
- If the AU does not need to be sub-divided, treat the entire AU as one ASU and/or one SEA.
- See Chapters 4C, 4D, 4E and 4F for instructions on field data documentation.

IMPORTANT: Annotate field maps to record any of the following:

Changes to the extent/boundary of the preliminary AU

Changes to the number, type or boundaries of preliminary Sub-Units

Changes to the number or location of preliminary SEAs

STEP 9: FINALIZE ASSESSMENT UNIT BOUNDARY AND SUB-UNIT DIVISIONS

- Use annotated/edited field maps and notes to revise the AU extent and boundary and ASU sub-divisions if necessary.
- AU boundary and ASU subdivisions must be finalized prior to desktop data collection/analysis.

Step 10: Complete Desktop Data Collection

- Use most recent orthophotography and GIS tools to complete Part G of the data sheet.
- Detailed GIS instructions and examples are located in Appendix J.
- See Chapter 4G for instructions on documentation.

Step 11: Determine Variable Scores

- Use the completed data sheets to assign values and scores to the variables.
- See Chapter 5 for information on variable values and scoring tables.

Step 12: Calculate Functional Capacity Grade (FCG)

- Calculate the FCG for each applicable function.
- See Chapter 6 for information on functions and FCG models.

Step 13: Complete Summary Page

- Complete summary page found at the end of the data sheet for each assessment unit.

Method Results: Interpretation of the FCG

The Functional Capacity Grade (FCG) represents the potential performance of the assessed functions based on characteristics of the wetland and the surrounding area which are indicative of a given function. It does not signify the actual performance, as that requires lengthy and detailed monitoring. It is assumed that the wetland will perform the function if the appropriate structural components exist when the opportunity is present. Functional capacity grades are interpreted independently for each function performed by the wetland.

IMPORTANT: Individual functional capacity grades should NEVER be added together or averaged as an overall grade for the wetland.

NEWFA uses functional efficacy ratings to interpret the FCG calculated for each function. FCGs of 1 to 3 are considered low functioning; FCGs of 4 to 6 are considered moderate functioning; and FCGs of 7 to 10 are considered high functioning. In most circumstances, comparisons should be made by efficacy rating rather than actual FCG.

Table 3: Functional Efficacy Ratings

FCG	Potential Functional Efficacy
N/A	Function not applicable
0	Function does not appear to occur
1 to 3	Low functioning
4 to 6	Moderate functioning
7 to 10	High functioning

While calculations may be made to several decimal points, the actual degree of precision from these models is much cruder and the placement of individual scores within broader grade categories is meant to reflect this.

LIMITATIONS

There are many things that NEWFA is designed to do; however, there are some things that it is specifically NOT intended to do. Understanding the limitations of the methods is important in order to discourage misconceptions and misapplications of the methods. Additional clarifications and cautions regarding the methods are provided throughout the specific sections.

1) **NEWFA does not alter wetland regulations**, nor does it indicate to what degree different wetlands or functions should be protected. It does not change the regulations or policies that determine how and which wetlands are regulated.
2) **NEWFA does not alter or affect the Federal definition of wetlands**, nor does it affect the methods for identifying wetlands.
3) **NEWFA does not assess the economic values** of wetlands or the importance of individual functions or wetlands.
4) **NEWFA assesses function only**, not condition nor goods and services (values).
5) **NEWFA does not produce a total assessment score** for the wetland evaluated. Individual function scores should **NEVER** be added all together or averaged for a single score for the wetland. Performance is assessed for each individual function. Condensing the results into a single assessment score will invalidate the method.

Chapter 4: Data Sheet Instructions

The NEWFA data sheet is separated into seven parts (see below) for ease and efficiency of data collection. The same data sheet is used regardless of the type of wetland being assessed. If the site has been divided into multiple assessment units (AUs), use a separate data sheet for each AU.

IMPORTANT: See Appendix A for a copy of the NEWFA data sheet.

USING THE DATA SHEET

1) Print Parts A and B (pages 1-4) and complete in the office.
2) Determine the estimated number of Vegetated Wetland ASUs and print one copy of Part C (pages 5-6) for each one.
3) Determine the estimated number of SEAs and print one copy of Part D (page 7) for each one.
4) Print one copy of Parts E and F (pages 8-9).
5) Complete Parts C, D, E, and F during the site visit (on the same day).
    - Parts C-F can be completed in any order or split apart and completed simultaneously by different members of the assessment team.
    - Field data can be collected over the course of multiple consecutive days, if necessary due to challenges with site access or complexity.
6) Print Part G (pages 10-11) and complete in the office after the site visit has been completed.

IMPORTANT: All measurements must be recorded in the metric system.

Part A: SITE OVERVIEW (Desktop/GIS Data)

Part A must be completed in the office, PRIOR TO any field data collection.

- Use GIS and digital mapping data.
- Preliminary determination of assessment unit (AU) boundary, assessment sub-unit (ASU) divisions and number of soil examination areas (SEAs).
- Data recorded in Section A must be confirmed and/or revised during site visit.

Part B: APPLICABILITY OF RESOURCE SPECIFIC FUNCTIONS (Desktop/GIS Data)

Part B must be completed in the office, PRIOR TO any field data collection.

- Use GIS and digital mapping data.
- Preliminary evaluation of applicability of resource specific functions (RSF).
- Some data recorded in Section B must be confirmed and/or revised during site visit.
- Determines whether additional resource specific data needs to be collected during the site visit.

Part C: ASSESSMENT SUB-UNIT DATA (Field Data)

Part C must be completed at EACH Vegetated Wetland Sub-Unit.

- Must be completed during the site visit.
- Data is recorded at EACH vegetated wetland sub-unit (make multiple copies of Part C).
- Vegetation Cover and Structural Complexity, Heterogeneity, Invasive Species, Basal Area and Tree Density, Microfeatures, Specialized Wildlife Habitat Features.

Part D: SOIL EXAMINATION AREAS (Field Data)

Part D must be completed at EACH Soil Examination Area.

- Must be completed during the site visit.
- Data is recorded at EACH soil examination area (make multiple copies of Part D).
- Soil Profile, Soil Texture, Organic Layer Thickness, Surficial Geology, Landscape Position.

Part E: HYDROLOGY and RESOURCE SPECIFIC DATA (Field Data)

- Must be completed during the site visit.
- Data is recorded after observing the entire assessment unit.
- Flow Restriction(s), Hydrologic Connectivity
- ONLY WHEN APPLICABLE: Shoreline Barriers and Elevation, Open Water Body Characteristics, Streambank Characteristics.

Part F: HUMAN ACTIVITY and PLANT COMMUNITY STRESSORS (Field Data)

- Must be completed during the site visit.
- Data is recorded after observing the entire assessment unit.
- Presence, Intensity and Proportion Impacted.

Part G: LANDSCAPE and LAND USE (Desktop/GIS Data)

Part G must be completed in the office, AFTER the site visit has been completed, and the AU boundary/ASU divisions have been finalized.

- Use GIS and digital mapping data.
- Final AU and Sub-Unit delineations
- Area of Wetland System, Size of Assessment Unit, Sub-Unit(s) Type and Size, Habitat Proximity and Connections, Natural Buffer Perimeter and Width, Land Use Index.
- ONLY WHEN APPLICABLE: Wetland Width.

IMPORTANT: Chapters 4A through 4G contains detailed instructions for data collection, documentation and completion of the data sheet.

Chapter 4A: Site Overview

Data Sheet Part A (Pre-Site visit Reconnaissance)

ADVANCE RECONNAISSANCE (pre-site visit) allows the user to identify areas that will need to be accessed for on-site data collection and is the key to an efficient site visit. Part A of the data sheet documents site complexity and is divided into three sections: identification of the assessment unit (AU), identification of assessment sub-units (ASU), and identification of soil examination areas (SEA).

1 - Identify the Assessment Unit (AU)

Section A-1 of the data sheet is used to determine whether the wetland system of interest should be evaluated as a single AU or as multiple AUs. This is a preliminary identification, which may need to be adjusted after the site visit.

> IMPORTANT: The preliminary boundary should be printed or drawn onto a site map for confirmation and/or correction during the site visit. After the site visit, the AU boundary must be finalized before Part G of the data sheet can be completed.

A-1: Identification of Assessment Unit (AU)

Use recent digital imagery or other available data to determine which scenarios are applicable. If the site meets ANY criteria for multiple AUs, use the guidelines in Appendix D to determine how to divide the site and where to draw the AU boundary.

NOTE: See instructions in User Guide for scenarios in which the assessment unit boundary should be drawn at a location other than the wetland/non-wetland line to create assessment units. Final assessment unit boundaries should not be drawn until the field visit is complete and all criteria have been confirmed.		
☐ Site appears to be a discrete ecological unit		SINGLE AU
☐ Site appears to be part of a larger wetland complex	☐ Complex consists entirely of freshwater wetland	SINGLE AU
	☐ Complex consists entirely of saltwater wetland	SINGLE AU
	☐ Complex is composed of adjacent salt and freshwater wetlands	**MULTIPLE AUs**

Check the corresponding box(es) for **ALL** applicable scenarios.

☒ **DISCRETE UNIT**: check this box if the site is a discrete ecological unit.

⇨ MAINTAIN SINGLE AU

☒ **WETLAND COMPLEX**: check this box if the site appears to be part of a larger continuous wetland complex. Determine whether hydrology is entirely saltwater driven, freshwater driven, or both using the guidelines in Chapter 3 and Appendix D.

- ☒ **Entirely Freshwater Wetland**: check this box (regardless of variability in plant community or hydrologic regime).

⇨ MAINTAIN SINGLE AU

☒ **Entirely Saltwater Wetland:** check this box (regardless of variability in plant community or hydrologic regime).

⇨ MAINTAIN SINGLE AU

☒ **Adjacent Saltwater and Freshwater Wetland** are present within the system: check this box.

⇨ **CREATE MULTIPLE AUs USING CRITERIA IN APPENDIX D**

✎ A-1: Identification of Assessment Unit (AU) – continued

Use recent digital imagery or other available data to determine if the site is contiguous with a river, stream, lake or pond.

☐ Site appears to be contiguous with a river or stream	☐ River/stream is abutting the site		SINGLE AU
	☐ River/stream bisects the site	☐ River/stream is $<$ 3 m wide	SINGLE AU
		☐ River/stream is $\geq$ 3 m wide	**MULTIPLE AUs**
☐ Site appears to be contiguous with a lake or pond	☐ Lake/pond is $<$ 4 hectares in size		SINGLE AU
	☐ Lake/pond is $\geq$ 4 hectares in size		**MULTIPLE AUs**

Check the corresponding box(es) for **ALL** applicable scenarios.

☒ **RIVER/STREAM**: check this box if the site is contiguous with a river or stream.

☒ Site is **Abutting** the river or stream: check this box.

⇨ MAINTAIN SINGLE AU

☒ Site is **Bisected** by the river or stream: estimate the average width of the river or stream where it bisects the system and check the appropriate box.

☒ Average width is **LESS THAN 3 METERS**: check this box.

⇨ MAINTAIN SINGLE AU

☒ Average width is **3 METERS OR GREATER**: check this box.

⇨ **CREATE MULTIPLE AUs USING CRITERIA IN APPENDIX D**

☒ **LAKE/POND**: check this box if the site contains or is abutting a lake or pond and estimate the size of the water body.

☒ Lake/pond is **LESS THAN 4 HECTARES**: check this box.

⇨ MAINTAIN SINGLE AU

☒ Lake/pond is **4 HECTARES OR GREATER**: check this box.

⇨ **CREATE MULTIPLE AUs USING CRITERIA IN APPENDIX D**

A-1: Identification of Assessment Unit (AU) - continued

Use recent digital imagery or other available data to determine if the site is bisected by a road, railbed or berm (constructed or natural). It is not necessary to determine if the road/railbed is in use or not. It IS necessary to **determine if there is hydrologic exchange** occurring between the two sides, which may not be possible without a site visit.

☐ Site is bisected by a road, railbed, or berm	☐ Road/railbed/berm has appropriately-sized/functioning culverts		SINGLE AU
	☐ Road/railbed/berm does NOT have appropriately-sized/functioning culverts		
	☐ Unpaved road OR ☐ Berm	☐ ≤ 0.5 m above wetland surface	SINGLE AU
		☐ > 0.5 m above wetland surface	**MULTIPLE AUs**
	☐ Small paved road OR ☐ Single-track railbed	☐ ≤ 0.25 m above wetland surface	SINGLE AU
		☐ > 0.25 m above wetland surface	**MULTIPLE AUs**
	☐ Large paved road OR ☐ 2+ track railbed	☐ Wetland is bridged	SINGLE AU
		☐ Wetland is NOT bridged	**MULTIPLE AUs**

Check the corresponding box(es) for **ALL** applicable scenarios.

Note: Criteria with this symbol must be confirmed during the site visit:

☒ **ROAD/RAILBED/BERM**: check corresponding box if site is bisected by a road, railbed, or berm.

☒ **Appropriately Sized Functioning Culverts** (or tide gates) allow adequate hydrologic exchange: check this box.

⇨ MAINTAIN SINGLE AU

☒ **No Culverts or Non-Functioning Culverts**: it is necessary to determine if there is hydrologic exchange occurring through some other pathway.

☒ For UNPAVED ROADS OR BERMS: determine if the grade is low enough to allow exchange through or over the road/berm and check the appropriate box.

☒ Road/berm is **0.5 METERS OR LESS** above the wetland: check this box.

⇨ MAINTAIN SINGLE AU

☒ Road/berm is **MORE THAN 0.5 METERS** above the wetland: check this box.

⇨ **CREATE MULTIPLE AUs USING CRITERIA IN APPENDIX D**

☒ For SMALL PAVED ROADS OR SINGLE TRACK RAILBEDS: determine if the grade is low enough to allow exchange over the road/berm.

☒ Road /railbed is **0.25 METERS OR LESS** above the wetland: check this box.

⇨ MAINTAIN SINGLE AU

☒ Road /railbed is **MORE THAN 0.25 METERS** above the wetland: check this box.

⇨ **CREATE MULTIPLE AUs USING CRITERIA IN APPENDIX D**

☒ For LARGE PAVED ROADS OR MULTI-TRACK RAILBEDS: there must be hydrologic exchange underneath the road/railbed.

☒ **WETLAND IS BRIDGED**: check this box.

⇨ MAINTAIN SINGLE AU

☒ **WETLAND IS NOT BRIDGED**: check this box.

⇨ **CREATE MULTIPLE AUs USING CRITERIA IN APPENDIX D**

☐ Other (explain below)
NOTES: (Include information about any areas that need to be field-checked to determine the extent of the AU.)

☒ **OTHER**: if there is a scenario unlisted above and not covered by the criteria in Appendix D, check this box and explain in the notes section.

2 - Assessment Sub-Unit (ASU) Evaluation

Section A-2 of the data sheet is used to determine whether the AU should be sub-divided into Assessment Sub-Units. This is a preliminary determination which may need to be adjusted after the site visit.

> IMPORTANT: The preliminary Sub-Unit divisions should be printed or drawn onto a site map for confirmation and/or correction during the site visit. After the site visit, Sub-Unit boundaries must be finalized before Part G of the data sheet can be completed.

✎ A-2: Identification of Assessment Sub-Units

Use recent digital imagery or other available data to determine whether a site consists of multiple ASUs and which types are present. **See Appendix E for additional information about identifying and classifying ASUs.**

☐ AU does NOT appear to have multiple Vegetated Wetland Sub-Units	**(CHECK ONE ONLY)**	☐ EMERGENT (Prevalence of non-woody vegetation)	EM
		☐ SCRUB-SHRUB (Prevalence of woody plants < 6m tall)	SS
		☐ FORESTED (Prevalence of woody plants ≥ 6m tall)	FO

☒ **SINGLE Vegetated Wetland Sub-Unit**: check this box for a site with relatively homogenous vegetation. Determine the most prevalent vegetation type. **Select only ONE of the following**.

☒ Non-woody vegetation (includes aquatic bed) is prevalent: check this box.

⇨ **EMERGENT VEGETATED WETLAND SUB-UNIT**

☒ Woody vegetation less than 6 meters is prevalent: check this box.

⇨ **SCRUB-SHRUB VEGETATED WETLAND SUB-UNIT**

☒ Woody vegetation 6 meters or taller is prevalent: check this box.

⇨ **FORESTED VEGETATED WETLAND SUB-UNIT**

NOTE: Record **Number of Vegetated Wetland Sub-Units = 1** in the box below. Be sure to indicate if the AU contains any Non-Wetland Sub-Units.

A-2: Identification of Assessment Sub-Units (continued)

☐ AU appears to consist of multiple Vegetated Wetland Sub-Units	(CHECK ALL THAT APPLY)	☐ Emergent (Prevalence of non-woody vegetation)	EM
		☐ Scrub-Shrub (Prevalence of woody plants < 6m tall)	SS
		☐ Forested (Prevalence of woody plants ≥ 6m tall)	FO

☒ **MULTIPLE Vegetated Wetland Sub-Units**: check this box for a site with heterogeneous vegetation structure. Identify areas where there is a change and determine which vegetation type appears to be prevalent in each area. **Select ALL which are applicable.**

☒ Non-woody vegetation (includes aquatic bed) is prevalent: check this box.

⇨ **EMERGENT VEGETATED WETLAND SUB-UNIT**

☒ Woody vegetation less than 6 meters is prevalent: check this box.

⇨ **SCRUB-SHRUB VEGETATED WETLAND SUB-UNIT**

☒ Woody vegetation 6 meters or taller is prevalent: check this box.

⇨ **FORESTED VEGETATED WETLAND SUB-UNIT**

A-2: Identification of Assessment Sub-Units (continued)

☐ AU appears to contain Non-Wetland Sub-Units within the AU boundary	(CHECK ALL THAT APPLY)	☐ Standing Water (Semi-permanent with < 5% vegetation)	SW
		☐ Flowing Water (Semi-permanent with < 5% vegetation)	FW
		☐ Other Non-Wetland (Upland OR < 5% vegetation)	Other

☒ **NON- WETLAND Sub-Unit**: check this box for a site that has unvegetated or non-wetland areas within the AU boundary. **Check ALL applicable boxes.**

☒ Semi-permanent standing water with < 5% vegetation: check this box.

⇨ **STANDING WATER NON-WETLAND SUB-UNIT**

☒ Tidal or non-tidal flowing water with < 5% vegetation: check this box.

⇨ **FLOWING WATER NON-WETLAND SUB-UNIT**

☒ Upland or other unvegetated (mud flat, beach/dune, bedrock, any terrestrial area with < 5% vegetation): check this box.

⇨ **OTHER NON- WETLAND SUB-UNIT**

A-2: Identification of Assessment Sub-Units (continued)

Estimated Number of Sub-Units:	Vegetated Wetland ☐	Non-Wetland ☐	**NOTE: Vegetation and wildlife data will be collected at EACH Vegetated Wetland Sub-Unit during the field visit.**

NOTES: (Include information about any areas that need to be field-checked to determine if they are separate sub-units.)

Record the estimated number of Vegetated Wetland Sub-Units. The number and type of Vegetated Wetland Sub-Units will determine the locations where vegetation and wildlife field data must be collected during the site visit.

3 - Draw Preliminary ASU Boundaries

Mark preliminary ASU boundaries/type on a site map for use during the site visit. Note that some AU's may have multiple Sub-Units of the same type (**see Appendix E for details on combining sub-units**). Although all ASUs should be confirmed during the site visit, data is only recorded at **Vegetated Wetland** ASU: make one **copy of Part C as for each** estimated Vegetated Wetland ASU.

4 - Soil Examination Area (SEA) Evaluation

Section A-3 of the data sheet is used to determine whether the AU requires multiple Soil Examination Areas for data collection. This is a preliminary determination which may need to be adjusted during the site visit. **See Appendix F for detailed information on identifying Soil Examination Areas.**

A-3a: Soil Map Unit Names

Use soil survey data from WebSoil Survey or other recent soil mapping data to determine which soil map units appear to be present within the AU.

a. SOIL MAP UNIT NAME(S) List all soil map unit(s) shown in the AU by WebSoil Survey or other current soil survey (certified or produced by certified soil scientist).	1. 2. 3. 4. 5.

Record the names of **ALL soil map units that are mapped wholly or partially within the AU**. If there are more than 5, add additional lines.

5 - Evaluate Surficial Geology

Use most recent available geologic maps/data layers to determine the type(s) of surficial (quaternary) deposits which may be found underlying the AU. **See Appendix G for information about NEWFA Surficial Geology GIS layer.**

A-3b: Surficial Geology

b. SURFICIAL GEOLOGY Select ALL applicable choices **NOTE: See User Guide for all surficial geology definitions**	☐ Lodgment Till ☐ Melt-Out Till ☐ Mixed Glacial Materials ☐ Stratified Coarse Materials ☐ Stratified Fine Material	☐ Coarse-Grained Alluvium ☐ Fine-Grained Alluvium ☐ Colluvium ☐ Dense Anthropogenic ☐ Loose Anthropogenic	☐ Shallow Bedrock ☐ Coastal Sands ☐ Inland Organic Materials ☐ Tidally-Flooded Organic Materials

Record **ALL surficial geology types which are mapped wholly or partially within the AU**, by checking the box next to each applicable type. See table below for surficial geology definitions.

> **IMPORTANT**: The list of terms and definitions for surficial geology were developed specifically for this functional assessment and may be different than definitions used in other circumstances. **Make sure to carefully read the NEWFA definition for each term**.

Surficial Geology Term Definitions:

LODGMENT TILL	subglacial till deposited by an active glacier (flowing ice) commonly characterized by dense, fissile (“platy”) structure and containing rock fragments with their long axes oriented generally parallel to the direction of ice flow.
MELT-OUT TILL	till formed by slow melting of debris-rich stagnant ice, but without secondary flow processes; the fabric and clast orientations, imparted by ice processes, remain mostly intact and the materials are primarily friable in consistence.
MIXED GLACIAL MATERIALS	glacial drift (primarily till) materials containing a variety of layers both firm and friable in consistence, or layers of an intermediate consistence that may slow soil water movement but not to the effect of restrictive layers in lodgment till.
STRATIFIED COARSE MATERIALS	material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice; the deposits are stratified and may occur in the form of outwash plains, valley trains, deltas, kames, eskers, and kame terraces.
STRATIFIED FINE MATERIALS	material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes by water originating mainly from the melting of glacial ice. Many are bedded or laminated with varves or rhythmites. Also, glacially eroded, terrestrially derived sediments (clay, silt, sand, and gravel) that accumulated on the ocean floor as marine deposits.
COARSE-GRAINED ALLUVIUM	unconsolidated, clastic material subaerially deposited by running water (channel flow), including gravel and sandy-texture soil materials.
FINE-GRAINED ALLUVIUM	unconsolidated, clastic material subaerially deposited by running water (channel flow), including primarily loamy, silty, and fine -textured soil materials.
COLLUVIUM	unconsolidated, unsorted earth material being transported or deposited on side slopes, at the base of slopes, or both by mass movement (e.g., direct gravitational action) and by local, unconcentrated runoff.
DENSE ANTHROPOGENIC	organic or mineral soil material, typically loamy-textured, that has been moved from a source area outside of that area by directed human activity, usually with the aid of machinery. The method of deposition and material physical properties often result in firm layers that reduce or restrict soil water movement.
LOOSE ANTHROPOGENIC	organic or mineral soil material, typically coarse-textured, that has been moved from a source area outside of that area by directed human activity, usually with the aid of machinery. The coarse-textured material generally lacks firm, water-restricting layers.
SHALLOW BEDROCK	glacial drift (primarily till) materials with a bedrock contact typically within observable depths (i.e., within 2 meters of depth).
COASTAL SANDS	sand-sized, clastic material transported and deposited primarily by wind, commonly in the form of a dune or a sand sheet, and/or well sorted, sand-sized, clastic material transported and deposited primarily by wave action and deposited in a shore environment.

INLAND ORGANIC MATERIALS	unconsolidated sediments or deposits in which carbon is an essential, substantial component, formed in the inland environment where soil water is fresh.
TIDALLY-FLOODED ORGANIC MATERIALS	unconsolidated organic and mineral materials formed in areas subject to periodic or occasional overflow by salt water, containing water that is brackish to strongly saline.

6 - Evaluate Landscape Position

Landscape position may be defined by topographic location, hydrologic inputs and/or relationship to a water body.

A-3c: Landscape Position

Use any topographic or elevation data (digital data layers if available) to determine the landscape position(s) of the AU.

c. LANDSCAPE POSITION Select ALL applicable choices	☐ Groundwater Slope	☐ Groundwater Depression	☐ Marine Fringe
	☐ Surface Water Slope	☐ Surface Water Depression	☐ Estuarine Fringe
NOTE: See User Guide for all landscape position definitions	☐ Groundwater Flat	☐ River/Stream Fringe	☐ Freshwater Tidal Fringe
	☐ Surface Water Flat	☐ River Stream Floodplain	☐ Lake/Pond Fringe

If the AU appears to span more than one landscape position, **record ALL landscape positions which occur wholly or partially within the AU**, by checking the box next to each applicable type. See table below for landscape position terms and definitions.

> **IMPORTANT:** The list of terms and definitions for landscape position were developed specifically for this functional assessment and may be different than definitions used in other circumstances. **Make sure to carefully read the NEWFA definition for each term.**

Landscape Position Term Definitions

GROUNDWATER SLOPE	wetlands located on sloping land, where the dominant source of water is groundwater discharge.
SURFACE WATER SLOPE	wetlands located on sloping land, where the dominant sources of water are precipitation and overland flow.
GROUNDWATER FLAT	wetlands located on land lacking in topographic relief, where the dominant source of water is groundwater discharge.
SURFACE WATER FLAT	wetlands located on land lacking in topographic relief, where the dominant sources of water are precipitation and overland flow.
GROUNDWATER DEPRESSION	wetlands that occur in topographic depressions, where the dominant source of water is groundwater discharge.
SURFACE WATER DEPRESSION	wetlands that occur in topographic depressions, where the dominant sources of water are precipitation and overland flow.
RIVER/STREAM FRINGE	wetlands that are contained within the channel of a flowing waterbody; may include wetlands comprised of floating vegetation attached to land.

RIVER/STREAM FLOODPLAIN	wetlands that occur in riparian corridors in association with stream channels, where the dominant water sources are overbank flooding and subsurface hydraulic connections between the stream channel and the wetland.
MARINE FRINGE	wetlands that are contiguous with marine waters, where water regime is determined by the ebb and flow of oceanic tides.
ESTUARINE FRINGE	wetlands that are contiguous with estuarine waters; that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land.
FRESHWATER TIDAL FRINGE	wetlands that occur in the upper reaches of tidal systems where the main source of hydrology is from freshwater river flow but still are subject to diurnal tidal cycles.
LAKE/POND FRINGE	wetlands that are adjacent to lakes or ponds where the water elevation of the lake maintains the water table in the wetland and may include wetlands comprised of floating vegetation attached to land.

7 - Determine Preliminary Soil Examination Area Locations

NOTE: User must identify a separate soil examination area for each unique combination of soil map unit, surficial geology and landscape position.

Preliminary soil unit, surficial geology and landscape position determinations should be marked on a site map for confirmation/correction during the site visit. These characteristics will be used to identify the locations where soil and landscape context data will be documented during the site visit**. See Appendix F for additional information on identifying SEAs.**

Estimated Number of Soil Examination Areas:		**NOTE: User must identify a separate Soil Examination Area for each unique soil map unit, surficial geology type and/or landscape position.**

Determine the estimated number of Soil Examination Areas and make <u>as many copies of Part D</u> as necessary.

Chapter 4B: Resource Specific Functions (RSF)

Data Sheet Part B (Pre-Site visit Reconnaissance)

RESOURCE-SPECIFIC FUNCTIONS are functions which are <u>only assessed if there is a stream or open water body associated with the wetland</u>. Part B of the data sheet guides the investigator through the preliminary identification of these resources and the applicability criteria for each RSF.

> **IMPORTANT: If none of the 4 RSFs are applicable, the AU will not receive a Functional Capacity Grade for those functions.**

Applicability criteria are assessed primarily through a combination of aerial photography and digital mapping data. Determination of applicability allows the user to plan for the collection of resource-specific data during the site visit when necessary (see Chapter 4E). Part B of the data sheet has four parts: each documents the resource identification and applicability criteria for one of the four RSF.

> NOTE: In cases where the AU is associated with more than aquatic resource, continue through each table as long as there is still <u>at least one stream or water body</u> which still meets the relevant criteria.

1 - Determine Applicability of Streamflow Maintenance

Use recent digital imagery or other available mapping data to determine if the AU meets the applicability criteria for assessment of Streamflow Maintenance.

B-1: Streamflow Maintenance

☐ There is a river or stream associated with the AU (including downstream from the AU)			Continue to (1) Flow
☐ There is NO river or stream associated with the AU			STOP
(1) Flow	☐ Flow is non-tidal (unidirectional)	☐ Receives flow from AU at least periodically	Continue to (2) Location
		☐ Does not typically receive flow from AU	STOP
	☐ Flow is tidal (bidirectional)		STOP
(2) Location	☐ Flow is entirely external (outside AU boundary)	☐ River or stream is downstream from AU	ASSESS STREAMFLOW MAINTENANCE
		☐ Bordering AU (flows along AU boundary)	ASSESS STREAMFLOW MAINTENANCE
	☐ Flow is at least partially internal (inside boundary)	☐ Flow at AU outlet (outflow or throughflow)	ASSESS STREAMFLOW MAINTENANCE
		☐ Flow at AU inlet but not outlet (inflow)	STOP
	☐ Flow is entirely internal (inside AU boundary)		STOP

☒ If there is a **RIVER OR STREAM** (of any size) associated with the AU: check the first box and CONTINUE to <u>(1) Flow</u>.

> NOTE: Be sure to examine the downstream area for a river or stream which may not be immediately abutting the assessment unit.

☒ If there is **NO RIVER OR STREAM** associated with the AU: check the second box and **STOP**. Go to **Section B-2** of the data sheet.

✖ **DO NOT ASSESS STREAMFLOW MAINTENANCE**

(1) Flow – Using available mapping data, determine whether the stream is tidal or non-tidal.

- ☒ If flow is **NON-TIDAL**: check this box and determine whether the stream is positioned to receive flow from the AU at least periodically.
  - ☒ If stream **receives flow from AU (at least periodically)**: check this box and CONTINUE to (2) Location.
  - ☒ If stream **does NOT receive flow from AU**: check this box and **STOP**. Go to **Section B-2** of the data sheet.

    ✖ **DO NOT ASSESS STREAMFLOW MAINTENANCE**
- ☒ If flow is **TIDAL**: check this box and **STOP**. Go to **Section B-2** of the data sheet.

  ✖ **DO NOT ASSESS STREAMFLOW MAINTENANCE**

(2) Location – Using available mapping data, determine whether the stream flows within the AU boundary at any point.

- ☒ If streamflow is **ENTIRELY EXTERNAL** to the AU: check this box and indicate the location of the stream relative to the AU.
  - ☒ If stream is **downstream of the AU**: check this box even if the stream is not abutting the AU (stream receives flow from AU as indicated in (1) Flow).

    ⇨ **ASSESS STREAMFLOW MAINTENANCE**
  - ☒ If stream is **bordering the AU**: check this box if the stream flows along the outside of the AU boundary without crossing into the AU.

    ⇨ **ASSESS STREAMFLOW MAINTENANCE**
- ☒ If stream is **PARTIALLY INTERNAL**: check this box and determine whether the streamflow occurs at the AU outlet or just the AU inlet.
  - ☒ If there is any **flow at the AU outlet**: check this box.

    ⇨ **ASSESS STREAMFLOW MAINTENANCE**
  - ☒ If there is **flow ONLY at the AU inlet**: check this box and **STOP**. Go to **Section B-2** of the data sheet.

    ✖ **DO NOT ASSESS STREAMFLOW MAINTENANCE**
- ☒ If stream is **ENTIRELY INTERNAL**: check this box and **STOP**. Go to **Section B-2** of the data sheet.

  ✖ **DO NOT ASSESS STREAMFLOW MAINTENANCE**

NOTE: Indicate the applicability status of the Streamflow Maintenance function on the Summary Sheet (p. 12 of the data sheet).

2 - Determine Applicability of Storm Surge Reduction

Use recent digital imagery or other available mapping data to determine if the AU meets the applicability criteria for assessment of Storm Surge Reduction.

NOTE: Criteria with this symbol must be confirmed in the field:

B-2: Storm Surge Reduction

☐ AU is associated with tidally-influenced waters (qualifying water body)			Continue to (1) Location
☐ AU is associated Lake Champlain (qualifying water body)			Continue to (1) Location
☐ AU is NOT associated with tidally-influenced waters or Lake Champlain			STOP
(1) Location	☐ AU boundary is ≤ 100 m from the water body edge		Continue to (2) Elevation
	☐ AU boundary is > 100 m from the water body edge		STOP
(2) Elevation	☐ Elevation of AU is the same as the elevation at the water body edge		Skip to (4) Barriers
	☐ Elevation of AU is lower than the elevation at the water body edge		Skip to (4) Barriers
	☐ Elevation of AU is higher than the elevation at the water body edge		Continue to (3) Height
(3) Height	☐ AU is located < 3 m above elevation of water body		Continue to (4) Barriers
	☐ AU is located ≥ 3 m above elevation of water body		STOP
(4) Barriers	☐ No barrier (berm, dune) between the AU and the water body		ASSESS STORM SURGE REDUCTION
	☐ Barrier partially separates AU from water body		ASSESS STORM SURGE REDUCTION
	☐ Barrier completely separates AU from water body	☐ Barrier is < 3 m high	ASSESS STORM SURGE REDUCTION
		☐ Barrier is ≥ 3 m high	STOP

☒ If there are **TIDALLY-INFLUENCED WATERS** (including tidal creeks) or **LAKE CHAMPLAIN** is associated with the AU check the corresponding box and CONTINUE to (1) Location.

☒ If there is **NO QUALIFYING WATER BODY** associated with the AU: check the third box and **STOP**. Go to **Section B-3** of the data sheet.

✖ **DO NOT ASSESS STORM SURGE REDUCTION**

NOTE: Qualifying water bodies for Storm Surge Reduction include ALL tidally-influenced waters (including tidal creeks) AND Lake Champlain.

(1) **Location** – Use most recent available imagery to determine if the AU boundary appears to be within 100 meters of the edge of the qualifying water body.

☒ If the AU is **WITHIN 100 meters** of the qualifying water body: check this box and CONTINUE to (2) Elevation.

☒ If the AU is **NOT WITHIN 100 meters** of the qualifying water body: check this box and **STOP**. Go to **Section B-3** of the data sheet.

✖ DO NOT ASSESS STORM SURGE REDUCTION

(2) Elevation – Use most recent available LIDAR/topographic data to compare the elevation of the landward edge of the water body and the closest edge of the AU.

☒ If the **ELEVATION IS THE SAME**: check this box and SKIP to (4) Barriers.

☒ If the AU is at a **LOWER ELEVATION**: check this box and SKIP to (4) Barriers.

☒ If the AU is at a **HIGHER ELVATION**: check this box and CONTINUE to (3) Height.

NOTE: Difference in elevation needs to be confirmed during the site visit.

(3) Height – Use most recent available LIDAR/topographic data to determine whether the elevation difference is less than 3 meters.

☒ If difference is **LESS THAN 3 meters**: check this box and CONTINUE to (4) Barriers.

☒ If difference is **AT LEAST 3 meters**: check this box and **STOP**. Go to **Section B-3** of the data sheet.

✖ DO NOT ASSESS STORM SURGE REDUCTION

(4) Barriers – Use most recent available imagery to determine there are any barriers separating the AU from the qualifying water body (berm, dune, road).

☒ If there are **NO BARRIERS**: check this box.

⇨ ASSESS STORM SURGE REDUCTION

☒ If there is **AT LEAST ONE BARRIER**: use most recent available topographic/LIDAR data to determine whether the barrier creates a complete or partial separation.

☒ If **separation is only partial**: check this box.

⇨ ASSESS STORM SURGE REDUCTION

☒ If **separation is complete**: check this box and determine whether the barrier is less than 3 meters tall using most recent available LIDAR/topographic data.

NOTE: Barrier height needs to be confirmed during the site visit.

☒ If barrier height is **LESS THAN 3 meters**: check this box.

⇨ ASSESS STORM SURGE REDUCTION

☒ If barrier height is **AT LEAST 3 meters**: check this box and **STOP**. Go to **Section B-3** of the data sheet.

✖ DO NOT ASSESS STORM SURGE REDUCTION

> NOTE: Indicate the applicability status of the Storm Surge Reduction function on the Summary Sheet (p. 12 of the data sheet).
>
> When Storm Surge Reduction is applicable, Sections E-3 (Shore Zone Characteristics) and G-7 (Wetland Width) must be completed.

3 - Determine Applicability of Shoreline Stabilization

Use recent digital imagery or other available mapping data to determine if the AU meets the applicability criteria for assessment of Shoreline Stabilization. NEWFA defines the shoreline as: the feature at the interface of a waterbody and the adjacent terrestrial system.

> NOTE: Criteria with this symbol must be confirmed in the field:

B-3: Shoreline Stabilization

☐ There is an open water body associated with the AU		Continue to (1) Location
☐ There is NO open water body associated with the AU		STOP
(1) Location	☐ AU boundary is abutting/contiguous with water body shoreline	Continue to (2) Type
	☐ AU boundary is NOT abutting/contiguous with water body shoreline	STOP
(2) Type	☐ Water body is tidally-influenced	Skip to (4) Erosive Forces
	☐ Water body is NOT tidally-influenced	Continue to (3) Size
(3) Size	☐ Area of water body is < 8 hectares	Continue to (4) Erosive Forces
	☐ Area of water body is ≥ 8 hectares	ASSESS SHORELINE STABILIZATION
(4) Erosive Forces	☐ Tidal and/or wind-driven erosive forces are regularly present	ASSESS SHORELINE STABILIZATION
	☐ Fetch is long enough to generate erosive waves at least periodically	ASSESS SHORELINE STABILIZATION
	☐ High-density motor vessel traffic creates regular erosive forces	ASSESS SHORELINE STABILIZATION
	☐ NEITHER periodic tidal/wind-driven waves NOR high density motorized vessel traffic create regular erosive forces	STOP

☒ If there is an **OPEN WATER BODY** (of any size) associated with the AU: check the first box and CONTINUE to (1) Location.

☒ If there is **NO OPEN WATER BODY** associated with the AU: check the second box and **STOP**. Go to **Section B-4** of the data sheet.

✖ **DO NOT ASSESS SHORELINE STABILIZATION**

(1) Location – Use most recent available imagery to determine if the shoreline of the open water body is abutting/contiguous with the AU.

☒ If the AU is **ABUTTING/CONTIGUOUS** with the shoreline: check this box and CONTINUE to (2) Type.

☒ If the AU is **NOT ABUTTING/CONTIGUOUS**: with the shoreline: check this box and **STOP**. Go to **Section B-4** of the data sheet.

✖ **DO NOT ASSESS SHORELINE STABILIZATION**

(2) **Type** – Use most recent available data to determine if the water body is tidally-influenced.

☒ If the water body is **TIDALLY-INFLUENCED**: check this box and SKIP to (4) Erosive Forces.

☒ If the water body is **NOT TIDALLY-INFLUENCED**: check this box and CONTINUE to (3) Size.

(3) **Size** – Use most recent available imagery to determine if the size of the open water body.

> NOTE: Water body size may need to be confirmed during the site visit.

☒ If water body is **LESS THAN 8 hectares**: check this box and CONTINUE to (4) Erosive Forces**.**

☒ If water body is **AT LEAST 8 hectares**: check this box.

⇨ **ASSESS SHORELINE STABILIZATION**

(4) **Erosive Forces** – Use any available data to evaluate whether the water body is subject to forces which could cause shoreline erosion.

> NOTE: Erosive forces may need to be confirmed during the site visit.

☒ If there are regular **TIDAL/WIND-DRIVEN** erosive forces: check this box.

⇨ **ASSESS SHORELINE STABILIZATION**

☒ If there is enough **FETCH** to generate erosive waves: check this box.

⇨ **ASSESS SHORELINE STABILIZATION**

☒ If there is frequent **MOTORIZED VESSEL TRAFFIC** capable of generating erosive wakes: check this box.

⇨ **ASSESS SHORELINE STABILIZATION**

☒ If there are **NO EROSIVE FORCES**: check this box and **STOP**. Go to **Section B-4** of the data sheet**.**

✖ **DO NOT ASSESS SHORELINE STABILIZATION**

> NOTE: Indicate the applicability status of the Shoreline Stabilzation function on the Summary Sheet (p. 12 of the data sheet).
>
> If Shoreline Stabilization is applicable, data sheet Sections E-4 (Water Body Characteristics) and G-7 (Wetland Width) must be completed.

4 - Determine Applicability of Bank Stabilization

Use recent digital imagery or other available mapping data to determine if the AU meets the applicability criteria for assessment of Bank Stabilization.

> NOTE: Criteria with this symbol must be confirmed in the field: 🍄

B-4: Bank Stabilization (check all that apply)

☐ There is a river or stream associated with the AU			Continue to (1) Flow
☐ There is NO river or stream associated with the AU			STOP
(1) Flow	☐ Flow is at least partially internal (within AU boundary)		Skip to (3) Bank
	☐ Flow is entirely external (outside the AU boundary)		Continue to (2) Location
(2) Location	☐ River or stream is bordering AU (shares boundary with AU)		Continue to (3) Bank
	☐ River or stream is at AU inlet only (does not share a boundary with AU)		STOP
	☐ River or stream is at AU outlet only (does not share a boundary with AU)		STOP
(3) Bank	☐ At least one bank of the river or stream is within the AU boundary		Continue to (4) Height
	☐ One bank of the river or stream is abutting the AU		STOP
	☐ Neither bank of the river or stream is within or abutting the AU boundary		STOP
(4) Height	☐ Bank surface is < 10 cm above the high tide line (HTL) or ordinary high water mark (OHWM) of the river or stream	🍄	STOP
	☐ Bank surface is ≥ 10 cm above the high tide line (HTL) or ordinary high water mark (OHWM) of the river or stream	🍄	ASSESS BANK STABILIZATION

☒ If there is a **RIVER OR STREAM** (of any size) associated with the AU: check the first box and CONTINUE to (1) Flow.

☒ If there is **NO RIVER OR STREAM** associated with the AU: check the second box and **STOP**. Go to **Part C** of the data sheet.

✖ **DO NOT ASSESS BANK STABILIZATION**

(1) Flow – Use most recent available imagery to determine whether the stream flows within the AU at any point or if flow is entirely outside the boundary of the AU.

☒ If streamflow is at least **PARTIALLY INTERNAL**: check this box and SKIP to (3) Bank.

☒ If streamflow is entirely **EXTERNAL**: check this box and CONTINUE to (2) Location.

(2) Location – Use most recent available imagery to determine location of the stream channel in relation to the AU.

☒ If the stream channel is **BORDERING** the AU: check this box if the stream channel runs adjacent and parallel to the AU boundary and CONTINUE to (3) Bank.

☒ If the stream channel is present **ONLY AT THE AU INLET** but not within the AU: check this box and **STOP**. Go to **Part C** of the data sheet.

✖ **DO NOT ASSESS BANK STABILIZATION**

☒ If the channel is present **ONLY AT THE AU OUTLET** but not within the AU: check this box and **STOP**. Go to **Part C** of the data sheet.

✖ **DO NOT ASSESS BANK STABILIZATION**

(3) Bank – Use recent imagery to determine location of the streambank(s) in relation to the AU.

☒ If there is a streambank at least partially **WITHIN THE AU**: check this box and CONTINUE to (4) Height.

☒ If the streambank is **ABUTTING THE AU** but located entirely outside the AU boundary: check this box and **STOP**. Go to **Part C** of the data sheet.

✖ **DO NOT ASSESS BANK STABILIZATION**

☒ If the streambank is **NEITHER WITHIN NOR ABUTTING** the AU boundary: check this box and **STOP**. Go to **Part C** of the data sheet.

✖ **DO NOT ASSESS BANK STABILIZATION**

(4) Height – Use most recent available LIDAR/topographic data to determine the height of the streambank above the high tide line (HTL) or ordinary high-water mark (OHWM) of the river or stream (in centimeters). **See Glossary for definitions of HTL and OHWM.**

> NOTE: Height of the streambank must be confirmed during the site visit.

☒ If the streambank is **LESS THAN 10 cm** above the HTL or OHWM of the stream/river: check this box and **STOP**. Go to **Part C** of the data sheet.

☒ If the stream bank is **AT LEAST 10 cm** above the HTL or OHWM of the stream/river: check this box.

⇨ **ASSESS BANK STABILIZATION**

> NOTE: Indicate the applicability status of the Bank Stabilization function on the Summary Sheet (p. 12 of the data sheet).
>
> When Bank Stabilization is applicable, Section E-5 (StreamBank Characteristics) of the data sheet must be completed.

Chapter 4C: Vegetated Wetland Sub-Unit Data

Data Sheet Part C (Field Data Protocol)

VEGETATION AND WILDLIFE HABITAT DATA are collected at each Vegetated Wetland Sub-Unit. NEWFA requires documentation of the physical and structural features of the plant community, however documentation of plant species is NOT required although plant identification is necessary when examining the site for invasive species. Part C of the data sheet consists of four sections: structural complexity, tree stem volume, microfeatures density, and wildlife habitat features.

> IMPORTANT: Part C must be completed for EVERY Vegetated Wetland Sub-Unit, make additional copies of Part C for each one. Every Sub-Unit should be assigned an unique ID# (i.e V1, V2, etc).

C. SUB-UNIT DATA (Field Data Collection)

Sub-Unit #: ☐ of ☐ Type: ☐ EM ☐ SS ☐ FO ID #: (i.e. V1) ☐

Complete Part C for EACH Vegetated Wetland Sub-Unit. Make as many copies of pages 5-6 as necessary.

At the top of each copy of Part C, indicate the number of the Sub-Unit being recorded, the total number of Sub-Units, the Sub-Unit type, and the ID# (which corresponds to the Sub-Unit #). If the AU does not consist of multiple Vegetated Wetland Sub-Units, consider the entire AU to be ASU #V1 (1 of 1) and fill out the header accordingly. Only one copy of Part C will be necessary in that case.

Example Header:

Sub-Unit #: 2 of 3 Type: ☒ EM ☐ SS ☐ FO ID #: (i.e. V1) V2

In this example, the AU consists of three Vegetated Wetland Sub-Units, and this is the second one being documented. The box for EM is checked, because this Sub-Unit has a prevalence of non-woody plants. The ID# is V2 (Vegetated Wetland Sub-Unit #2).

1 - Field Protocol - Meander Transect (Vegetation Structure)

A meander transect is performed by a rambling walk through the area being assessed, paying particular attention to vegetation structure, presence/absence of invasive species, and other features.

2 - Document Vertical Complexity (Strata)

A stratum must cover at least 5% of the ground within the boundary of its sub-unit and be rooted in the sub-unit to be recorded. Vines and saplings do not have their own strata; they are included in the three woody plant strata, based upon their height (tallest point measured vertically).

> **<u>NOTE</u>**: The words strata and layer are often interchangeable, however NEWFA uses both to distinguish between different data. The categories are different for each though there is some overlap between the two.
>
> **STRATA** is used to indicate evaluation of vertical complexity.
>
> **LAYERS** is used to indicate evaluation of areal cover.

C-1a: Strata Present

During the meander transect take note of each stratum present in the Sub-Unit.

a. STRATA PRESENT Record all strata observed within the Sub-Unit which have at least 5% areal cover	☐ CANOPY = all woody plants (including vines) greater than 12m in height ☐ SUB-CANOPY = all woody plants (including vines) 6-12m in height ☐ SHRUB = all woody plants (including vines) less than 6m in height ☐ HERB = all non-woody plants (including mosses and aquatic bed plants) of any height

Check the corresponding box(es) for ALL strata observed within the Sub-Unit.

<u>Strata Definitions:</u>

CANOPY	all woody plants (including vines) which are more than 12 meters tall, highest vegetation stratum in an assemblage.
SUB-CANOPY	all woody plants (including vines) which are 6 to 12 meters tall, saplings usually occur in this stratum.
SHRUB STRATA	all woody plants (including vines) which are less than 6 meters tall.
HERB STRATA	all non-woody plants (including mosses and aquatic bed plants).

3 - Document Areal Cover of Each Vegetation Layer

Cover is the visual estimate of the horizontal projection of the outermost perimeter of the natural spread of foliage. The cover would equal the shadow cast if the sun was directly overhead, where small openings in the canopy, or overlap within the plant, are excluded.

> **<u>Relative cover</u>** is a measure of the percentage of the ground surface covered by a plant species (or group of species) in comparison to the rest of the vegetation. Relative cover for all species in a community will total 100%.
>
> **<u>Absolute cover</u>** is a measure of the percentage of the ground surface covered by a plant species (or group of species) independent of any other vegetation. Due to overlapping plant layers, the sum of absolute cover values for all species in a community may exceed 100 percent.
>
> Make sure to record ABSOLUTE COVER in the NEWFA data sheet.

C-1b: Areal Cover

Record absolute cover for each layer in the Sub-Unit	N/A	< 1 % (trace)	1-4 %	5-15 %	16-25 %	26-39 %	40-60 %	61-74 %	75-84 %	85-95 %	> 95 %
(1) Herbaceous Layer	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
(2) Shrubaceous Layer	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
(3) Understory Layer	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
(4) Tree Layer	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Estimate the areal cover of each layer (observed during the meander transect. Cover classes are used to reduce variability between users. **Definitions for vegetation layers are in the table below.**

(1) **<u>Herbaceous Layer</u>**: Select the box corresponding to the cover class which best represents the areal cover of the herbaceous layer throughout the Sub-Unit. The herbaceous layer consists of all non-woody plants (including mosses and aquatic bed plants).

(2) **<u>Shrubaceous Layer</u>**: Select the box corresponding to the cover class which best represents the areal cover of the shrubaceous layer throughout the Sub-Unit. The shrubaceous layer consists of all woody plants (including vines) less than 6 meters tall.

(3) **<u>Understory Layer</u>**: Select the box corresponding to the cover class which best represents the areal cover of the understory layer throughout the Sub-Unit. The understory layer consists of all woody plants (including vines) less than 6 meters tall AND all non-woody plants (including mosses and aquatic bed plants).

> NOTE: The Understory layer includes everything in the herbaceous layer and everything in the shrubaceous layer, however it should be evaluated as an independent layer. It is <u>NOT the sum of the cover classes</u> of the herbaceous and shrubaceous layers. **See example in Appendix H.**

(4) **<u>Tree Layer</u>**: Select the box corresponding to the cover class which best represents the areal cover of the tree layer throughout the Sub-Unit. The tree layer consists of all woody plants (including vines) 6 meters tall or taller.

Strata and Layer Definitions Compared

<table>
<tr><th colspan="2">STRATA TERM</th><th colspan="4">LAYER TERM (FOR AREAL COVER)</th></tr>
<tr><td>CANOPY</td><td>all woody plants (including vines) more than 12m tall.</td><td rowspan="2">TREE LAYER
(CANOPY & SUB-CANOPY)</td><td rowspan="2">all woody plants (including vines) at least 6m tall.</td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>SUB-CANOPY</td><td>all woody plants (including vines) 6 to 12m tall.</td></tr>
<tr><td>SHRUB STRATA</td><td>all woody plants (including vines) less than 6m tall.</td><td>SHRUBACEOUS LAYER</td><td>all woody plants (including vines) less than 6m tall.</td><td rowspan="2">UNDERSTORY LAYER
(SHRUB & HERB)</td><td rowspan="2">all woody plants (including vines) less than 6m tall AND all non-woody plants</td></tr>
<tr><td>HERB STRATA</td><td>all non-woody plants (including mosses and aquatic bed plants).</td><td>HERBACEOUS LAYER</td><td>all non-woody plants (including mosses and aquatic bed plants)</td></tr>
</table>

4 - Document Extent of Unvegetated Area

Document the unvegetated area observed throughout the Sub-Unit during the meander transect. Unvegetated areas have less than 5% vegetation cover, such as bare ground, rock outcrop or standing water, but are not large enough to be a separate Non-Wetland Sub-Unit.

C-1b: Areal Cover (continued)

Record absolute cover for each layer in the Sub-Unit	N/A	< 1 % (trace)	1-4 %	5-15 %	16-25 %	26-39 %	40-60 %	61-74 %	75-84 %	85-95 %	> 95 %
(5) UNVEGETATED AREAS	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

(5) **Unvegetated Areas**: Select the box corresponding to the cover class which best represents the areal extent of unvegetated areas throughout the Sub-Unit.

5 - Document Extent of Invasive Species

Record the absolute cover of invasive and/or aggressive plant species observed throughout the Sub-Unit during the meander transect. **Invasive/aggressive plant species are listed in Appendix I**.

> NOTE: Although areal cover recorded in lines (1)-(4) may include plants listed as invasive, the value recorded in line (6) should represent the areal cover of ALL invasives species present, regardless of the layer in which they are located.

C-1b: Areal Cover (continued)

Record absolute cover for each layer in the Sub-Unit	N/A	< 1 % (trace)	1-4 %	5-15 %	16-25 %	26-39 %	40-60 %	61-74 %	75-84 %	85-95 %	> 95 %
(6) INVASIVE SPECIES	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

(6) **Invasives**: Select the box corresponding to the cover class which best represents the total areal cover of invasive species throughout the Sub-Unit.

6 - Document Horizontal Complexity (Microhabitats)

Horizontal complexity (habitat heterogeneity) refers to the mosaic of different habitat types that may occur within the Sub-Unit. Heterogeneity is evaluated by recording the presence of areas which are different from the overall Sub-Unit type but are too small to be designated as a separate Sub-Unit.

C-1c: Heterogeneity

c. HETEROGENEITY	NOTE: Microhabitat type must be DIFFERENT from the Sub-Unit type.			
Record all Microhabitats observed within the Sub-Unit. Areas less than $4m^2$ are NOT Microhabitats.	☐ Forested	☐ Emergent	☐ Flowing Water	☐ Unvegetated Areas
	☐ Scrub-Shrub	☐ Aquatic Bed	☐ Standing Water (semi-permanent)	

Document all microhabitats observed within the Sub-Unit during the meander transect. Microhabitats must be a minimum of $4m^2$ in size, and of a different type than the Sub-Unit (e.g. a Forested Sub-Unit can NOT have Forested Microhabitats).

Microhabitat Definitions:

FORESTED MICROHABITAT	an area (at least $4m^2$ but not large enough to be readily identified on aerial photography) comprised of trees (woody plants at least 6m tall) contained within a Vegetated Wetland Sub-Unit which is NOT itself classified as a Forested Sub-Unit.
SCRUB-SHRUB MICROHABITAT	an area (at least $4m^2$ but not large enough to be readily identified on aerial photography) comprised of shrubs (woody plants less than 6m tall) contained within a Vegetated Wetland Sub-Unit which is NOT itself classified as a Scrub-Shrub Sub-Unit.
EMERGENT MICROHABITAT	an area (at least $4m^2$ but not large enough to be readily identified on aerial photography) comprised of emergent plants (all non-woody plants, including mosses) contained within a Vegetated Wetland Sub-Unit which is NOT itself classified as an Emergent Sub-Unit. Emergent microhabitats do not include aquatic bed plants.
AQUATIC BED MICROHABITAT	an area (at least $4m^2$ but not large enough to be readily identified on aerial photography) comprised of aquatic bed plants, contained within a Vegetated Wetland Sub-Unit of any type.
STANDING WATER MICROHABITAT	an area of semi-permanent standing water (at least $4m^2$) contained within a Vegetated Wetland Sub-Unit which is not large enough to be readily identified on aerial photography as a separate Non-Wetland Sub-Unit.

FLOWING WATER MICROHABITAT	an area of semi-permanent flowing water (at least $4m^2$) contained within a Vegetated Wetland Sub-Unit which is not large enough to be readily identified on aerial photography as a separate Non-Wetland Sub-Unit.
UNVEGETATED MICROHABITAT	an area with less than 5% vegetative cover (at least $4m^2$) contained within a Vegetated Wetland Sub-Unit which is not large enough to be readily identified on aerial photography as a separate Non-Wetland Sub-Unit.

7 - Field Protocol - Establish a Representative $10m^2$ Plot

Data documenting tree stem presence and density is collected within a $10m^2$ plot. The location of the $10m^2$ plot should be established randomly but must be entirely within the Sub-Unit and should be representative of the vegetation in that Sub-Unit. In some cases, the plot size and/or shape will require altering so that the plot will remain within the resource type under examination **(see Appendix H).**

8 - Document Number and Size of Trees

Every tree rooted within the $10m^2$ plot is measured and documented, including standing dead trees. Because dead trees contribute some, but not all, of the same structural features as live trees, the status of each tree (live or dead) is also recorded. Tree stems are measured by recording the diameter at breast height (DBH) for each tree. DBH can then be converted to basal area (BA), which is the measurement used to identify the volume of tree stems in a given area. **See Appendix H for Basal Area calculations**.

C-2a: DBH/BA

Measure and document **<u>every tree</u>** (woody plants at least 6m tall) rooted in the $10m^2$ plot. If the tree is no longer living, but is still rooted within the plot, it should be included in the assessment.

a. DBH/BASAL AREA — **NOTE: Add additional lines if there are more than 20 trees rooted in the $10m^2$ plot.**

Record DBH for all trees rooted in the $10m^2$ plot. Check the box to indicate whether each tree is live or standing dead.

(1) L/D	(2) DBH	(3) BA	(1) L/D	(2) DBH	(3) BA	(1) L/D	(2) DBH	(3) BA	(1) L/D	(2) DBH	(3) BA
1 ☐ Live ☐ Dead	cm(s)		6 ☐ Live ☐ Dead	cm(s)		11 ☐ Live ☐ Dead	cm(s)		16 ☐ Live ☐ Dead	cm(s)	
2 ☐ Live ☐ Dead	cm(s)		7 ☐ Live ☐ Dead	cm(s)		12 ☐ Live ☐ Dead	cm(s)		17 ☐ Live ☐ Dead	cm(s)	
3 ☐ Live ☐ Dead	cm(s)		8 ☐ Live ☐ Dead	cm(s)		13 ☐ Live ☐ Dead	cm(s)		18 ☐ Live ☐ Dead	cm(s)	
4 ☐ Live ☐ Dead	cm(s)		9 ☐ Live ☐ Dead	cm(s)		14 ☐ Live ☐ Dead	cm(s)		19 ☐ Live ☐ Dead	cm(s)	
5 ☐ Live ☐ Dead	cm(s)		10 ☐ Live ☐ Dead	cm(s)		15 ☐ Live ☐ Dead	cm(s)		20 ☐ Live ☐ Dead	cm(s)	

(1) **<u>Live or Dead</u>**: For each tree, indicate whether it is living or dead.

☒ **LIVE**: check this box if the tree is live.

☒ **DEAD**: check this box if the tree is no longer living, but still upright and rooted in the plot.

(2) **<u>DBH</u>**: Measure and record the <u>diameter of each tree using a DBH tape</u>, (or other foresters measuring tape), if available. Alternatively, <u>use a tape measure to measure circumference and divide by 3.14</u> to get the diameter.

- DBH is measured at a height of approximately 1.37 m off the ground (4.5 ft).

(3) **<u>Basal Area</u>**: Calculate and record the BA for each tree.

> NOTE: It is NOT necessary to calculate BA in the field. The conversion and subsequent total basal area calculations can be computed in the office after the site visit has been completed. **(See Appendix H for BA conversion calculation.)**

C-2b: Total Basal Area

Total basal area can be calculated in the office.

b. TOTAL BASAL AREA Calculate the total BA of all LIVE trees in the 10m² plot and the total BA of ALL trees (live and standing dead).	(1) LIVE Trees	(2) ALL Trees	**NOTE: DBH to Basal Area conversions can be calculated in the office.**

(1) **<u>LIVE Trees</u>**: Calculate LIVE BA by finding the sum of the values recorded in Section C-2a(3) for basal area of trees marked Live and record the total. Do not include the basal area of trees marked Dead.

(2) **<u>ALL Trees</u>**: Calculate the TOTAL BA by finding the sum of ALL values recorded in Section C-2a(3) and record the total.

C-2c: Tree Stem Count

c. TREE STEM COUNT Record the total number of trees (both live and standing dead) rooted in the 10m² plot.	

Record the **TOTAL NUMBER** of trees in the 10m² plot. Include both live and standing dead trees in the count total.

9 - Field Protocol – Microfeature Transects

Establish three 30m transects radiating from the same point of origination within the 10m² plot. The three transects should be spaced as close to 120° apart as possible. **(See Appendix H for additional instructions on transect placement and spacing)**.

C-3a: Microfeature Count

a. MICROFEATURE COUNT — **NOTE: See User Guide for modification of transect location in narrow Sub-Units.**

Record # of microfeatures along three 30m transects starting from the center of the 10m² plot (spaced 120° apart).

MICROFEATURE KEY:
CWM = Coarse Woody Material (≥ 0.9m length/≥ 10 cm diameter)
BDS = Boulders (≥ 25cm diameter)
MTC = Microtopographic Changes (>10 cm height/depth)

	(1) Direction	(2) CWM	+	(3) BDS	+	(4) MTC	=	(5) Total
1			+		+		=	
2			+		+		=	
3			+		+		=	

The presence, type, and quantity of microfeatures are recorded for each of the three 30m transects.

(1) **<u>Direction</u>**: Record the direction (in degrees) of the transect from the starting point towards the end of the transect.

(2) **<u>CWM (Coarse Woody Material)</u>**: Record the number of times the transect intersects dead or dying woody material at least 0.9m long and a minimum of 10cm in diameter at the widest part.

(3) **BDS (Boulders)**: Record the number of times the transect intersects a rock fragment at least 25 cm in diameter.

(4) **MTC (Microtopographic Change)**: Record the number of times the transect intersects a topographic change on the soil surface of at least 10cm in height or depth.

(5) **Total # of Features**: Calculate the total number of features recorded on each transect.

C-3b: Average Number of Microfeatures

b. AVERAGE NUMBER OF MICROFEATURES (per 30m): ☐

Calculate the and record the average number of microfeatures per 30 meters in the Sub-Unit.

10 - Document Wildlife Habitat Features

Pay attention to any wildlife habitat features during the meander transect. Wildlife habitat features are structural and biotic features that provide cover, breeding sites, and food for different types of wildlife. Examples of such wildlife features include tree cavities, snags, open water, large, exposed rocks, coarse woody material, and many others.

> **IMPORTANT: Some features are not applicable to all Sub-Unit types, such as the presence/absence of canopy openings in an emergent sub-unit. Make sure to use the correct column for the Sub-Unit type.**

C-4a: Feature Presence/Absence

a. FEATURE PRESENCE/ABSENCE	**NOTE:** Be sure to use the column that corresponds to the Sub-Unit type		
Record all wildlife habitat features observed within the Sub-Unit	☐ (1) EM	☐ (2) SS	☐ (3) FO

☒ Check the box indicating the Sub-Unit Type at the top of the appropriate column.

Presence/Absence: Document the presence or absence of each listed wildlife habitat feature.

- ☒ **YES**: if the feature was observed anywhere within the Sub-Unit, check this box.
- ☒ **NO**: if the feature was not observed in the Sub-Unit during the site visit, check this box.

> NOTE: Every habitat feature observed within the Sub-Unit should be documented, even if there is only one example.

C-4a: Feature Presence/Absence (continued)

a. FEATURE PRESENCE/ABSENCE	NOTE: Be sure to use the column that corresponds to the Sub-Unit type		
Record all wildlife habitat features observed within the Sub-Unit	☐ (1) EM	☐ (2) SS	☐ (3) FO
1. Canopy openings (at least one opening of $10m^2$ in size)		☐ Y ☐ N	☐ Y ☐ N
2. Conifer cover (at least 10% of tree cover)		☐ Y ☐ N	☐ Y ☐ N
3. Shaggy bark trees (such as shagbark hickory or other bat roosting habitat)		☐ Y ☐ N	☐ Y ☐ N
4. Large trees (greater than 1m DBH)		☐ Y ☐ N	☐ Y ☐ N
5. Tree cavities (at least one cavity greater than 50cm diameter trunk or limb)		☐ Y ☐ N	☐ Y ☐ N
6. Shade trees (in Emergent Sub-Units)	☐ Y ☐ N		
7. Snags (standing dead trees)	☐ Y ☐ N	☐ Y ☐ N	☐ Y ☐ N

Features 1-7 relate to the **PRESENCE or CHARACTERISTICS OF TREES**
Features 1-5 - NOT applicable to Emergent Sub-Units.
Feature 6 - ONLY applicable to Emergent Sub-Units.
Feature 7 - Applicable to ALL Sub-Unit Types.

C-4a: Feature Presence/Absence (continued)

8. Dense understory or herbaceous ground cover (shrub/thicket)	☐ Y ☐ N	☐ Y ☐ N	☐ Y ☐ N
9. Coarse woody material on ground (≥ 10 cm diameter AND ≥ 0.9 m in length)	☐ Y ☐ N	☐ Y ☐ N	☐ Y ☐ N
10. Fine woody material on ground (< 10 cm diameter OR < 0.9 m in length)	☐ Y ☐ N	☐ Y ☐ N	☐ Y ☐ N
11. Sphagnum hummocks or mats or moss-covered logs	☐ Y ☐ N	☐ Y ☐ N	☐ Y ☐ N
12. Microtopography (pit and mound topography, hummocks)	☐ Y ☐ N	☐ Y ☐ N	☐ Y ☐ N
13. Rock/boulder piles, crevices or hollow logs	☐ Y ☐ N	☐ Y ☐ N	☐ Y ☐ N
14. Large exposed rocks (in wetland or adjacent open water system)	☐ Y ☐ N	☐ Y ☐ N	☐ Y ☐ N
15. Persistent emergent vegetation such as *Phragmites, Typha* (either standing or on ground)	☐ Y ☐ N		
16. Emergent vegetation flooded > 25 cm at least seasonally	☐ Y ☐ N		
17. Abundant small mammal burrows	☐ Y ☐ N	☐ Y ☐ N	☐ Y ☐ N
18. Depressions that may serve as seasonal pools	☐ Y ☐ N	☐ Y ☐ N	☐ Y ☐ N
19. Exposed areas of well-drained, sandy soil suitable for turtle nesting	☐ Y ☐ N	☐ Y ☐ N	☐ Y ☐ N

Features 8-19 are all features **LOCATED ALONG THE GROUND**

Features 8-14 - Applicable to ALL Sub-Unit Types.
Features 15 and 16 - ONLY applicable to Emergent Sub-Units.
Features 17-19 - Applicable to ALL Sub-Unit Types.

C-4a: Feature Presence/Absence (continued)

20. Standing water (pool/pond/lake) internal or immediately adjacent to Sub-Unit	☐ Y ☐ N	☐ Y ☐ N	☐ Y ☐ N
21. Flowing water (river/stream) internal or immediately adjacent to Sub-Unit	☐ Y ☐ N	☐ Y ☐ N	☐ Y ☐ N
NOTE: Lines 22 to 26 should only be completed if Line 20 and/or 21 are marked YES			
22. Gravel stream bottoms in flowing water	☐ Y ☐ N	☐ Y ☐ N	☐ Y ☐ N
23. Riffle and pools complexes in flowing water	☐ Y ☐ N	☐ Y ☐ N	☐ Y ☐ N
24. Logs, roots, branches, hummocks, rocks, or crevices at or near surface in adjacent open water system	☐ Y ☐ N	☐ Y ☐ N	☐ Y ☐ N
25. Exposed mudflats in adjacent open water system	☐ Y ☐ N	☐ Y ☐ N	☐ Y ☐ N
26. Vegetated shallows (aquatic bed) in adjacent open water system	☐ Y ☐ N	☐ Y ☐ N	☐ Y ☐ N

Features 8-19 require the presence of **STANDING OR FLOWING WATER**

Features 20 and 21 - Applicable to ALL Sub-Unit Types.
Features 22-26: ONLY applicable if either 20 or 21 has been marked **YES**.
(If 20 and 21 are both marked NO, 22-26 should also be marked NO).

C-4a: Feature Presence/Absence (continued)

Use lines 27 and 28 to write in any other wildlife habitat features observed but not listed.

27. Other:	☐ Y ☐ N	☐ Y ☐ N	☐ Y ☐ N
28. Other:	☐ Y ☐ N	☐ Y ☐ N	☐ Y ☐ N
b. TOTAL NUMBER OF WILDLIFE HABITAT FEATURES	☐	☐	☐

Calculate and record the total number of wildlife features observed in the Sub-Unit.

Chapter 4D: Soil Examination Areas

Data Sheet Part D (Field Data Protocol)

SOIL AND RELATED LANDSCAPE DATA are collected at every Soil Examination Area (SEA). Data used for preliminary identification of SEAs and recorded in Section A-3 of the data sheet must be confirmed during the site visit. Part D of the data sheet consists of two sections: landscape characteristic data and soil description data.

IMPORTANT: Part D must be completed for EACH Soil Examination Area. If there are multiple SEAs, make additional copies of Part D for each one.

If the AU does not consist of multiple Soil Examination Areas, consider the entire AU to be SEA #1 (1 of 1) and fill out the header accordingly. Only one copy of Part D will be necessary in this case.

D. SOIL EXAMINATION AREAS (Field Data Collection)

Soil Examination Area #: ☐ of ☐ ☐ Representative ☐ Minor Component

Complete Part D for EACH Soil Examination Area. Make as many copies of page 7 as necessary.

At the top of each copy or Part D, indicate the number of the SEA being recorded, the total number of SEAs and whether the soil documented at the location is representative of the AU or if it appears to be a minor component or inclusion.

Example Header:

Soil Examination Area #: 4 of 4 ☐ Representative ☒ Minor Component

In this example, the AU consists of four separate soil examination areas and this SEA is the last one being documented. The box for Minor Component is checked, because the SEA is located in a soil unit that only intersects the AU in one corner and is not characteristic of the AU as a whole.

1 - Document Landscape Characteristics

Surficial geology and landscape position recorded in Part A during pre-site visit reconnaissance must be confirmed or updated in the field at each soil examination area.

NOTE: See Chapter 4A for surficial geology and landscape position definitions. All definitions are also found in the glossary.

D-1a: Surficial Geology

a. SURFICIAL GEOLOGY Record the surficial geology of the soil examination area **NOTE: Select only ONE surficial geology term**			
	☐ Lodgment Till	☐ Coarse-Grained Alluvium	☐ Shallow Bedrock
	☐ Melt-Out Till	☐ Fine-Grained Alluvium	☐ Coastal Sands
	☐ Mixed Glacial Materials	☐ Colluvium	☐ Inland Organic Materials
	☐ Stratified Coarse Materials	☐ Dense Anthropogenic	☐ Tidally-Flooded Organic Materials
	☐ Stratified Fine Materials	☐ Loose Anthropogenic	

Choose the <u>best descriptor</u> of the surficial geology underlying the SEA location. **Select ONE box only.**

D-1b: Landscape Position

Indicate the landscape position at the location of the Soil Examination Area.

b. LANDSCAPE POSITION Record the landscape position of the soil examination area **NOTE: Select only ONE term**			
	☐ Groundwater Slope	☐ Groundwater Depression	☐ Marine Fringe
	☐ Surface Water Slope	☐ Surface Water Depression	☐ Estuarine Fringe
	☐ Groundwater Flat	☐ River/Stream Fringe	☐ Freshwater Tidal Fringe
	☐ Surface Water Flat	☐ River/Stream Floodplain	☐ Lake/Pond Fringe

Choose the <u>best descriptor</u> of the landscape position at the SEA location. **Select ONE box only.**

2 - Field Protocol - Select Location for Soil Pit

Select a location which appears to be representative of the SEA. The soil pit should be hand dug to a minimum of 70 cm. Soil augers may be used for examining deeper soil layers. It may be necessary to dig one or more exploratory holes to determine the best spot in which to dig the soil pit. It is not necessary to document the soil characteristics from any exploratory holes.

> NEWFA uses a simplified soil profile description, it is not necessary to record additional soil layer characteristics beyond those listed in section D-2a of the data sheet.

D-2a: Soil Profile Description

Starting at the soil surface, describe each layer in the soil profile. Document a new layer anytime there is a change in color, texture, redoximorphic feature presence/color.

a. SOIL PROFILE Dig a pit in an area representative of the soil examination area and describe the layers down to a minimum depth of 70 cm. **NOTE: See User Guide for detailed instructions**		(1) Layer/ Horizon	(2) Depth (cm)	(3) Matrix Color	(4) Matrix Percent	(5) Redox Color	(6) Redox Percent	(7) Soil Texture
	1.				%		%	
	2.				%		%	
	3.				%		%	
	4.				%		%	
	5.				%		%	
	6.				%		%	

(1) **<u>Layer/Horizon:</u>** Identify each layer.

(2) **<u>Depth (cm)</u>**: Starting at the soil surface (depth = 0), record the depth (in cm) of each layer. The depth should be recorded as a range from the top to the bottom of the layer (e.g. 0-8 cm, 8-14 cm, etc.).

(3) **<u>Matrix Color</u>**: Use a color book (e.g. Munsell or Earth Colors) to determine the Hue, Value, and Chroma for each layer's matrix color.

- If there are **MULTIPLE MATRIX COLORS**: <u>record each one on a separate line</u>.

(4) **Matrix Percent**: If there are **REDOXIMORPHIC FEATURES PRESENT**, estimate the percentage of the layer which is matrix and record that value in Column (4).

- If the matrix consists of **MORE THAN ONE COLOR**: determine the relative percentages for each color.
- If matrix consists of **ONLY ONE COLOR** and there are **NO REDOXIMORPHIC FEATURES** present, record 100% in Column (4) and skip to Column (7).

(5) **Redox Color**: If there are **REDOXIMORPHIC FEATURES PRESENT**, record the Hue, Value, and Chroma for those features in Column (5)

- If there are **NO REDOXIMORPHIC FEATURES** present, leave Column (5) and (6) empty and skip to Column (7).

(6) **Redox Percent**: If there are **REDOXIMORPHIC FEATURES PRESENT**, estimate the percentage of the layer composed of redox features and record that value in Column (6).

(7) **Layer Texture**: Record the texture of the layer.

- For **ORGANIC SOIL LAYERS**: indicate whether the layer is Fibric (Peat), Hemic (Mucky Peat) or Sapric (Muck).
- For **MINERAL SOIL LAYERS**, use only the following terms or codes.

Soil Texture	Code	Soil Texture	Code	Soil Texture	Code
Clay	C	Silt Loam	SIL	Loamy Fine Sand	LFS
Silty Clay	SIC	Loam	L	Loamy Sand	LS
Sandy Clay	SC	Very Fine Sandy Loam	VFSL	Loamy Coarse Sand	LCOS
Clay Loam	CL	Fine Sandy Loam	FSL	Very Fine Sand	VFS
Silty Clay Loam	SICL	Sandy Loam	SL	Fine Sand	FS
Sandy Clay Loam	SCL	Coarse Sandy Loam	COSL	Sand	S
Silt	SI	Loamy Very Fine Sand	LVFS	Coarse Sand	COS

- To indicate **MUCKY MODIFIED MINERAL SOILS**: add "(mucky)" or "+m" after the soil texture term or code. (See Glossary for definition of Mucky Modified.)

3 - Document Soil Texture Classes

Soil texture classes (listed in the Texture Class Key below) are used to document the range of mineral soil textures present in the SEA.

Mineral Soil Texture Class Key					
CLAYEY	LOAMY (FINE)	LOAMY (MEDIUM)	LOAMY (COARSE)	LOAMY SAND	SANDY
Clay	Clay Loam	Silt	Fine Sandy Loam	Loamy Very Fine Sand	Very Fine Sand
Silty Clay	Silty Clay Loam	Silt Loam	Sandy Loam	Loamy Fine Sand	Fine Sand
Sandy Clay	Sandy Clay Loam	Loam	Coarse Sandy Loam	Loamy Sand	Sand
		Very Fine Sandy Loam		Loamy Coarse Sand	Coarse Sand

D-2b: Soil Texture Classes

Indicate all organic soil textures and mineral soil textures classes recorded in the soil profile description in Section D-2a. **See example in Appendix H.**

b. SOIL TEXTURE CLASS(ES)
Record soil textures observed in the soil profile. Use the Texture Class Key for mineral soils.

(1) Upper Mineral Layer	(2) All Textures Present	TEXTURE CLASS KEY
Record the texture class of the uppermost mineral soil layer. ☐ No mineral soil layers present ☐ Clayey ☐ Loamy (Fine) ☐ mucky ☐ Loamy (Med) ☐ mucky ☐ Loamy (Coarse) ☐ mucky ☐ Loamy Sand ☐ mucky ☐ Sandy ☐ mucky	Record ALL texture classes in the soil profile. ORGANIC SOILS: ☐ Fibric (Peat) ☐ Hemic (Mucky Peat) ☐ Sapric (Muck) MINERAL SOILS: ☐ Clayey ☐ Loamy (Fine) ☐ mucky ☐ Loamy (Med) ☐ mucky ☐ Loamy (Coarse) ☐ mucky ☐ Loamy Sand ☐ mucky ☐ Sandy ☐ mucky NOTE: Check mucky modified box if applicable	CLAYEY = Clay, Silty Clay, Sandy Clay LOAMY (FINE) = Clay Loam, Silty Clay Loam, Sandy Clay Loam LOAMY (MED) = Silt, Silt Loam, Loam, Very Fine Sandy Loam LOAMY (COARSE) = Fine Sandy Loam, Sandy Loam, Coarse Sandy Loam LOAMY SAND = Loamy Very Fine Sand, Loamy Fine Sand, Loamy Sand, Loamy Coarse Sand SANDY = Very Fine Sand, Fine Sand, Sand, Coarse Sand

(1) Upper Mineral Layer: Check **ONE** box to indicate the texture class of the **UPPERMOST MINERAL SOIL** layer.

☒ **No mineral soil layers present**: check this box if the soil profile consists entirely of organic soils.

☒ **Mucky**: Check this box if the uppermost mineral soil layer is mucky modified.

(2) ALL Soil Textures Present: Check **ALL** box(es) next to **EVERY ORGANIC** soil texture **and** **EVERY MINERAL** soil texture class documented in the soil profile.

☒ **Mucky**: Check this box next to any of the mineral soils which are mucky modified.

4 - Measure Depth/Thickness of Organic Material

D-2c: Thickness Of Organic Layers

In an undisturbed site, organic soil layers (if present) will be the first layers documented. are the uppermost layers and the depth from the soil surface to the bottom of the layer(s) is equivalent to the thickness of the layer. For sites with a buried organic horizon, begin the measurement at the topmost organic soil surface. Measure the total thickness of all organic layers at the location of the soil pit. For thick organic soils, which continue beyond the bottom of the soil pit, use a tile probe to determine the depth of the layer. The tile probe will move smoothly through the organic layers and either stop or move with increased resistance at the bottom of the organic layer.

c. THICKNESS OF ORGANIC LAYERS [ ] cm(s) ☐ Total thickness > 130 cm ☐ No organic layers

Record the total thickness of the organic soil layers in cm.

☒ If the **total thickness > 130 cm (Deep Organic)**: record the thickness as 131 cm and check this box. It is not necessary to record the exact thickness for deep organic layers.

☒ If there are **no organic soil layers** present: record the thickness as 0 and check this box.

5 - Document Soil Map Unit

D-2d: Soil Map Unit Name

d. SOIL MAP UNIT NAME		☐ As mapped in Soil Survey ☐ Revised in the field

Record the name of the soil unit mapped at the soil examination area.

☒ **As mapped**: check this box if the soil map unit name recorded is the same as the soil map unit shown for the SEA on the relevant soil survey map. The soil map unit documented in this section will be the SAME as the map unit(s) documented in Section A-3a.

☒ **Revised in the field**: check this box if the soil map unit name recorded is NOT the same as the soil map unit shown for the SEA on the relevant soil survey map. The soil map unit documented in this section will be DIFFERENT from the map unit(s) documented in Section A-3a.

> **NOTE**: if the user does not feel qualified to determine the accuracy of the soil unit as mapped, check the first box labeled As Mapped.

Chapter 4E: Hydrology/Resource Specific Data

Data Sheet Part E (Field Data Protocol)

HYDROLOGY DATA, including observations of water source, movement and restrictions are made throughout the entire AU during the site visit and recorded in Part E of the data sheet. Part E of the data sheet consists of five sections: the first two sections (flow restrictions and hydrologic connections) are documented for all assessment units. The other three sections (shore zone characteristics, open water body characteristics, and streambank characteristics) are only completed when the corresponding RSF is applicable (as determined in Part B of the data sheet).

IMPORTANT: Sections E-1 and E-2 must be completed for all sites.

1 - Document Features which Restrict Flow

During the site visit, take note of the presence and characteristics of any features which might affect or impede the movement of surface water through of out of the AU. The number of flow restrictions features present will vary widely depending on whether flow takes places along a single discrete conveyance, through a complex network within the wetland, or not at all.

E-1: Flow Restrictions

Document all flow restriction features observed within the boundary of the AU. Include features located internally as well as at the outlet. **Do not include any features at the inlet of the AU.**

Record ALL flow restriction features observed in the AU.	☐ Open Exchange		☐ Tidal	☐ Non-Tidal	
	☐ Channel(s) Present	☐ Unrestricted			
		☐ Flow Restricted	☐ Restricted by Dam	☐ Human	☐ Beaver
			☐ Restricted by Debris Jam	Percent restricted or narrowed:	☐ < 25% ☐ 25-50% ☐ 50-75% ☐ >75%
		☐ Width Narrows	☐ By Geology		
			☐ By Bridge/Other Structure		
	☐ Culvert(s) Present	☐ Transmitting Flow	Culvert width relative to channel width:	☐ < 25% ☐ 25-50%	☐ 50-75% ☐ > 75%
		☐ Not Transmitting Flow	☐ Blocked by debris	☐ Partially	☐ Totally
			☐ Culvert located too high		
NOTE: Record flow restriction features located anywhere in the AU including, but not limited to the outlet.	☐ Tide Gate(s)/Weir(s)	☐ Operational			
		☐ Non-Operational	☐ Open	☐ Closed	
	☐ Closed System				

Check ALL that apply:

☒ **<u>Open Exchange</u>**: check this box if there is **UNIMPEDED MOVEMENT OF SURFACE WATER** between the AU and a contiguous water body. Note whether the movement of water is <u>tidally-driven, non-tidal or both</u>. **Do not check this box if exchange occurs only at the inlet of the AU.**

- ☒ Exchange is **TIDAL**: check this box if exchange is due to the **<u>regular rising and falling of tides.</u>** Tidal exchange typically occurs twice a day in New England. High tide lines and low tide lines may be visible evidence of tidal exchange.

- ☒ Exchange is **NON-TIDAL**: check this box if exchange is **due to currents or regular streamflow**.

☒ **Channel(s) Present**: check this box if flow through the AU is **CONTAINED IN A FEATURE** (whether natural or artificial) with a **RECOGNIZABLE FLOW PATH**.

- ☒ Flow is **UNRESTRICTED:** check this box if the channel flows unrestricted through the entirety of the AU.
- ☒ Flow is **RESTRICTED:** check this box if channel flow through the AU is restricted or slowed at one or more locations by any of the listed features.
  - ☒ Flow is **restricted by a dam** in the channel: check this box and indicate whether the dam was constructed by humans or beavers.
  - ☒ Flow is **restricted by debris** (e.g. tree branches, trash) in the channel: check this box and note whether the debris jam spans the entire width of the channel or just restricts flow across part of the channel. Record degree of restriction by estimating the percent of the channel that is impacted.

> NOTE: If the channel has multiple locations where flow is restricted by debris, check ALL percent restricted boxes that are applicable.

- ☒ Channel **WIDTH NARROWS** due to hardened structures or geology: check this box.
  - ☒ If narrowing is due to **erosion-resistant geology**: check this box and determine the percent change in channel width occurring at that location.
  - ☒ If narrowing is due to **bridge supports** (or some other **structure)**: check this box and determine the percent change in channel width at that location.

> NOTE: If the channel has multiple locations where width narrows, check ALL percent narrowed boxes that are applicable.

☒ **Culvert(s) Present**: if there are any culverts present, either within the AU or at the outlet, check this box. Determine whether the culvert is receiving at least some flow or not receiving any flow.

- ☒ If culvert is **TRANSMITTING FLOW** or would transmit flow when surface water is present: check this box and note the width of the culvert relative to the channel width.
- ☒ If culvert is **NOT TRANSMITTING FLOW**: check this box and note whether it is due to a debris blockage or the position of the culvert.

> NOTE: Do NOT check this box if absence of flow is only temporary due to current hydrologic or precipitation conditions.

  - ☒ If culvert is **blocked by debris** preventing flow: check this box and note whether the culvert is partially or totally blocked by debris.
  - ☒ If culvert **located too high** for flow to be transmitted: check this box.

☒ **<u>Tide Gate(s)/Weirs</u>**: check this box if there are tide gates or weirs which might affect the flow of water through the AU.

> ☒ If the tide gate or weir is **FULLY OPERATIONAL** and maintained as designed: check this box.
>
> ☒ If the tide gate or weir is **NON-OPERATIONAL**: check this box. <u>Note if it is permanently open or permanently closed</u>.

☒ **<u>Closed System</u>**: check this box if the system does not have an outlet and surface water is typically unable to move out of the AU.

2 - Document Connectivity to other Aquatic Resources

✎ E-2: Hydrologic Connectivity

Record ALL hydrologic connections between the AU and other aquatic systems.	☐ Contiguous with Other Aquatic Resources	☐ Ocean ☐ Bay	☐ Estuary ☐ Tidal Creek	☐ River ☐ Stream	☐ Lake ☐ Pond
	☐ Tidal Flow (includes Tidal Creeks)	☐ Constricted	☐ Not Constricted		
	☐ Surface Water Channel(s) (Non-Tidal Flow)	☐ Perennial (year-round continuous) ☐ Intermittent (seasonal continuous) ☐ Periodic (discontinuous/event-driven)		☐ At Inlet ☐ At Inlet ☐ At Inlet	☐ At Outlet ☐ At Outlet ☐ At Outlet
	☐ Overbank Flooding from Channel	☐ Into AU	☐ Out of AU		
	☐ Evidence of Overland Flow (sheetflow)	☐ Into AU	☐ Out of AU		
	☐ No Evidence of Hydrologic Connections				

Check ALL that apply:

☒ **<u>Contiguous with Other Aquatic Resources</u>**: Check this box if the AU is contiguous with any other aquatic resources and indicate which one(s). See Glossary for definitions.

☒ **<u>Tidal Flow (including Tidal Creeks)</u>**: Check this box if there is tidal flow to/from the AU. Note whether tidal flow is constricted in any way.

> ☒ Tidal flow is **CONSTRICTED**: check this box if there are any human-made structures or landforms interfering with tidal flow.
>
> ☒ Tidal flow is **NOT CONSTRICTED**: check this box if there are no structures or landforms affecting tidal flow.

☒ **<u>Surface Water Channel (non-tidal flow):</u>** Check this box if there is a surface water conveyance (non-tidal only) either in to or out of the AU. Determine the frequency of the flow and the location of the channel.

> ☒ Flow in channel is **PERENNIAL**: Check this box if there is year-round flow in the channel. Document whether there is flow <u>into (at the inlet) the AU, out of (at the outlet) the AU, or both.</u>
>
> ☒ Flow in channel is **INTERMITTENT**: Check this box if there is continuous seasonal flow in the channel. Document whether there is flow <u>into (at the inlet) the AU, out of (at the outlet) the AU, or both.</u>

☒ Flow in channel is **PERIODIC**: Check this box if flow in the channel is discontinuous or event-driven only. Document whether there is flow <u>into (at the inlet) the AU, out of (at the outlet) the AU, or both.</u>

☒ **<u>Overbank Flooding from Channel</u>**: Check this box is there is overbank flooding from a river or stream. Depending on the location of the channel in relation to the AU boundary, overbank flooding may be <u>entering the AU, exiting the AU or both</u>. Indicators of overbank flooding include sedimentation, drainage patterns, debris lines, reclining vegetation and/or gauge data.

☒ If there is overbank flooding **INTO THE AU**: check this box.

☒ If there is overbank flooding **OUT OF THE AU**: check this box.

☒ **<u>Evidence of Overland Flow</u>**: Check this box if there is water moving over the AU surface that is not contained within a conveyance. Overland flow may be <u>entering the AU, exiting the AU or both</u>.

☒ If there is overland flow **INTO THE AU:** check this box.

☒ If there is overland flow **OUT OF THE AU**: check this box.

☒ **<u>No evidence of hydrologic connection</u>**: check this box if none of the above hydrologic connections are observed.

Sections E-3, E-4 and E-5 are completed ONLY when the corresponding resource specific function(s) are applicable as determined in Part B.

3 - Document Shore Zone Characteristics (when applicable)

The applicability of Storm Surge Reduction (as determined in Section B-2 of the data sheet) requires the characteristics of the shore zone to be confirmed and documented during the site visit. NEWFA defines the shore zone as the terrestrial area adjacent to the edge of the qualifying water body, which include all tidally-influenced waters (including tidal creeks) and any non-tidal water body large enough to produce storm surge under the right conditions (e.g., Lake Champlain is considered a qualifying non-tidal water body).

✎ E-3: Shore Zone Characteristics

☐ N/A	a. ELEVATION Elevation of AU relative to water body	☐ Same Elevation ☐ AU is Lower	☐ AU is < 3m Higher ☐ AU is ≥ 3m Higher	**NOTE: Complete this table for any qualifying water body which is within 100m of the AU. See User Guide for definitions.**
☐ Assess	b. BARRIERS Barriers separating AU from water body	☐ No Separation ☐ Partial Separation	☐ Barrier < 3m High ☐ Barrier ≥ 3m High	

☒ **<u>N/A</u>**: If Storm Surge Reduction is NOT applicable per Section B-2 of the data sheet, check this box and **<u>STOP</u>**. Go to **<u>Section E-4</u>**.

✕ **<u>DO NOT Calculate FCG for Storm Surge Reduction</u>**

☒ **<u>Assess</u>**: If Storm Surge Reduction appears to be applicable as determined in Section B-2, confirm that the AU is **no more than 100m from the edge of a qualifying water body**. Check this box and CONTINUE to <u>Section E-3(a) - Elevation</u>.

(a) ELEVATION: assess the elevation of the closest edge of the AU in relation to the elevation at the edge of the qualifying water body.

☒ If the AU is at the **same or lower elevation** than the water body: check this box and CONTINUE to Section E-3(b) – Barriers.

☒ If the AU is at a **higher elevation** than the water body: determine the difference.

☒ If the elevation difference is **LESS THAN 3 meters:** check this box and CONTINUE to Section E-3(b) – Barriers.

☒ If the elevation difference is **AT LEAST 3 meters or more**: check this box and **STOP**. Go to **Section E-4** of the data sheet.

✕ **DO NOT Calculate FCG for Storm Surge Reduction**

(b) BARRIER(S): confirm whether there are any barriers separating the AU from the water body (e.g., a berm or dune).

☒ If there are **no barriers separating** the AU and the water body: check this box.

☑ **Calculate FCG for Storm Surge Reduction**

☒ If the AU is **partially separated** from the water body by a discontinuous barrier: check this box.

☑ **Calculate FCG for Storm Surge Reduction**

☒ If the AU is **completely separated** from the shoreline by a barrier, determine the height of the barrier.

> NOTE: It is not necessary to determine the height of a barrier which does NOT create a complete separation between the AU and the shoreline.

☒ If the barrier is **LESS THAN 3 meters**: check this box.

☑ **Calculate FCG for Storm Surge Reduction**

☒ If the barrier is **AT LEAST 3 meters or more:** check this box.

✕ **DO NOT Calculate FCG for Storm Surge Reduction**

> NOTE: Section G-7 (Wetland Width) must be completed in order to assess Storm Surge Reduction.

4 - Document Water Body Characteristics (when applicable)

The applicability of Shoreline Stabilization (as determined in Section B-3 of the data sheet) requires the characteristics of the associated open water body to be confirmed and documented during the site visit.

E-4: Open Water Body Characteristics

☐ N/A	a. TYPE/SIZE ☐ Tidally-Influenced ☐ Non-Tidal (< 8 ha) ☐ Non-Tidal (≥ 8 ha)		**NOTE: Complete this table for any open water body which is abutting the AU.**
☐ Assess	b. EROSIVE FORCES Note presence of any forces which might affect shoreline stability. Evidence may be direct observation or other evidence.	(1) Regular tidal or wind-driven waves ☐ Y ☐ N (2) Enough fetch to generate waves ☐ Y ☐ N (3) High density motor vessel traffic ☐ Y ☐ N	

☒ **N/A**: If Shoreline Stabilization is NOT applicable per Section B-3 of the data sheet, check this box and **STOP**. Go to **Section E-5** of the data sheet.

✕ **DO NOT Calculate FCG for Shoreline Stabilization**

☒ **Assess**: If Shoreline Stabilization appears to be applicable as determined in Section B-3, confirm that the AU is **abutting/contiguous with an open water body.** Check this box and CONTINUE to Section E-4(a) - Type/Size.

(a) TYPE/SIZE: confirm whether the water body is tidally-influenced or non-tidal.

☒ If the water body is **tidally-influenced:** check this box and CONTINUE to Section E-4(b) - Erosive Forces**.**

☒ If the water body is **NOT tidally-influenced**: confirm the size of the water body.

☒ If the water body is **LESS THAN 8 hectares**: check this box and CONTINUE to Section E-4(b) - Erosive Forces**.**

☒ If the water body **AT LEAST 8 hectares or larger** check this box. DO NOT complete Section E-4(b) - Erosive Forces**.**

☑ **Calculate FCG for Shoreline Stabilization**

(b) EROSIVE FORCES: determine whether erosive forces might impact the shoreline.

(1) If there is evidence of **frequent wind or tide-driven waves** that could destabilize the shoreline: check the box marked **YES**. If not, check the box marked **NO**.

(2) If the size and shape of the water body allows wind to blow uninterrupted towards the shoreline with **enough fetch to generate erosive waves periodically:** check the box marked **YES**. If not, check the box marked **NO**.

(3) If there is evidence of **high-density motorboat traffic** with enough frequency and speed that vessel wake might impact the shoreline, check the box marked **YES**. If not, check the box marked **NO**.

→ If **AT LEAST ONE erosive force is present**.

☑ **Calculate FCG for Shoreline Stabilization**

→ If **NO EROSIVE FORCES are present**.

✕ **DO NOT Calculate FCG for Shoreline Stabilization**

> NOTE: Section G-7 (Wetland Width) must be completed in order to assess Shoreline Stabilization.

5 - Document Streambank Characteristics (when applicable)

The applicability of Bank Stabilization (as determined in Section B-4 of the data sheet) requires the characteristics of the streambank(s) to be confirmed and documented during the site visit.

E-5: Streambank Characteristics

☐ N/A	a. HEIGHT OF BANK (above OWHM/HTL of river or stream): ☐ < 10 cm ☐ ≥ 10 cm											
	b. BANK LAYER COVER See User Guide for Definitions	N/A	< 1 % (trace)	1-4 %	5-15 %	16-25 %	26-39 %	40-60 %	61-74 %	75-84 %	85-95 %	> 95 %
	(1) HERBACEOUS LAYER	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
☐ Assess	(2) UNVEGETATED AREAS	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

NOTE: Complete this table for any streambank which is located within or abutting the AU.

☒ **<u>N/A</u>**: If Bank Stabilization is NOT applicable per Section B-4, check this box and **<u>STOP</u>**. Go to **<u>Part F</u>** of the data sheet.

✕ **<u>DO NOT Calculate FCG for Bank Stabilization</u>**

☒ **<u>Assess</u>**: If Bank Stabilization appears to be applicable as determined in Section B-4, confirm that there is at least **one streambank within or abutting the AU**. Check this box and CONTINUE to <u>Section E-5(a) - Height of Bank</u>.

(a) **<u>HEIGHT OF BANK</u>**: determine the <u>height of the streambank(s) relative to the stream</u> OHWM or HTL. See Appendix C for Glossary.

☒ If the bank is **<u>less than 10 cm</u>** above the OHWM/HTL: check this box and **STOP.** Go to **<u>Part F</u>** of the data sheet.

✕ **<u>DO NOT Calculate FCG for Bank Stabilization</u>**

☒ If the bank is **at least 10 cm or more** above the OHWM/HTL: check this box and CONTINUE to <u>Section E-5(b) – Bank Layer Cover</u>**.**

☑ **<u>Calculate FCG for Bank Stabilization</u>**

> NOTE: Section E-5b (Bank Layer Cover) must be completed in order to calculate the FCG for Bank Stabilization

(b) **<u>BANK LAYER COVER:</u>** Walk a meandering transect and assess the vegetation on the streambank. DO NOT consider vegetation <u>more than 10 meters from the stream</u>. Select the appropriate cover class for each layer listed below. See Part C of the data sheet for additional details on meander surveys and areal cover classes.

(1) **Herbaceous Vegetation**: Estimate the areal cover of vegetation in the herbaceous layer (defined as all non-woody plants, including mosses and aquatic bed plants). Select the box corresponding to the cover class which best represents the areal cover of the herbaceous layer on the streambank.

(2) **Unvegetated Area**: Estimate the areal extent of unvegetated areas (defined as areas with less than 5% vegetation cover, such as bare ground, rock outcrop or standing water, but not large enough to be a separate Non-Wetland Sub-Unit. Select the box corresponding to the cover class which best represents the areal extent of unvegetated area along the streambank.

Chapter 4F: Human Activity/Stressors

Data Sheet Part F (Field Data Protocol)

STRESSORS are disturbances in the form of human activity and non-anthropogenic factors affecting the ability of a wetland to maintain habitat integrity for wildlife and plant communities. The degree to which each individual stressor affects the wetland may vary. Stressors may impact the entire assessment unit or just a portion of it. Some stressors may be present but have minimal effect on wildlife or plant communities. In addition, the impact of any one stressor depends on the degree of disturbance from other stressors. Part F of the data sheet is divided into three sections: human activity within the AU, human activity within 100m of the AU and plant community stressors.

1 - Field Protocol – Activity/Stressor Intensity and Proportion

Look for evidence of recent human activity or other stressors while completing the other sections of the data sheet. Be sure to review the list of potential stressors in the data sheet. Evidence can be direct observation during the site visit, visual evidence on recent imagery, or local knowledge. **Note: Part F can be revised after the site visit if additional information is available in the office.**

N/A	(1) Intensity				(2) Proportion Affected					(3) Sub-Score
	A	B	C	D	< 10 %	10 - 33 %	34 - 66 %	67 - 90 %	> 90 %	
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

The protocol for documenting the intensity of disturbance and the proportion of the assessment unit impacted by each individual activity/stressor is the same for all three sections of Part F.

☒ **N/A**: check this box if there is NO EVIDENCE of the activity/stressor occurring within the last 2 years and proceed to the next listed activity/stressor. Otherwise leave this box empty and CONTINUE to **(1) Intensity**.

IMPORTANT: Only document RECENT disturbance. Do NOT record any activities/stressors which have not occurred within the last 2 years.

(1) **Intensity**: Use the intensity key to select the letter that best corresponds to the magnitude of disturbance resulting from each activity/stressor.

- ☒ A = Activity/Stressors present, but no evidence of impacts (affects aesthetics only)
- ☒ B = Slight impact evident (likely affecting sensitive species)
- ☒ C = Significant impact evident (changing abundances of multiple species)
- ☒ D = Severe impact evident (altering basic community composition)

(2) **Proportion**: Select the class that best represents the proportion of the assessment unit affected by each listed activity.

- ☒ < 10%: Check this box if the activity/stressor only affects a small section of the AU.
- ☒ 10-33%: Check this box for any activity/stressor which affects less one third of the AU.

☒ 34-66%: Check this box for any activity/stressor which affects about half of the AU.

☒ 67-90%: Check this box for any activity/stressor which affects more than two thirds of the AU.

☒ > 90%: Check this box for any activity/stressor which appears to affect entire AU.

(3) **<u>Sub-Score</u>**: Sub-scores can be calculated and recorded after the site visit in the office.

> See Appendix K for instructions on sub-score calculation.

2 - Document Observations of Recent Human Activity

Section F-1 is separated into two sections based on the location of the activity.

F-1a: Internal Activity

Document evidence of activities which are presently occurring or have recently occurred **<u>within the AU boundary.</u>**

For each activity observed, document the proportion of the AU affected and the intensity of the disturbance (using the intensity key).

INTENSITY OF DISTURBANCE KEY
A = Activity/Stressor present, but no evidence of impact (aesthetic only)
B = Slight impact evident (likely affecting sensitive species)
C = Significant impact evident (changing abundances of multiple species)
D = Severe impact evident (altering basic community composition

a. INTERNAL ACTIVITY Record any ongoing or recent human activity within the AU boundary.	N/A	(1) Intensity				(2) Proportion Affected					(3) Sub-Score
		A	B	C	D	< 10 %	10 - 33 %	34 - 66 %	67 - 90 %	> 90 %	
1. Gravel or 2-lane paved roads	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
2. Trash or refuse dumping	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
3. Tree clearing or logging activity	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
4. Non-passive recreational activity (e.g. hunting, fishing)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
5. Active managed hydrology (e.g. dams, tide-gates)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
6. Point source discharge (wastewater treatment)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
7. Non-point source discharge (agricultural run-off)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Record the presence, intensity and proportion affected for each of the 7 listed activities.

1. Gravel or 2-lane paved roads: must be in active use within the last 2 years.
2. Trash or refuse dumping.
3. Recent tree clearing, logging, burning or species management.
4. Active recreational use (hunting, fishing, camping, ATV, mountain biking, motorized boats) within the last 2 years.
5. Active managed hydrology (dams, impoundments, ditches, diversions, pumps that move water in or out, tide-gates).
6. Point source discharge (wastewater treatment, factory discharge) within the last 2 years.

7. Non-point source discharge (storm water, agricultural or mine runoff, discharge from oil and gas) within the last 2 years.

F-1b: Nearby Activity

Document evidence of activities which are presently occurring or have recently occurred **within 100m of the AU** and/or **within the boundaries** of the AU.

b. NEARBY ACTIVITY Record any ongoing or recent human activity within 100m of the AU or within the AU boundary.	N/A	(1) Intensity				(2) Proportion Affected					(3) Sub-Score
		A	B	C	D	< 10 %	10 - 33 %	34 - 66 %	67 - 90 %	> 90 %	
1. Large (4+ lane) roads or highways											
2. Active railroad (passenger or freight)											
3. Active mowing or plowing (e.g. golf course, row crops)											
4. Occupied development (e.g. residential, commercial)											
5. Industrial activity											
6. Substrate removal and/or physical resource extraction											
7. Filling/dumping of sediment or other soil disturbance											
8. Direct application of agricultural chemicals											

Record the presence, intensity and proportion affected for each of the 8 listed activities.

1. Large (4+ lane) roads or highways in active use within the last 2 years.
2. Active railroad (passenger or freight).
3. Active mowing or plowing (sports field, golf course, urban parkland, expansive lawns, row crop agriculture).
4. Existing occupied development (residential, recreational, commercial buildings).
5. Industrial activity within the last 2 years.
6. Substrate removal (excavation) and/or physical resource extraction (rock, sand, gravel, minerals) within the last 2 years.
7. Filling/dumping of sediment (excavation spoils) or other soil disturbance (grading, compaction) within the last 2 years.
8. Direct application of agricultural chemicals, pesticides, or herbicides within the last 2 years.

3 - Document Observations of Plant Community Stressors

F-2: Plant Community Stressors

Document evidence of plant community stressor which are presently occurring or have recently occurred **within 100m of the AU** and/or **within the boundaries** of the AU.

Record stressors which are currently or have recently been present within 100 m of the AU or within the AU boundary	N/A	(1) Intensity				(2) Proportion Affected					(3) Sub-Score
		A	B	C	D	< 10 %	10 - 33 %	34 - 66 %	67 - 90 %	> 90 %	
1. Livestock grazing or excessive wildlife browse											
2. Insect pest damage											
3. Urban freshwater inputs to saltwater wetland environment											
4. Evidence of excess salinity (dead/stressed plants, salt crusts)											

Record the presence, intensity and proportion affected for each of the 4 listed stressors.

1. Livestock grazing or excessive wildlife browse (deer, geese).
2. Insect pest damage (exotic species or excessive damage by native species).
3. Urban freshwater inputs to saltwater wetland environment (stressed plants or unvegetated areas near culvert/drainage channel).
4. Evidence of excess salinity (dead/stressed plants, salt crusts).

Chapter 4G: Landscape and Land Use

Data Sheet Part G (GIS Data Protocol)

LANDSCAPE AND LANDUSE DATA are important criteria for assessment of several wetland functions. Data are recorded after the site visit using remote sensing and GIS.

> **IMPORTANT: Instructions presume some experience with GIS software. Part G may be completed using any available geospatial or mapping software. Detailed ArcGIS instructions are located in Appendix J.**

Part G consists of seven sections: AU/wetland system area, Sub-Unit size and weighting factor calculation, assessment of buffer integrity, assessment of habitat connectivity, assessment of surrounding land use, and wetland width calculation.

1 - Finalize Extent of AU/Wetland System and all Sub-Units

Using photointerpretation and any notes recorded during the site visit, make any necessary revisions to the extent of the AU and Wetland System. Create a finalized AU polygon and a separate polygon for the Wetland System if necessary.

> Record all area/size measurements in hectares (ha) to one decimal place.

G-1: Area of Assessment Unit/Wetland System

Use GIS to calculate the area of the AU and Wetland System polygons. Visual estimation of area is unreliable and not acceptable for this method.

a. SIZE OF ASSESSMENT UNIT: ______ ha(s)	b. AREA OF WETLAND SYSTEM: ______ ha(s)

(a) **Assessment Unit**: Record the size (area) of the AU polygon in hectares.

(b) **Wetland System**: Record the area of the wetland system polygon in hectares.

> NOTE: The area of the wetland system and the size of the assessment unit may be equivalent in some cases and different in others. See Chapter 3 for scenarios where the AU does not encompass the entire wetland system.

2 - Record Final Area/Classification for All Sub-Units

Confirm or revise the classification and boundaries for all ASU sub-divisions and create individual polygons for each. Use GIS to calculate the area of all Sub-Unit polygons. Visual estimation of area is unreliable and not acceptable for this method.

G-2a: Non-Wetland ASU(s)

a. TYPE AND SIZE Record type/size for each Non-Wetland ASU	(1) ID #	N1	N2	N3	N4	NOTE: If there are more than 4 Non-Wetland Sub-Units add columns and sequential ID#s (N5, N6).
NON-WETLAND ASU TYPE KEY: SW = Standing Water FW = Flowing Water Other = Upland/Unvegetated	(2) Type	☐ SW ☐ FW ☐ Other	☐ SW ☐ FW ☐ Other	☐ SW ☐ FW ☐ Other	☐ SW ☐ FW ☐ Other	
	(3) Size	☐ ha(s)	☐ ha(s)	☐ ha(s)	☐ ha(s)	

Record the type and size of each Non-Wetland ASU. If there are more than 4 Non-Wetland Sub-Units, it will be necessary to add additional columns.

(1) **ID #**: Each Non-Wetland Sub-Unit should be assigned an ID# starting with the letter N followed by a number. In cases where there are more than 4 Non-Wetland Sub-Units, continue to assign ID# sequentially (i.e. N5, N6, etc.).

(2) **Type**: Check the box which corresponds to the Non-Wetland type of each ASU.

(3) **Size**: Calculate the size of each Non-Wetland Sub-Unit using GIS and record in hectares.

G-2b: Total Non-Wetland Area

b. TOTAL NON-WETLAND AREA:	☐	ha(s)

Record the total area of non-wetland by calculating the sum of the values recorded in Section G-2a(3). If there are no Non-Wetland Sub-Units in the AU, record the total area as 0.

G-3a: Vegetated Wetland ASU(s) Type and Size

a. TYPE AND SIZE Record type/size for each Veg. Wetland ASU	(1) ID #	V1	V2	V3	V4	NOTE: If there are more than 4 Veg. Wetland Sub-Units add columns and sequential ID#s (V5, V6).
VEGETATED WETLAND ASU TYPE KEY: EM = Emergent Wetland SS = Scrub-Shrub Wetland FO = Forested Wetland	(2) Type	☐ EM ☐ SS ☐ FO	☐ EM ☐ SS ☐ FO	☐ EM ☐ SS ☐ FO	☐ EM ☐ SS ☐ FO	
	(3) Size	☐ ha(s)	☐ ha(s)	☐ ha(s)	☐ ha(s)	

Record the type and size of each Vegetated Wetland Sub-Unit. If there are more than 4 Vegetated Wetland Sub-Units, it will be necessary to add additional columns.

(1) **ID #**: Each Vegetated Wetland Sub-Unit should be assigned an ID# starting with the letter V followed by a number. They should be numbered sequentially in the order assessed during the site visit. In cases where there are more than 4 Vegetated Wetland Sub-Units, ID#s should continue sequentially (V5, V6, etc.).

(2) **Type**: Check the box which corresponds to the Vegetated Wetland type of each ASU. Confirm that the type recorded in Section G-3a(2) matches the type recorded on the corresponding copy of Part C of the data sheet.

> IMPORTANT: Confirm that the ID #s and ASU type recorded in Section G-3a(1)and (2) match the ID # and type recorded on the corresponding copy of Part C of the data sheet for each Vegetated Wetland Sub-Unit.

(3) **Size**: Calculate the size of each Vegetated Wetland Sub-Unit using GIS and record in hectares (to 1 decimal places).

G-3b: Total Vegetated Wetland Area

b. TOTAL VEGETATED WETLAND AREA: ______ ha(s)

Record the total area of vegetated wetland by calculating the sum of the values recorded in Section G-3a(3). If the AU does not contain any Non-Wetland Sub-Units, this value should match the value recorded in Section G-1a.

> The sum of the area of non-wetland (recorded in Section G-2b) and the area of vegetated wetland (recorded in G-3b) should be equivalent to the value recorded in Section G-1a.

3 - Calculate Vegetated Wetland Sub-Unit Weighting Factors

All Sub-Unit data collected in Part C are converted to variable scores by calculating the weighted average (by relative size) across all Vegetated Wetland Sub-Units.

G-3c: Weighting Factors

c. WEIGHTING FACTOR Calculate the weighting factor for each Vegetated Wetland Sub-Unit	V1	V2	V3	V4	NOTE: See User Guide for detailed instructions

Calculate the weighting factor (to 2 decimal places) for each Vegetated Wetland Sub-Unit by dividing the corresponding ASU size recorded in Section G-3a(3) by the total vegetated wetland area recorded in Section G-3b. **See example in Appendix E**.

4 - Calculate Amount of Perimeter with Intact Buffer

G-4a: Length of AU Perimeter

Use GIS to calculate the distance (length) of the perimeter of the AU polygon.

a. LENGTH OF AU PERIMETER: ______ m

Record the length of the perimeter in meters to one decimal place.

G-4b: Percent of Perimeter with Intact Buffer

Follow the perimeter of the AU polygon and identify all locations where there is undisturbed buffer at least 10 meters wide adjacent to the AU. Undisturbed buffer includes any undeveloped area that is not actively managed, including open water.

b. INTACT BUFFER (percent of perimeter with at least 10m wide undisturbed buffer): ______ %

Measure the length of all segments with adjacent buffer and calculate the percentage of the total perimeter with intact undisturbed buffer.

5 - Calculate Adjacent Buffer Width

Locate the centerpoint of the AU and create 8 transects radiating from the center in each of the cardinal (N, S, E, W) and ordinal (NE, SE, NW, SW) directions. See Appendix ?? for Examples and directions for linear or horseshoe shaped Assessment Units.

G-4c: Buffer Width Measurements

Buffer width is measured from the location where each transect intersects the AU boundary to a maximum of 100 meters.

c. BUFFER WIDTH MEASUREMENTS
Measure distance (up to 100m max) from AU edge to buffer edge along 8 directional spokes radiating from the AU centroid.

(1) N: ____ m(s)
(8) NW: ____ m(s)
(2) NE: ____ m(s)
(7) W: ____ m(s)
AU Centroid
(3) E: ____ m(s)
(6) SW: ____ m(s)
(4) SE: ____ m(s)
(5) S: ____ m(s)

Using the most recent digital imagery measure the distance (in meters) from the AU boundary to the first point where there is visible development. Record each value (to 1 decimal place) in Section G-4c(1-8). If the distance is greater than 100 meters, record 100.0 as the buffer width measurement for the corresponding transect.

G-4d: Average Buffer Width

d. AVERAGE BUFFER WIDTH: ____ m(s) **NOTE: See User Guide for buffer measurement details.**

Calculate the average of the buffer width measurements and record the value in Section G-4d.

6 - Document Habitat Connectivity

Using recent digital imagery locate any other habitat blocks in the surrounding area.

G-5a: Number of Habitat Connections

a. NUMBER OF CORRIDORS TO UNDISTURBED HABITAT (minimum width 5m)
Undisturbed habitat must be at least 2.5 hectares in size (any type including non-wetland)

Locate any blocks of undisturbed habitat that are visible on recent aerial photography. Undisturbed habitat blocks must be at least 2.5 hectares in size, but do not need to be the similar to the assessment unit and can include upland. Determine if these habitat blocks are connected to the AU by a habitat corridor that is at least 5 meters wide. Record the number of corridors which connect the AU to an undisturbed habitat block located no further than 500m from the AU.

G-5b: Distance to Nearest Similar Wetland

b. DISTANCE TO NEAREST SIMILAR WETLAND Must be the same primary wetland type as the AU and at least 0.25 hectare in size		m(s)

Locate the nearest wetland (minimum size 0.25) that is of the same type as the AU, or the largest Sub-Unit, and measure the distance to the wetland edge from the AU boundary. If there is no wetland within 500 meters of the AU boundary, record 500 meters as the value in Section G-5a.

7 - Document Surrounding Land Use

G-6a: Land Use Zone Area

Using GIS create a 500-meter buffer polygon around the AU.

a. AREA of LAND USE ZONE Create a 500m buffer polygon around the AU and record the area in hectares.		ha(s)

Calculate the area of the land use zone polygon (in hectares up to one decimal place) and record in Section G-6a. The value for the land use zone area should NOT include the area of the AU.

G-6b: Land Use/Land Cover (LULC) Classification

Use the most recent LULC data available from the National Landcover Database (NLCD) to classify land use in the Land Use Zone. NLCD data is also available as a NEWFA-specific LULC data layer.

b. LULC CLASSIFICATION
Record the area within the land use zone classified as each LULC class and calculate the percent of the total land use zone for each.

NOTE: Use most recent LULC (land use/land cover) dataset available. See User Guide for detailed instructions on LULC class coefficients and calculation of sub-scores.

(1) LULC Class	(2) Area	(3) % of Total	(4)	(5) Sub-Score	(1) LULC Class	(2) Area	(3) % of Total	(4)	(5) Sub-Score
Developed, Open Space	ha(s)		X 3 =		Deciduous Forest	ha(s)		X 10 =	
Developed, Low	ha(s)		X 2 =		Evergreen Forest	ha(s)		X 10 =	
Developed, Med	ha(s)		X 1 =		Mixed Forest	ha(s)		X 10 =	
Developed, High	ha(s)		X 0 =		Scrub/Shrub	ha(s)		X 10 =	
Pasture/Hay	ha(s)		X 6 =		Grassland/Herbaceous	ha(s)		X 10 =	
Cultivated Crops	ha(s)		X 3 =		Woody Wetlands	ha(s)		X 10 =	
Barren	ha(s)		X 7 =		Emergent Wetlands	ha(s)		X 10 =	
Open Water	ha(s)		X 10 =		Perennial Ice/Snow	ha(s)		X 10 =	

The land use classes listed are those used by NLCD (based on a modified Anderson classification). The definitions for each class are listed in the Glossary.

(1) **Land Use Class:** Overlay the Land Use Zone polygon with the LULC data layer to determine the presence/absence of each of the listed classes.

(2) **Area:** Calculate the area classified as each LULC class within the Land Use Zone. Record the area in hectares (to 2 decimal places) in column (2). If a class is not present within the Land Use Zone, record 0.0 as the value in column (2) for that class.

(3) **<u>Percent of Total:</u>** Calculate the percent of the total area occupied by each class by dividing the values recorded in column (2) by the value recorded in Section G-6a.

(4) **<u>Coefficients</u>** the values listed in column 4 represent the relative impact of each land use class.

(5) **<u>Sub-Score</u>** – Calculate the sub-score for each class by multiplying the values recorded in column (3) by the coefficients listed in column (4).

8 - Calculate Land Use Index Score

G-6c: Land Use Index Score

c. LULC SCORE (total of sub-scores): [ ]

Calculate the Land Use Index Score by adding the values documented in Column (5) and record the total in Section G-6c.

9 - Width of Wetland System (when applicable)

Must be completed if Storm Surge Reduction and/or Shoreline Stabilization will be assessed. NEWFA defines shoreline as the feature at the interface of a waterbody and the adjacent terrestrial system.

G-7a: Shoreline Length

Use recent digital imagery to delineate the shoreline of the relevant water body. It is not necessary to distinguish between high and low tide as long as the imagery captures a typical tidal cycle.

a. SHORELINE LENGTH/TRANSECTS
Measure the length of the shoreline (to the nearest 10m) and calculate the number of transects required. Transects should be spaced every 100m.

(1) Shoreline Length: [ ] m(s)
(2) # of Transects: [ ]

(1) Calculate the length of the shoreline line using GIS and record the value to the nearest 10m.

(2) Calculate number of transects required by dividing value recorded in G-7a(1) by 100.

G-7b: Width Transects

Width transects are drawn perpendicular to shoreline towards the landward wetland edge. Width transects should be spaced every 100 meters starting 50 meters from either end of the shoreline.

b. WIDTH MEASUREMENTS
Measure the width of the wetland perpendicular to the shoreline.

NOTE: See User Guide for instructions on measuring shoreline length and establishing wetland width transects.

	Width		Width		Width		Width
T-1	m(s)	T-11	m(s)	T-21	m(s)	T-31	m(s)
T-2	m(s)	T-12	m(s)	T-22	m(s)	T-32	m(s)
T-3	m(s)	T-13	m(s)	T-23	m(s)	T-33	m(s)
T-4	m(s)	T-14	m(s)	T-24	m(s)	T-34	m(s)
T-5	m(s)	T-15	m(s)	T-25	m(s)	T-35	m(s)
T-6	m(s)	T-16	m(s)	T-26	m(s)	T-36	m(s)
T-7	m(s)	T-17	m(s)	T-27	m(s)	T-37	m(s)
T-8	m(s)	T-18	m(s)	T-28	m(s)	T-38	m(s)
T-9	m(s)	T-19	m(s)	T-29	m(s)	T-39	m(s)
T-10	m(s)	T-20	m(s)	T-30	m(s)	T-40	m(s)

Record the length of each transect (in meters) from the shoreline to the point where they intersect the wetland edge. See Appendix J for instructions on width transects that cross and measuring complex shorelines.

G-7c: Average Wetland Width

c. AVERAGE WIDTH OF WETLAND SYSTEM	m(s)

Calculate the average of the width transects and record the value in Section G-7c.

Chapter 5: Variables

1 - Variables Overview

There are over 30 NEWFA variables derived directly from the data collected about the assessment unit and another 14 composite variables. This chapter describes each variable, the type of data from which is derived, and how each variable's values are scored so that they can be combined in the mathematical equations used to calculate the functional capacity models. The NEWFA variables can be categorized in several different ways including by the type of data they are derived from, scope of variable application and how the values are scored.

A. Variable Types

1) **Simple Variables**: variable score uses a single value derived from site assessment data (see section 2 of this chapter)

> **Example**: The *TreeCov* variable is derived from the absolute cover of the tree layer as recorded during the site visit.

2) **Composite Variables**: variable score is determined by combining two or more simple variable values in an equation (see section 3 of this chapter)

> **Example**: The variable *ET* (evapotranspiration) is the combination of *TreeCov* and *Understory* (absolute cover of the understory layer) in the equation:
> $$ET = \frac{2(TreeCov) + Understory}{3}$$

3) **Sub-Variables**: components of composite variables, usually simple variables

> **Example**: *TreeCov* and *Understory* are the sub-variable components of composite variable *ET*

4) **Stand-Alone Variables**: direct components of functional models, may be simple or composite; some variables may be utilized as both sub-variables and stand-alone variables.

B. Data Collection and Variables

Variables can be categorized by the type and scope of data collection that informs the variable value.

Data Collection Scope

Some data is collected in specific sub-sections of the assessment unit or only under specific conditions.

1) **Each Vegetated Wetland Sub-Unit (Sub-Unit)**: data collected at each sub-unit includes strata present, vegetation layer cover, and basal area of trees in a $10m^2$ plot (see section 2-A of this chapter)
2) **Each Soil Examination Area (SEA)**: data collected at each soil examination area includes soil texture, surficial geology type, landscape position and organic layer thickness (see section 2-B of this chapter)

3) **Resource-Specific**: only collected if a resource specific feature is present, such as vegetation cover on the stream bank (see section 2-D of this chapter)
4) **Entire Assessment Unit (AU)**: data collected for entire AU includes hydrology data, stressor data, and desktop data (see sections 2-C, 2-E and 2-F of this chapter)

DATA COLLECTION TYPE

For the purposes of this method, these are the different categories of data collection:

1) **Field Observation**: recorded observations during the site visit of a specific category of features, either presence/absence or classification of feature type
2) **Field Assessment**: an estimation of area, proportion or relative degree based on visual observation during the site visit.
3) **Field Measurement**: use of a measuring tool, or transect/plot-based counts during the site visit

> **Examples:**
>
> Number of plant strata in the assessment unit = FIELD OBSERVATION
>
> Absolute cover of the tree layer in the assessment unit = FIELD ASSESSMENT
>
> Basal area of trees in a representative 10m2 plot = FIELD MEASUREMENT

4) **Desktop Assessment**: presence of features using aerial photo interpretation and/or geospatial data layers.
5) **Desktop Measurement**: length or distance between features identified using aerial photo interpretation and/or geospatial data layers.
6) **Desktop Calculation**: percentage of area or total area of a polygon calculated using GIS.

> **Examples**:
>
> Number of corridors to other habitat blocks = DESKTOP OBSERVATION
>
> Distance to another similar habitat block = DESKTOP MEASUREMENT
>
> Area of the assessment unit polygon = DESKTOP CALCULATION

C. VARIABLE VALUES AND SCORING

Each variable has a limited set of possible attribute values which may be numerical or descriptive.

1) **Variables derived from Ordinal Data:**

   These variables will have numerical attribute values. Ordinal data includes measurements such as basal area or distance, areal extent such as cover class, and feature count (either overall or count per unit).

2) **Variables derived from Nominal Data:**

   These variables will have descriptive attribute values. Nominal data includes ranked categories (such as underlying surficial geology) and feature presence/absence (such as flow restriction features). For the purposes of this document, variables derived from nominal data will be referred to as categorical variables.

3) **Variable Scoring**

Most NEWFA variables are scored on a 10-point whole number scale (either 0-10 or 1-10), although there are several variables that use a different scoring scale. In this method, most numerical variable values are grouped in bins to simplify scoring. Categorical variables are scored by ranking values or classes of values.

D. VARIABLE APPLICATION SCOPE

- Some variables are used by only one model.
- Some variables are used in multiple models.
- Variables used in multiple models may have the same scoring for all models OR scoring may be model specific.

E. SUMMARY OF VARIABLE SCOPE AND TYPE CATEGORIES

<table>
<tr><th></th><th>SCOPE</th><th colspan="2">TYPE</th></tr>
<tr><td>DATA COLLECTION</td><td>Each Soil Examination Area
Each Vegetated Wetland Sub-Unit
Resource Specific Applicability
Entire Assessment Unit</td><td colspan="2">Field Observation
Field Assessment
Field Measurement
GIS/Desktop Assessment
GIS/Desktop Measurement
GIS/Desktop Calculation</td></tr>
<tr><td>VARIABLE APPLICATION</td><td>Single Model
Multiple Models</td><td colspan="2">Stand-Alone Variable
Sub-Variable Component of Composite Variable</td></tr>
<tr><td>ATTRIBUTE VALUES AND SCORING</td><td>Model-Specific Scoring
No Variation in Scoring</td><td>NUMERICAL
Size/Distance/Depth
Feature Count
Proportion
Cover Class
Basal Area</td><td>CATEGORICAL
Ranked Values/Classes
Presence/Absence</td></tr>
</table>

2 - Simple Variables

A. Variables Derived from Sub-Unit Field Data

These variables are derived from data collected at EACH Vegetated Wetlands Sub-Unit (recorded in Part C of the Data Sheet) and then weighted by Sub-Unit area. See Appendix E for detailed instructions on weighting Sub-Unit variables.

HerbCov

HerbCov represents the density of vegetation in the herbaceous layer.

	SCOPE	TYPE
DATA COLLECTION	Each Vegetated Sub-Unit	Field Assessment
VARIABLE APPLICATION	Multiple Models	Stand-Alone Variable and Sub-Variable Component of Composite Variable
SCORING	No Variation in Scoring	Numerical (Areal Cover): 11 Classes (scored 0-10)

Absolute cover of the herbaceous layer (defined as all non-woody plants, regardless of height, including mosses and aquatic bed plants) is estimated in the field and recorded in Section C-1b(1) of the Data Sheet at each Vegetated Wetland Sub-Unit. This variable is derived from a quantitative metric, areal cover estimates are recorded by cover class (see table below).

HerbCov is utilized as a stand-alone variable in the Removal/Sequestration of Heavy Metals model. It is also a sub-variable component of *NitrogenBiomass* (a composite variable in the Nitrogen Transformation model). *HerbCov* value descriptors are the same for all functions and there is no variation in scoring between models. *HerbCov* is scored from 0-10.

***HerbCov* Classes and Scores**	**FUNCTION**	
	Removal/Sequestration of Heavy Metals	Nitrogen Transformation
		NitrogenBiomass
COVER CLASS	VARIABLE SCORE	SUB-VARIABLE SCORE
None	0	0
<1% (Trace)	0	0
1 – 4%	0	0
5 – 15%	1	1
16 – 25%	2	2
26 – 39%	3	3
40 – 60%	5	5
61 – 74%	7	7
75 – 84%	8	8
85 – 95%	9	9
> 95%	10	10

HETEROGENEITY

Heterogeneity represents the degree of horizontal complexity throughout the AU.

	SCOPE	TYPE
DATA COLLECTION	Each Vegetated Sub-Unit	Field Observation
VARIABLE APPLICATION	Single Model	Sub-Variable Component of Composite Variable
SCORING	No Variation in Scoring	Numerical (Feature Count): 4 Classes (scored 0-3)

All microhabitat types observed in the field are recorded in Section C-1c of the Data Sheet at each Vegetated Wetland Sub-Unit. Microhabitats are defined as patches at least $4m^2$ which are of a different type than the Sub-Unit in which they are located. This variable is derived from a quantitative metric, field observations are counted, and the corresponding class is selected (see table below).

Heterogeneity is used by only one function; it is utilized as a sub-variable component of *HabFeat* (a composite variable in the Wildlife Habitat Integrity model). *Heterogeneity* is scored from 0-3.

***Heterogeneity* Classes and Scores**	**FUNCTION**
	WILDLIFE HABITAT INTEGRITY
	HabFeat
COUNT CLASS	SUB-VARIABLE SCORE
None	0
1 – 2	1
3 – 4	2
5+	3

INVASIVES

Invasives represents the presence and extent of invasive and/or aggressive plant species in the AU.

	SCOPE	TYPE
DATA COLLECTION	Each Vegetated Sub-Unit	Field Assessment
VARIABLE APPLICATION	Single Model	Stand-Alone Variable
SCORING	No Variation in Scoring	Numerical (Areal Cover): 11 Classes (scored 0-10)

Total absolute cover of invasive plant species (see Appendix I for list) is estimated in the field and recorded in Section C-1b(6) of the Data Sheet at each Vegetated Wetland Sub-Unit. This variable is derived from a quantitative metric, areal cover estimates are recorded by cover class and higher scores are assigned to lower cover classes which represent less invasive species (see table below).

Invasives is used by only one function, it is utilized as a stand-alone variable in the Plant Community Integrity model. *Invasives* is scored from 0-10.

Invasives Classes and Scores	**FUNCTION**
	PLANT COMMUNITY INTEGRITY
COVER CLASS	VARIABLE SCORE
None	10
<1% (Trace)	10
1 – 4%	9
5 – 15%	7
16 – 25%	5
26 – 39%	3
40 – 60%	2
61 – 74%	2
75 – 84%	1
85 – 95%	1
> 95%	0

LIVEBA

LiveBA represents the volume of live tree stems rooted in the AU.

	SCOPE	TYPE
DATA COLLECTION	Each Vegetated Sub-Unit (10x10m² plot)	Field Measurement
VARIABLE APPLICATION	Single Model	Sub-Variable Component of Composite Variable
SCORING	No Variation in Scoring	Numerical (Measurement): 12 Classes (scored 0-10)

The basal area of every live tree (defined as woody plants 6m or taller, regardless of diameter) in a 10x10m² plot is measured in the field and recorded in Section C-2a of the Data Sheet at each vegetated wetland sub-unit. The total basal area of live trees is calculated and recorded in Section C-2b(1). This variable is derived from a quantitative metric, field measurements are recorded and the class which corresponds to the total basal area is selected (see table below).

LiveBA is used by only one function, it is utilized as a sub-variable component of *CarbonBiomass* (a composite variable in the Carbon Sequestration model). *LiveBA* is scored from 0-10.

***LiveBA* Classes and Scores**	**FUNCTION**
	CARBON SEQUESTRATION
	CarbonBiomass
LIVE BASAL AREA	SUB-VARIABLE SCORE
< 0.0250	0
0.0250 – 0.0749	1
0.0750 – 0.1249	2
0.1250 – 0.1749	3
0.1750 – 0.2249	4
0.2250 – 0.2749	5
0.2750 – 0.3249	6
0.3250 – 0.3749	7
0.3750 – 0.4249	8
0.4250 – 0.4749	9
≥ 0.4750	10

MICROFEAT

MicroFeat represents the density of features which contribute to the roughness of the AU.

	SCOPE	TYPE
DATA COLLECTION	Each Vegetated Sub-Unit	Field Measurement
VARIABLE APPLICATION	Multiple Models	Sub-Variable Component of Composite Variables
SCORING	No Variation in Scoring	Numerical (Feature Count): 7 Classes (scored 0-10)

Coarse woody material, boulders and microtopographic changes are counted along three 30m transects in the field and recorded in Section C-3a of the Data Sheet at each Vegetated Wetlands Sub-Unit. This variable is derived from a quantitative metric, the average feature count is calculated and recorded in Section C-3b of the Data Sheet and applicable count class is selected (see table below).

MicroFeat is utilized as a sub-variable component of *VelocityReduct* (a composite variable in the Particulate Retention, Surface Water Detention and Storm Surge Reduction models) and as a sub-variable component of *Retentionability* (a composite variable in the Nitrogen Transformation, Phosphorus Retention, Removal/Sequestration of Heavy Metals and Carbon Sequestration models). *MicroFeat* value descriptors are the same for all functions and there is no variation in scoring between models. *MicroFeat* is scored from 0-10.

MicroFeat **Classes and Scores**	**FUNCTION**	
	SURFACE WATER DETENTION STORM SURGE DETENTION PARTICULATE RETENTION	NITROGEN TRANSFORMATION PHOSPHORUS RETENTION REMOVAL OF HEAVY METALS CARBON SEQUESTRATION
	VelocityReduct	*Retentionability* (as component of sub-variable *VelocityReduct*)
COUNT CLASS	SUB-VARIABLE SCORE	
None	0	0
1 – 3	1	1
4 – 6	3	3
7 – 9	5	5
10 – 12	7	7
13 – 15	9	9
> 15	10	10

SHRUBCOV

ShrubCov represents the density of vegetation in the shrubaceous layer.

	SCOPE	TYPE
DATA COLLECTION	Each Vegetated Sub-Unit	Field Assessment
VARIABLE APPLICATION	Multiple Models	Sub-Variable Component of Composite Variables
SCORING	No Variation in Scoring	Numerical (Areal Cover): 11 Classes (scored 0-10)

Absolute cover of the shrubaceous layer (defined as all woody plants less than 6m in height, regardless of diameter) is estimated in the field and recorded in Section C-1b(2) of the Data Sheet at each Vegetated Wetland Sub-Unit. This variable is derived from a quantitative metric, areal cover estimations are recorded by cover class (see table below).

ShrubCov is utilized as a sub-variable component of *NitrogenBiomass* (a composite variable in the Nitrogen Transformation model). *ShrubCov* value descriptors are the same for all functions and there is no variation in scoring between models. *ShrubCov* is scored from 0-10.

***ShrubCov* Classes and Scores**	**FUNCTION**
	NITROGEN TRANSFORMATION
	NitrogenBiomass
COVER CLASS	SUB-VARIABLE SCORE
None	0
<1% (Trace)	0
1 – 4%	0
5 – 15%	1
16 – 25%	2
26 – 39%	3
40 – 60%	5
61 – 74%	7
75 – 84%	8
85 – 95%	9
> 95%	10

STRATA

Strata represents the degree of vertical layering within the AU.

	SCOPE	TYPE
DATA COLLECTION	Each Vegetated Sub-Unit	Field Observation
VARIABLE APPLICATION	Single Model	Sub-Variable Component of Composite Variable
SCORING	No Variation in Scoring	Numerical (Feature Count): 4 Classes (scored 1-3 relative to Sub-Unit Type)

All plant strata, with at least 5% areal cover, observed in the field are recorded in Section C-1a of the Data Sheet at each Vegetated Wetlands Sub-Unit. This variable is derived from a quantitative metric, field observations are counted and the corresponding class, based on Sub-Unit type, is selected (see table below).

Strata is used by only one function; it is utilized as a sub-variable component of *HabFeat* (a composite variable in the Wildlife Habitat Integrity model). *Strata* is scored from 1-3, scoring varies by Sub-Unit Type.

***Strata* Classes and Scores**	**FUNCTION**					
	WILDLIFE HABITAT INTEGRITY					
	HabFeat					
	SUB-VARIABLE SCORE					
	Emergent Sub-Unit		Scrub-Shrub Sub-Unit		Forested Sub-Unit	
One	Typical	2	Low	1	Low	1
Two	High	3	Typical	2	Low	1
Three	High	3	High	3	Typical	2
Four +	High	3	High	3	High	3

TOTALBA

TotalBA represents the volume of tree stems rooted in the AU (both live and standing dead).

	SCOPE	TYPE
DATA COLLECTION	Each Vegetated Sub-Unit (10x10m² plot)	Field Measurement
VARIABLE APPLICATION	Multiple Models	Sub-Variable Component of Composite Variables
SCORING	No Variation in Scoring	Numerical (Measurement): 12 Classes (scored 0-10)

The basal area of every tree (defined as woody plants 6m or taller, regardless of diameter) in a 10x10m² plot is measured in the field and recorded in Section C-2a of the Data Sheet at each Vegetated Wetland Sub-Unit. The total basal area of trees (including standing dead) is calculated and recorded in Section C-2b(2). This variable is derived from a quantitative metric, field measurements are recorded and the class which corresponds to the total basal area is selected (see table below).

TotalBA is utilized as a sub-variable component of *VelocityReduct* (a composite variable in the Particulate Retention, Surface Water Detention and Storm Surge Reduction models) and as a sub-variable component of *Retentionability* (a composite variable in the Nitrogen Transformation, Phosphorus Retention, Removal/Sequestration of Heavy Metals and Carbon Sequestration models). *TotalBA* value descriptors are the same for all functions and there is no variation in scoring between models. *TotalBA* is scored from 0-10.

***TotalBA* Classes and Scores**	**FUNCTION**	
	SURFACE WATER DETENTION STORM SURGE DETENTION PARTICULATE RETENTION	NITROGEN TRANSFORMATION PHOSPHORUS RETENTION REMOVAL OF HEAVY METALS CARBON SEQUESTRATION
	VelocityReduct	*Retentionability* (as component of sub-variable *VelocityReduct*)
BASAL AREA	SUB-VARIABLE SCORE	
No Trees	0	0
< 0.0250	0	0
0.0250 – 0.0749	1	1
0.0750 – 0.1249	2	2
0.1250 – 0.1749	3	3
0.1750 – 0.2249	4	4
0.2250 – 0.2749	5	5
0.2750 – 0.3249	6	6
0.3250 – 0.3749	7	7
0.3750 – 0.4249	8	8
0.4250 – 0.4749	9	9
≥ 0.4750	10	10

TREECOUNT

TreeCount represents the total number of tree stems rooted in the AU (both live and standing dead).

	SCOPE	TYPE
DATA COLLECTION	Each Vegetated Sub-Unit ($10x10m^2$ plot)	Field Measurement
VARIABLE APPLICATION	Multiple Models	Sub-Variable Component of Composite Variables
SCORING	No Variation in Scoring	Numerical (Feature Count): 7 Classes (scored 0-10)

The number of tree stems (defined as woody plants 6m or taller, regardless of diameter, both living and standing dead) in a $10x10m^2$ plot is counted in the field and recorded in Section C-2c of the Data Sheet at each Vegetated Wetland Sub-Unit. This variable is derived from a quantitative metric, field observations are counted and the class which corresponds to the total number of tree stems is selected (see table below).

TreeCount is utilized as a sub-variable component of *VelocityReduct* (a composite variable in the Particulate Retention, Surface Water Detention and Storm Surge Reduction models) and as a sub-variable component of *Retentionability* (a composite variable in the Nitrogen Transformation, Phosphorus Retention, Removal/Sequestration of Heavy Metals and Carbon Sequestration models). *TreeCount* value descriptors are the same for all functions and there is no variation in scoring between models. *TreeCount* is scored from 0-10.

***TreeCount* Classes and Scores**	**FUNCTION**	
	SURFACE WATER DETENTION STORM SURGE DETENTION PARTICULATE RETENTION	NITROGEN TRANSFORMATION PHOSPHORUS RETENTION REMOVAL OF HEAVY METALS CARBON SEQUESTRATION
	VelocityReduct	*Retentionability* (as component of sub-variable *VelocityReduct*)
COUNT CLASS	SUB-VARIABLE SCORE	
None	0	0
1 – 3	1	1
4 – 6	3	3
7 – 9	5	5
10 – 12	7	7
13 – 15	9	9
> 15	10	10

TREECOV

TreeCov represents the density of vegetation in the tree layer.

	SCOPE	TYPE
DATA COLLECTION	Each Vegetated Sub-Unit	Field Assessment
VARIABLE APPLICATION	Multiple Models	Sub-Variable Component of Composite Variables
SCORING	No Variation in Scoring	Numerical (Areal Cover): 11 Classes (scored 0-10)

Absolute cover of the tree layer (defined as all live woody plants 6m or taller, regardless of diameter) is estimated in the field and recorded in Section C-1b(4) of the Data Sheet at each Vegetated Wetland Sub-Unit. This variable is derived from a quantitative metric, areal cover estimations are recorded by cover class (see table below).

TreeCov is utilized as a sub-variable component of *NitrogenBiomass* (a composite variable in the Nitrogen Transformation model), *CarbonBiomass* (a composite variable in the Carbon Sequestration model), *ET* (a composite variable in the Streamflow Maintenance model), and *ExportBiomass* (a composite variable in the Production Export model). *TreeCov* value descriptors are the same for all functions and there is no variation in scoring between models. *TreeCov* is scored from 0-10.

***TreeCov* Classes and Scores**	**FUNCTION**			
	STREAMFLOW MAINTENANCE	NITROGEN TRANSFORMATION	CARBON SEQUESTRATION	PRODUCTION EXPORT
	ET	*NitrogenBiomass*	*CarbonBiomass*	*ExportBiomass*
COVER CLASS	SUB-VARIABLE SCORE			
None	0	0	0	0
<1% (Trace)	0	0	0	0
1 – 4%	0	0	0	0
5 – 15%	1	1	1	1
16 – 25%	2	2	2	2
26 – 39%	3	3	3	3
40 – 60%	5	5	5	5
61 – 74%	7	7	7	7
75 – 84%	8	8	8	8
85 – 95%	9	9	9	9
> 95%	10	10	10	10

UNDERSTORY

Understory represents the density of vegetation in the understory layer.

	SCOPE	TYPE
DATA COLLECTION	Each Vegetated Sub-Unit	Field Assessment
VARIABLE APPLICATION	Multiple Models	Sub-Variable Component of Composite Variables
SCORING	No Variation in Scoring	Numerical (Areal Cover): 11 Classes (scored 0-10)

Absolute cover of the understory layer (defined as all woody plants less than 6m in height and all non-woody plants, regardless of height, including mosses and aquatic bed plants) is estimated in the field and recorded in Section C-1b(3) of the Data Sheet at each Vegetated Wetland Sub-Unit. This variable is derived from a quantitative metric, areal cover estimations are recorded by cover class (see table below).

Understory is utilized as a sub-variable component of *NitrogenBiomass* (a composite variable in the Nitrogen Transformation model), *CarbonBiomass* (a composite variable in the Carbon Sequestration model), *ET* (a composite variable in the Streamflow Maintenance model), and *ExportBiomass* (a composite variable in the Production Export model), *VelocityReduct* (a composite variable in the Particulate Retention, Surface Water Detention and Storm Surge Reduction models) and as a sub-variable component of *Retentionability* (a composite variable in the Nitrogen Transformation, Phosphorus Retention, Removal/Sequestration of Heavy Metals and Carbon Sequestration models). *Understory* value descriptors are the same for all functions and there is no variation in scoring between models. *Understory* is scored from 0-10.

***Understory* Classes and Scores**	**FUNCTION**					
	SURF. WATER DETENTION STORM SURGE REDUCTION PARTICULATE. RETENTION	STREAM FLOW MAINT.	NITROGEN TRANSFORM.	CARBON SEQUEST.	NITROGEN PHOSPHORUS HEAVY METALS CARBON	PRODUCTION EXPORT
	VelocityReduct	*ET*	*NitrogenBiomass*	*CarbonBiomass*	*Retentionability* (as component of sub-variable *VelocityReduct*)	*ExportBiomass*
COVER CLASS	SUB-VARIABLE SCORE					
None	0	0	0	0	0	0
<1% (Trace)	0	0	0	0	0	0
1 – 4%	0	0	0	0	0	0
5 – 15%	1	1	1	1	1	1
16 – 25%	2	2	2	2	2	2
26 – 39%	3	3	3	3	3	3
40 – 60%	5	5	5	5	5	5
61 – 74%	7	7	7	7	7	7
75 – 84%	8	8	8	8	8	8
85 – 95%	9	9	9	9	9	9
> 95%	10	10	10	10	10	10

VEGCOV

VegCov represents the extent of vegetation cover of any type throughout the AU.

	SCOPE	TYPE
DATA COLLECTION	Each Vegetated Sub-Unit	Field Assessment
VARIABLE APPLICATION	Single Model	Stand-Alone Variable
SCORING	No Variation in Scoring	Numerical (Areal Cover): 11 Classes (scored 0-10)

Vegetation cover is assessed by identifying unvegetated patches (defined as areas with less than 5% vegetation cover, such as bare ground, rock outcrop or standing water) within each Vegetated Wetland Sub-Unit. The areal extent of unvegetated patches is estimated in the field and recorded in Section C-1b(5) of the Data Sheet at each Vegetated Wetland Sub-Unit. This variable is derived from a quantitative metric, unvegetated area is recorded by class and scored inversely from 0-10 to derive the *VegCov* value (see table below).

VegCov is used by only one function, it is utilized as a stand-alone variable in the Shoreline Stabilization model. *VegCov* is scored from 0-10.

VegCov **Classes and Scores**	**FUNCTION**
	SHORELINE STABILIZATION
UNVEGETATED CLASS	VARIABLE SCORE
None	10
<1% (Trace)	10
1 – 4%	10
5 – 15%	9
16 – 25%	8
26 – 39%	7
40 – 60%	5
61 – 74%	3
75 – 84%	2
85 – 95%	1
> 95%	0

WILDFEAT

WildFeat represents the presence and number of specialized wildlife habitat features within the AU.

	SCOPE	TYPE
DATA COLLECTION	Each Vegetated Sub-Unit	Field Observation
VARIABLE APPLICATION	Single Model	Sub-Variable Component of Composite Variable
SCORING	No Variation in Scoring	Numerical (Feature Count): 5 Classes (scored 0-4)

Observations of any of the listed habitat features in the field are recorded in Section C-4b of the Data Sheet at each Vegetated Wetlands Sub-Unit. This variable is derived from a quantitative metric, field observations are counted, and the corresponding count class is selected (see table below).

WildFeat is used by only one function, it is utilized as a sub-variable component of *HabFeat* (a composite variable in the Wildlife Habitat Integrity model). *WildFeat* is scored from 0-4.

***WildFeat* Classes and Scores**	**FUNCTION**
	WILDLIFE HABITAT INTEGRITY
	HabFeat
COUNT CLASS	SUB-VARIABLE SCORE
None	0
1 – 2	1
3 – 5	2
6 – 9	3
10 +	4

B. Variables Derived from Soil Examination Area Field Data

> These variables are derived from data collected at EACH Soil Examination Area (recorded in Part D of the Data Sheet). See Appendix F for detailed instructions on calculating SEA variables.

Organic

Organic represents the amount of organic material below the soil surface.

	SCOPE	TYPE
DATA COLLECTION	Each Soil Examination Area	Field Measurement
VARIABLE APPLICATION	Multiple Models	Stand-Alone Variable and Sub-Variable Component of Composite Variable
SCORING	Model-Specific Scoring	Quantitative – 6 Binned Classes (scored 0/1 or 1-10)

Organic layer thickness is measured in the field and recorded in Section D-2c of the Data Sheet at each Soil Examination Area. This variable is derived from a combination quantitative/categorical metric, the applicable organic layer thickness class is selected from four possible *Organic* attribute values and when there is no organic layer thicker than 4cm, the texture class of the uppermost mineral soil layer is selected as the attribute value (see table below).

Organic is utilized as a stand-alone variable in the Phosphorus Retention, Carbon Sequestration and Groundwater Recharge models. It is also a sub-variable component of *GWDischarge* (a composite variable in the Streamflow Maintenance model). *Organic* value descriptors are the same for all functions, but value ranking and scoring is model-specific (0-1 or 1-10).

***Organic* Classes and Scores**			**FUNCTION**			
			GROUNDWATER RECHARGE	PHOSPHORUS RETENTION	CARBON SEQUESTRATION	STREAMFLOW MAINTENANCE *GWDischarge*
THICKNESS	ORGANIC LAYER CLASS		VARIABLE SCORE			SUB-VARIABLE SCORE
> 130 cm	Deep Organic		10	1	10	10
41 – 130 cm	Shallow Organic		8	0	8	8
5 – 40 cm	Limited Organic		6	0	6	6
0 – 4 cm	TOP MINERAL LAYER	Mucky Mineral	2	0	4	2
		Loamy or Clayey	1	0	2	1
		Loamy Sand/Sandy	4	0	1	4

***P*OSITION**

Position represents the landscape context (geomorphic position or location) of the AU.

	SCOPE	TYPE
DATA COLLECTION	Each Soil Examination Area	Desktop Assessment and Field Observation
VARIABLE APPLICATION	Multiple Models	Stand-Alone Variable and Sub-Variable Component of Composite Variables
SCORING	Model-Specific Scoring	Categorical: 12 Ranked Values (scored 1-10)

Geomorphic position is evaluated remotely before the site visit and then confirmed in the field and recorded in Section D-1b of the Data Sheet at each Soil Examination Area. This variable is derived from a categorical metric, the most suitable descriptor is selected from the 12 possible *Position* attribute values (see table below).

Position is utilized as a stand-alone variable in the Particulate Retention, Surface Water Detention and Groundwater Recharge models. It is also utilized as a sub-variable component of *Retentionability* (a composite variable in the Nitrogen Transformation, Phosphorus Retention, Removal/Sequestration of Heavy Metals and Carbon Sequestration models) and a sub-variable component of *GWDischarge* (a composite variable in the Streamflow Maintenance model). *Position* value descriptors are the same for all functions, but value ranking and scoring is model-specific. *Position* is scored from 1-10.

Position **Values and Scores** (See Ch. 4A for definitions)	**FUNCTION**				
	Surface Water Detention	Groundwater Recharge	Particulate Retention	Streamflow Maintenance	Nitrogen Transformation Phosphorus Retention Removal of Heavy Metals Carbon Sequestration
				GWDischarge	*Retentionability*
VALUE	VARIABLE SCORE			SUB-VARIABLE SCORE	
Groundwater Slope	1	1	1	10	1
Surface Water Slope	1	2	1	1	1
Groundwater Flat	6	4	5	5	5
Surface Water Flat	6	8	5	1	5
Groundwater Depression	10	5	10	10	10
Surface Water Depression	10	10	10	1	10
River/Stream Fringe	1	8	1	9	1
River/Stream Floodplain	6	8	7	2	7
Marine Fringe	1	4	1	4	1
Estuarine Fringe	1	6	5	8	5
Fresh Water Tidal Fringe	1	6	5	9	5
Lake/Pond Fringe	2	10	2	10	2

SOILTEXT

SoilText represents the relative proportions of sand, silt, and clay in mineral soils and/or the degree of peat decomposition in organic soils.

	SCOPE	TYPE
DATA COLLECTION	Each Soil Examination Area	Field Assessment
VARIABLE APPLICATION	Multiple Models	Stand-Alone Variable
SCORING	Model-Specific Scoring	Categorical: 12 Ranked Values (scored 1-10)

The soil profile is documented in the field and recorded in Section D-2a of the Data Sheet at each Soil Examination Area. Mineral soil layer textures present are grouped by texture class and mucky modified soil textures are noted (see key in Chapter 4 and Appendix F) and recorded along with any organic soil layers in Section D-2b of the Data Sheet. This variable is derived from a categorical metric, ALL applicable soil texture classes present are selected from the 12 possible *SoilText* attribute values (see table below).

SoilText is utilized as a stand-alone variable in the Phosphorus Retention and Removal/ Sequestration of Heavy Metals models. *SoilText* value descriptors are the same for all functions, but value ranking and scoring is model-specific. *SoilText* is scored from 1-10.

***SoilText* Classes and Scores**	**FUNCTION**	
	PHOSPHORUS RETENTION	REMOVAL/SEQUESTRATION OF HEAVY METALS
VALUE	VARIABLE SCORE	
Fibric (Peat)	2	2
Hemic (Mucky Peat)	4	8
Sapric (Muck)	6	10
Clayey Textured	10	10
Fine-Textured Loamy	7	8
+ mucky modifier	8	9
Medium-Textured Loamy	5	5
+ mucky modifier	6	7
Coarse-Textured Loamy	3	3
+ mucky modifier	4	6
Loamy Sand/Sandy	1	1
+ mucky modifier	2	5

SURFICIALGEO

SurficialGeo represents the origin and composition of the unconsolidated deposits underlying the AU.

	SCOPE	TYPE
DATA COLLECTION	Each Soil Examination Area	Desktop Assessment and Field Observation
VARIABLE APPLICATION	Multiple Models	Stand-Alone Variable and Sub-Variable Component of Composite Variable
SCORING	No Variation in Scoring	Categorical: 14 Ranked Values (scored 1-10)

Surficial geology is evaluated remotely before the site visit and then confirmed in the field and recorded in Section D-1a of the Data Sheet at each Soil Examination Area. This variable is derived from a categorical metric, the most suitable descriptor is selected from the 14 possible *SurficialGeo* attribute values (see table below).

SurficialGeo is utilized as a stand-alone variable in the Groundwater Recharge model. It is also a sub-variable component of *GWDischarge* (a composite variable in the Streamflow Maintenance model). *SurficialGeo* value descriptors are the same for all functions and there is no variation in scoring between models. *SurficialGeo* is scored from 1-10.

SurficialGeo **Values and Scores** (See Ch. 4A for definitions)	**FUNCTION**	
	GROUNDWATER RECHARGE	STREAMFLOW MAINTENANCE
		GWDischarge
VALUE	VARIABLE SCORE	SUB-VARIABLE SCORE
Lodgment Till	2	2
Melt-Out Till	9	9
Mixed Glacial Materials	5	5
Stratified Coarse Materials	10	10
Stratified Fine Materials	1	1
Coarse-Grained Alluvium	10	10
Fine-Grained Alluvium	1	1
Colluvium	9	9
Dense Anthropogenic	2	2
Loose Anthropogenic	9	9
Shallow Bedrock	1	1
Coastal Sands	10	10
Inland Organic Materials	5	5
Tidally-Flooded Organic Materials	5	5

C. VARIABLES DERIVED FROM RESOURCE SPECIFIC FIELD DATA

BANKHERBCOV

BankHerbCov represents the density of herbaceous vegetation on the streambank (when present).

	SCOPE	TYPE
DATA COLLECTION	Resource Specific	Field Assessment
VARIABLE APPLICATION	Single Model	Stand-Alone Variable
SCORING	No Variation in Scoring	Numerical (Areal Cover): 11 Classes (scored 0-10)

Absolute cover of the herbaceous layer (defined as all non-woody plants, regardless of height, including mosses and aquatic bed plants) along the stream bank is estimated in the field and recorded in Section E-5b(1) of the Data Sheet when applicable. This variable is derived from a quantitative metric, areal cover estimations are recorded by cover class (see table below).

BankHerbCov is used by only one function, it is utilized as a stand-alone variable in the Bank Stabilization model. *BankHerbCov* is scored from 0-10.

	FUNCTION
***BankHerbCov* Classes and Scores**	BANK STABILIZATION
COVER CLASS	VARIABLE SCORE
None	0
<1% (Trace)	0
1 – 4%	0
5 – 15%	1
16 – 25%	2
26 – 39%	3
40 – 60%	5
61 – 74%	7
75 – 84%	8
85 – 95%	9
> 95%	10

BANKVEGCOV

BankVegCov represents the extent of vegetation cover of any type on the streambank (when present).

	SCOPE	TYPE
DATA COLLECTION	Resource Specific	Field Assessment
VARIABLE APPLICATION	Single Model	Stand-Alone Variable
SCORING	No Variation in Scoring	Numerical (Areal Cover): 11 Classes (scored 0-10)

Bank vegetation cover is assessed by identifying unvegetated patches (defined as areas with less than 5% vegetation cover, such as bare ground, rock outcrop or standing water) along the streambank. The areal extent of all unvegetated patches along the stream bank is estimated in the field and recorded in Section E-5b(2) of the Data Sheet when applicable. This variable is derived from a quantitative metric, unvegetated area is recorded by class and scored inversely from 0-10 to derive the *BankVegCov* value (see table below).

BankVegCov is used by only one function, it is utilized as a stand-alone variable in the Bank Stabilization model. *BankVegCov* is scored from 0-10.

	FUNCTION
***BankVegCov* Classes and Scores**	BANK STABILIZATION
UNVEGETATED CLASS	VARIABLE SCORE
None	10
<1% (Trace)	10
1 – 4%	10
5 – 15%	9
16 – 25%	8
26 – 39%	7
40 – 60%	5
61 – 74%	3
75 – 84%	2
85 – 95%	1
> 95%	0

D. VARIABLES DERIVED FROM OTHER FIELD DATA

ACTIVINTENSITY

ActivIntensity represents the presence and intensity of recent human activity in or near the AU.

	SCOPE	TYPE
DATA COLLECTION	Entire Assessment Unit	Field Observation
VARIABLE APPLICATION	Multiple Models	Sub-Variable Component of Composite Variable
SCORING	No Variation in Scoring	Categorical: 5 Ranked Classes (scored 1-10)

The presence and intensity of each listed activity occurring in or within 100m of the AU is assessed in the field and recorded in Sections F-1a(1) and F-1b(1) of the Data Sheet using the intensity scale. This variable is derived from a categorical metric, the most suitable descriptor is selected from the 5 possible *ActivIntensity* attribute values (see table below).

ActivIntensity is utilized as a sub-variable component of *HumanActivity* (a composite variable in the Plant Community Integrity and Wildlife Habitat Integrity models). *ActivIntensity* value descriptors are the same for all functions and there is no variation in scoring between models. *ActivIntensity* is scored from 1-10.

		FUNCTION	
***ActivIntensity* Scale and Scores**		PLANT COMMUNITY INTEGRITY	WILDLIFE HABITAT INTEGRITY
		HumanActivity	
RATING	DESCRIPTION	SUB-VARIABLE SCORE	
None	None observed	10	10
A	Activity present, but no evidence of impacts	8	8
B	Slight impact evident	5	5
C	Significant impact evident	3	3
D	Severe impact evident	1	1

ACTIVPROPORTION

ActivProportion represents the proportion of the AU impacted by recent human activity.

	SCOPE	TYPE
DATA COLLECTION	Entire Assessment Unit	Field Assessment
VARIABLE APPLICATION	Multiple Models	Sub-Variable Component of Composite Variable
SCORING	No Variation in Scoring	Numerical (Proportion): 6 Classes (scored 1-10)

The proportion of the assessment unit impacted by each activity observed in or within 100m of the AU is estimated in the field and recorded in Sections F-1a(2) and F-1b(2) of the Data Sheet. This variable is derived from a quantitative metric, site proportion estimates are recorded by selecting the most suitable class (see table below).

ActivProportion is utilized as a sub-variable component of *HumanActivity* (a composite variable in the Plant Community Integrity and Wildlife Habitat Integrity models). *ActivProportion* value descriptors are the same for all functions and there is no variation in scoring between models. *ActivProportion* is scored from 1-10.

	FUNCTION	
***ActivProportion* Classes and Scores**	PLANT COMMUNITY INTEGRITY	WILDLIFE HABITAT INTEGRITY
	HumanActivity	
PROPORTION CLASS	SUB-VARIABLE SCORE	
None Present	10	10
< 10%	9	9
10 – 33%	7	7
34 – 66%	5	5
67 – 90%	3	3
> 90%	1	1

FLOWRESTRICT

FlowRestrict represents the presence and characteristics of features which slow or restrict the passage of surface water through the AU.

	SCOPE	TYPE
DATA COLLECTION	Entire Assessment Unit	Field Observation
VARIABLE APPLICATION	Multiple Models	Stand-Alone Variable and Sub-Variable Component of Composite Variable
SCORING	Model-Specific Scoring	Categorical (Presence/Absence): 24 Features (scored 1-10)

The presence and characteristics of any features observed in the field which might restrict the passage of water through the AU (whether at the outlet or internal) are recorded in Section E-1 of the Data Sheet. This variable is derived from a categorical metric, ALL applicable descriptors are selected from the 23 possible *FlowRestrict* attribute values and documented (see table below).

FlowRestrict is utilized as a stand-alone variable in the Particulate Retention, Surface Water Detention and Production Export models. It is also a sub-variable component of *Retentionability* (a composite variable in the Nitrogen Transformation, Phosphorus Retention, Removal/Sequestration of Heavy Metals and Carbon Sequestration). *FlowRestrict* value descriptors are the same for all functions, but value ranking and scoring is model-specific (0-10 or 1-10).

FlowRestrict **Values and Scores**	**FUNCTION**			
	SURFACE WATER DETENTION	PARTICULATE RETENTION	PRODUCTION EXPORT	NITRO. TRANSFORMATION PHOSPHORUS RETENTION REMOVAL OF HEAVY METALS CARBON SEQUESTRATION
				Retentionability
VALUE	VARIABLE SCORE			SUB-VARIABLE SCORE
Open Exchange – Tidal	2	2	9	2
Open Exchange – Non-Tidal	1	1	10	1
Channel Present – Unrestricted	1	1	10	1
Human/Beaver Constructed Dam Present	9	9	1	9
Channel Restricted by Debris Jam (< 25%)	2	3	8	3
Channel Restricted by Debris Jam (25-50%)	4	5	6	5
Channel Restricted by Debris Jam (50-75%)	6	7	5	7
Channel Restricted by Debris Jam (>75%)	8	9	3	9
Channel Width Narrowed (< 25%)	1	2	9	2
Channel Width Narrowed (25-50%)	2	3	7	3
Channel Width Narrowed (50-75%)	3	4	6	4
Channel Width Narrowed (>75%)	5	6	4	6
Functional Culvert >75% of Channel Width	2	2	9	2
Functional Culvert 50-75% of Channel Width	4	4	7	4
Functional Culvert 25-50% of Channel Width	6	6	6	6
Functional Culvert < 25% of Channel Width	8	8	4	8
Culvert Partially Blocked by Debris	5	5	5	5
Culvert Totally Blocked by Debris	10	10	0	10
Culvert Located too High Above Flow	10	10	0	10
Tide Gate/Weir - Operational	5	5	5	5
Tide Gate/Weir - Non-operational (Open)	2	2	9	2
Tide Gate/Weir - Non-operational (Closed)	10	10	0	10
Closed System	10	10	0	10

HYDROCONNECT

HydroConnect represents the degree of hydrologic connectivity between the AU and other aquatic systems.

	SCOPE	TYPE
DATA COLLECTION	Entire Assessment Unit	Field Observation
VARIABLE APPLICATION	Single Model	Stand-Alone Variable
SCORING	No Variation	Categorical (Presence/Absence): 20 Features (scored 0-10)

The presence and characteristics of any hydrologic connections between the assessment unit and other aquatic systems observed in the field are recorded in Section E-2 of the Data Sheet. This variable is derived from a categorical metric, ALL applicable descriptors are selected from the 20 possible *HydroConnect* attribute values and documented (see table below).

HydroConnect is used by only one function, it is utilized as a stand-alone variable in the Production Export model. *HydroConnect* is scored from 0-10.

	FUNCTION
***HydroConnect* Values and Scores**	PRODUCTION EXPORT
VALUE	VARIABLE SCORE
Contiguous with Ocean/Bay	10
Contiguous with Estuary	10
Contiguous with Tidal Creek	10
Contiguous with River	10
Contiguous with Stream	7
Contiguous with Lake	5
Contiguous with Pond	1
Inlet Channel (Perennial)	0
Inlet Channel (Intermittent)	0
Inlet Channel (Periodic)	0
Outlet Channel (Perennial)	10
Outlet Channel (Intermittent)	7
Outlet Channel (Periodic)	4
No Surface Channels	0
Tidal Restricted	10
Tidal Unrestricted	10
Overbank Flooding In	0
Overbank Flooding Out	4
Overland Flow In	0
Overland Flow Out	4
No Hydrologic Connections	0

STRESSINTENSITY

StressIntensity represents the presence and intensity of plant community stressors in or near the AU.

	SCOPE	TYPE
DATA COLLECTION	Entire Assessment Unit	Field Observation
VARIABLE APPLICATION	Single Model	Sub-Variable Component of Composite Variable
SCORING	No Variation	Categorical: 5 Ranked Classes (scored 1-10)

The presence and intensity of each listed stressor occurring in or within 100m of the AU is assessed in the field and recorded in Section F-2(1) of the Data Sheet using the intensity scale. This variable is derived from a categorical metric, the most suitable descriptor is selected from the 5 possible *StressIntensity* attribute values (see table below).

StressIntensity is used by only one function, it is utilized as a sub-variable component of *PlantStress* (a composite variable in the Plant Community Integrity model). *StressIntensity* is scored from 1-10.

		FUNCTION
***StressIntensity* Scale and Scores**		PLANT COMMUNITY INTEGRITY
		PlantStress
RATING	DESCRIPTION	SUB-VARIABLE SCORE
None	None observed	10
A	Stressor present, but no evidence of impacts	8
B	Slight impact evident	5
C	Significant impact evident	3
D	Severe impact evident	1

STRESSPROPORTION

StressProportion represents the proportion of the AU impacted by plant community stressors.

	SCOPE	TYPE
DATA COLLECTION	Entire Assessment Unit	Field Assessment
VARIABLE APPLICATION	Single Model	Sub-Variable Component of Composite Variable
SCORING	No Variation	Numerical (Proportion): 6 Classes (scored 1-10)

The proportion of the assessment unit impacted by each plant community stressor observed in or within 100m of the AU is estimated in the field and recorded in Section F-2(2) of the Data Sheet This variable is derived from a quantitative metric, site proportion estimates are recorded by selecting the most appropriate class (see table below).

StressProportion is used by only one function, it is utilized as a sub-variable component of *PlantStress* (a composite variable in the Plant Community Integrity model). *StressProportion* is scored from 1-10.

***StressProportion* Classes and Scores**	**FUNCTION**
	PLANT COMMUNITY INTEGRITY
	PlantStress
PROPORTION CLASS	SUB-VARIABLE SCORE
None Present	10
< 9%	10
10 – 33%	8
34 – 66%	5
67 – 90%	3
> 90%	1

E. VARIABLES DERIVED FROM DESKTOP DATA

AUSIZE

AUSize represents the size of the assessment unit.

	SCOPE	TYPE
DATA COLLECTION	Entire Assessment Unit	GIS Calculation
VARIABLE APPLICATION	Single Model	Stand-Alone Variable
SCORING	No Variation in Scoring	Numerical (Measurement): 7 Classes (scored 1-10)

The initial AU boundary is evaluated remotely and then confirmed or modified during the site visit. After the AU boundary has been finalized, the size of the assessment unit is calculated using GIS in the office and recorded in Section G-1a of the Data Sheet. This variable is derived from a quantitative metric, area calculations are recorded in hectare(s) and the applicable size class is selected (see table below).

AUSize is used by only one function, it is utilized as a stand-alone variable in the Surface Water Detention model. *AUSize* is scored from 1-10.

	FUNCTION
***AUSize* Classes and Scores**	SURFACE WATER DETENTION
SIZE CLASS	VARIABLE SCORE
< 0.25 hectare	1
0.25 to < 2 hectare(s)	2
2 to < 4 hectares	4
4 to < 8 hectares	6
8 to < 20 hectares	8
20 to < 40 hectares	9
≥ 40 hectares	10

BUFFINTACT

BuffIntact represents the percent of the AU perimeter with adjacent intact buffer.

	SCOPE	TYPE
DATA COLLECTION	Entire Assessment Unit	GIS/Desktop Assessment
VARIABLE APPLICATION	Multiple Models	Sub-Variable Component of Composite Variable
SCORING	No Variation in Scoring	Numerical (Measurement): 12 Classes (scored 1-10)

Areas of intact buffer immediately adjacent to the assessment unit are identified using aerial photography in the office after the AU boundary has been finalized. Intact buffer (defined as undisturbed area, at least 10m wide, of any habitat type including open water) is calculated using GIS as a percentage of the total perimeter length and recorded in Section G-4b of the Data Sheet. This variable is derived from a quantitative metric, the percentage of intact buffer is recorded, and the applicable class is selected (see table below).

BuffIntact is utilized as a sub-variable component of *Buffer* (a composite variable in the Plant Community Integrity and Wildlife Habitat Integrity models). *BuffIntact* value descriptors are the same for all functions and there is no variation in scoring between models. *BuffIntact* is scored from 0-10.

***BuffIntact* Classes and Scores**	**FUNCTION**	
	PLANT COMMUNITY INTEGRITY	WILDLIFE HABITAT INTEGRITY
	Buffer	
PERCENTAGE	SUB-VARIABLE SCORE	
None	0	0
1 – 4%	0	0
5 – 14%	1	1
15 – 24%	2	2
25 – 34%	3	3
35 – 44%	4	4
45 – 54%	5	5
55 – 64%	6	6
65 – 74%	7	7
75 – 84%	8	8
85 – 94%	9	9
≥ 95%	10	10

BUFFWIDTH

BuffWidth represents the average width of any adjacent undisturbed buffer.

	SCOPE	TYPE
DATA COLLECTION	Entire Assessment Unit	GIS/Desktop Measurement
VARIABLE APPLICATION	Multiple Models	Sub-Variable Component of Composite Variable
SCORING	No Variation in Scoring	Numerical (Measurement): 12 Classes (scored 0-10)

Adjacent buffer width is measured along 8 equally spaced transects (up to a maximum of 100 meters) in the office using GIS after the AU boundary has been finalized. This variable is derived from a quantitative metric, average buffer width is calculated and recorded in Section G-4d of the Data Sheet and the applicable width class is selected (see table below).

BuffWidth is utilized as a sub-variable component of *Buffer* (a composite variable in the Plant Community Integrity and Wildlife Habitat Integrity models). *BuffWidth* value descriptors are the same for all functions and there is no variation in scoring between models. *BuffWidth* is scored on a scale from 0-10.

	FUNCTION	
***BuffWidth* Values and Scores**	PLANT COMMUNITY INTEGRITY	WILDLIFE HABITAT INTEGRITY
	Buffer	
WIDTH CLASS	SUB-VARIABLE SCORE	
None	0	0
1 – 4m	0	0
5 – 14m	1	1
15 – 24m	2	2
25 – 34m	3	3
35 – 44m	4	4
45 – 54m	5	5
55 – 64m	6	6
65 – 74m	7	7
75 – 84m	8	8
85 – 94m	9	9
≥ 95m	10	10

CORRIDOR

Corridor represents the degree of connectivity between the AU and other undisturbed habitat.

	SCOPE	TYPE
DATA COLLECTION	Entire Assessment Unit	GIS/Desktop Assessment
VARIABLE APPLICATION	Single Model	Stand-Alone Variable
SCORING	No Variation in Scoring	Numerical (Feature Count): 3 Classes (scored 0-10)

Any corridors (minimum 5m wide) connecting the assessment unit to undisturbed habitat blocks (minimum size of 2.5 hectares) are identified in the office using aerial photography after the AU boundary has been finalized. Habitat blocks may be any type including, non-wetland. This variable is derived from a quantitative metric, the number of connecting corridors is recorded in Section G-5b of the Data Sheet and the applicable class is selected (see table below).

Corridor is used by only one function; it is utilized as a stand-alone variable in the Wildlife Habitat Integrity model. *Corridor* is scored from 0-10.

	FUNCTION
***Corridor* Values and Scores**	WILDLIFE HABITAT INTEGRITY
NUMBER OF CORRIDORS	VARIABLE SCORE
None	0
One	7
Two or more	10

HABPROX

HabProx represents the proximity of the nearest similar wetland habitat.

	SCOPE	TYPE
DATA COLLECTION	Entire Assessment Unit	GIS/Desktop Measurement
VARIABLE APPLICATION	Single Model	Stand-Alone Variable
SCORING	No Variation in Scoring	Numerical (Measurement): 5 Classes (scored 1-10)

Nearby wetland areas that are the same dominant type and at least 0.25 hectare in area are identified in the office using aerial photography after the AU boundary has been finalized. The distance in a straight line between the AU boundary and the nearest edge of the other wetland(s) is calculated using GIS and the shortest distance is recorded in Section G-5a of the Data Sheet. This variable is derived from a quantitative metric, the distance calculation is recorded, and the applicable proximity class is selected (see table below).

HabProx is used by only one function, it is utilized as a stand-alone variable in the Wildlife Habitat Integrity model. *HabProx* is scored on a scale from 1-10.

	FUNCTION
***HabProx* Values and Scores**	WILDLIFE HABITAT INTEGRITY
DISTANCE CLASS	VARIABLE SCORE
< 100 meters	10
100 to < 200 meters	8
200 to < 300 meters	5
300 to < 500 meters	3
≥ 500 meters	1

LULCAREA

LULCArea represents the area within the adjacent land use zone classified as each LULC class.

	SCOPE	TYPE
DATA COLLECTION	Entire Assessment Unit	GIS/Desktop Calculation
VARIABLE APPLICATION	Single Model	Sub-Variable Component of Composite Variable
SCORING	No Variation in Scoring	Numerical (Measurement): Area in hectares

The land use zone (area within 500m of the AU) is classified by LULC class, using the classification in the National Land Cover Dataset (NLCD). The area occupied by each of the 16 LULC classes is calculated in the office using GIS after the AU boundary has been finalized and recorded in Section G-6b(2) of the Data Sheet. This variable is derived from a quantitative metric, area calculations are recorded in hectare(s).

LULCArea is used by only one function, it is utilized as a sub-variable component of *LandCov* (a composite variable in the Wildlife Habitat Integrity model). *LULCArea* is not scored, values are equivalent to the area calculations.

LULCZONE

LULCZone represents the area within 500m of the AU in which land use is evaluated.

	SCOPE	TYPE
DATA COLLECTION	Entire Assessment Unit	GIS/Desktop Calculation
VARIABLE APPLICATION	Single Model	Sub-Variable Component of Composite Variable
SCORING	No Variation in Scoring	Numerical (Measurement): Area in hectares

The area within 500m of the AU is calculated using GIS in the office after the AU boundary has been finalized and recorded in Section G-6a of the Data Sheet. This variable is derived from a quantitative metric, the area measurement is recorded in hectares.

LULCZone is used by only one function, it is utilized as a sub-variable component of *LandCov* (a composite variable in the Wildlife Habitat Integrity model). *LULCZone* is not scored, the value is equivalent to the area calculation.

LULCWeight

LULCWeight represents the relative impact of each LULC type.

	SCOPE	TYPE
DATA COLLECTION		
VARIABLE APPLICATION	Single Model	Sub-Variable Component of Composite Variable
SCORING	No Variation in Scoring	Categorical: 16 Ranked Classes (scored 0-10)

Relative impact coefficients are assigned to each LULC class (using the classification in the National Land Cover Dataset (NLCD)) to represent the effect of that land use class on wildlife habitat integrity. The relative effect coefficients are pre-recorded in Section G-6b(4) of the Data Sheet. This variable is derived from a categorical metric, there are 16 LULC classes, with coefficients between 0 and 10 (see table below).

LULCWeight is used by only one function, it is utilized as a sub-variable component of *LandCov* (a composite variable in the Wildlife Habitat Integrity model). Scoring for *LULCWeight* is from 0-10.

		FUNCTION
***LULCWeight* Values and Scores**		WILDLIFE HABITAT INTEGRITY
		LandCov
CODE	LAND USE TYPE	SUB-VARIABLE SCORE
11	Open Water	10
12	Perennial Ice/Snow	10
21	Developed, Open Space	3
22	Developed, Low Intensity	2
23	Developed, Med Intensity	1
24	Developed, High Intensity	0
31	Barren (Rock/Sand/Clay)	7
41	Deciduous Forest	10
42	Evergreen Forest	10
43	Mixed Forest	10
52	Scrub Shrub	10
71	Grassland/Herbaceous	10
81	Pasture/Hay	6
82	Cultivated Crops	3
91	Woody Wetlands	10
95	Emergent Wetlands	10

<u>SYSTOTAL</u>

SysTotal represents the area of entire wetland system (including but not limited to the AU).

	SCOPE	TYPE
DATA COLLECTION	Entire Assessment Unit	GIS Calculation
VARIABLE APPLICATION	Single Model	Sub-Variable Component of Composite Variable
SCORING	No Variation in Scoring	Numerical (Measurement): 7 Classes (scored 1-10)

The area of the entire wetland system (including but not limited to the assessment unit) is calculated using GIS in the office after the site visit and recorded in Section G-1b of the Data Sheet. This variable is derived from a quantitative metric, area calculations are recorded in hectare(s) and the applicable area class is selected (see table below).

SysTotal is used by only one function, it is utilized as a sub-variable component of *Detention* (a composite variable in the Storm Surge Detention model). *SysTotal* is scored from 1-10.

	FUNCTION
***SysTotal* Classes and Scores**	STORM SURGE REDUCTION
	Detention
AREA CLASS	SUB-VARIABLE SCORE
< 0.25 hectare	1
0.25 to < 2 hectare(s)	2
2 to < 4 hectares	4
4 to < 8 hectares	6
8 to < 20 hectares	8
20 to < 40 hectares	9
≥ 40 hectares	10

WETWIDTH

WetWidth represents the average width of the wetland system (including but not limited to the AU) as measured from the shoreline (when applicable).

	SCOPE	TYPE
DATA COLLECTION	Resource Specific	GIS/Desktop Measurement
VARIABLE APPLICATION	Multiple Models	Stand-Alone Variable and Sub-Variable Component of Composite Variable
SCORING	Model-Specific Scoring	Numerical (Measurement): 6 Classes (scored 0-10)

The width of the wetland is measured along transects using GIS in the office after the AU boundary has been finalized. The distance between the shoreline and the landward wetland edge is recorded in Section G-7b of the Data Sheet for each transect (spaced every 100m perpendicular to the shoreline). This variable is derived from a quantitative metric, average wetland width is calculated and recorded in Section G-7c of the Data Sheet and the applicable width class is selected (see table below).

WetWidth is utilized as a stand-alone variable in the Shoreline Stabilization model. It is also a sub-variable component of *Detention* (a composite variable in the Storm Surge Reduction model). *WetWidth* value descriptors, ranking and scoring are model-specific. *WetWidth* is scored from 0-10.

***WetWidth* Values and Scores**	**FUNCTION**			
	SHORELINE STABILIZATION		STORM SURGE DETENTION *Detention*	
	VARIABLE SCORE		SUB-VARIABLE SCORE	
	CLASS DESCRIPTION	SCORE	CLASS DESCRIPTION	SCORE
	< 5 meter(s)	0	< 10 meter(s)	0
	5 to < 10 meters	2	10 to < 20 meters	2
	10 to < 15 meters	4	20 to < 30 meters	4
	15 to < 20 meters	6	30 to < 40 meters	6
	20 to < 25 meters	8	40 to < 50 meters	8
	≥ 25 meters	10	≥ 50 meters	10

F. Simple Variable List and Definitions

ACTIVINTENSITY	intensity of human activity occurring in or within 100m of the AU within the last 2 years.
ACTIVPROPORTION	estimate of the proportion of the AU impacted by human activity occurring in or within 100m of the AU within the last 2 years.
AUSIZE	size (in hectares) of the assessment unit.
BANKHERBCOV	estimate of the areal cover of herbaceous vegetation (defined as all non-woody plants including mosses and aquatic bed plants) on the streambank (when applicable).
BANKVEGCOV	estimate of the extent of vegetation cover of any type on the streambank (when applicable).
BUFFINTACT	estimate of the percent of the AU perimeter with adjacent intact buffer at least 10m wide intact buffer.
BUFFWIDTH	average width of any adjacent undisturbed buffer.
CORRIDOR	number of corridors (at least 5m wide) between the AU and undisturbed habitat (at least 2.5 hectares) of any type including non-wetland.
FLOWRESTRICT	presence and characteristics of any features which slow or restrict the passage of surface water through the AU.
HABPROX	distance to the nearest similar wetland habitat (at least 0.25 hectare).
HERBCOV	estimate of the areal cover of vegetation in the herbaceous layer (defined as all non-woody plants including mosses and aquatic bed plants).
HETEROGENEITY	presence and type of microhabitats (defined as areas at least $4m^2$ which are contained within a sub-unit but are of a different type) as a measure of horizontal complexity.
HYDROCONNECT	presence and characteristics of hydrologic connections between the AU and other aquatic systems.
INVASIVES	estimate of the areal cover of invasive and/or aggressive plant species within the AU.
LIVEBA	estimate of the total cross-sectional area of live trees rooted in the AU.
LULCAREA	area within the adjacent land use zone classified as each LULC type.
LULCWEIGHT	relative impact coefficient assigned to each LULC type.
LULCZONE	area within 500m of the AU in which land use is evaluated.
MICROFEAT	estimate of the density of microtopographic features which contribute to the roughness of the AU.
ORGANIC	estimate of the amount of organic material below the soil surface.
POSITION	landscape context (geomorphic position or location) of the AU.

SHRUBCOV	estimate of the areal cover of vegetation in the shrubaceous layer (defined as all woody plants less than 6m in height)
SOILTEXT	relative proportions of sand, silt, and clay in mineral soils and/or the degree of peat decomposition in organic soils.
STRATA	number of plant strata present within the AU relative to the number of strata typical for that wetland type as a measure of vertical structural complexity.
STRESSINTENSITY	intensity of disturbance resulting from plant community stressors located in or within 100m of the AU.
STRESSPROPORTION	estimate of the proportion of the AU impacted by plant community stressors located in or within 100m of the AU.
SURFICIALGEO	origin and composition of the unconsolidated deposits underlying the AU as a measure of permeability and hydraulic conductivity
SYSTOTAL	area of the entire wetland system (including but not limited to the assessment unit).
TOTALBA	estimate of the total cross-sectional area of trees (both live and standing dead) rooted in the AU.
TREECOUNT	estimate of the total number of tree stems (both live and standing dead) rooted in the AU.
TREECOV	estimate of the areal cover of vegetation in the tree layer (defined as all woody plants at least 6m tall).
UNDERSTORY	estimate of the areal cover of vegetation in the understory layer (defined as all woody plants less than 6m in height and all non-woody plants including mosses and aquatic bed plants).
VEGCOV	estimate of the extent of vegetation cover of any type throughout the AU.
WETWIDTH	average width of the wetland system measured along transects perpendicular to the shoreline (when applicable).
WILDFEAT	presence and number of specialized wildlife habitat features in the AU.

G. Summary of Simple Variables

Data Collection Type and Scope

DATA COLLECTION	Field Observation	Field Assessment	Field Measurement	Desktop Assessment	Desktop Measurement	Desktop Calculation
Each Soil Examination Area	*Position* *SurficialGeo*	*SoilText*	*Organic*	*Position* *SurficialGeo*		
Each Vegetated Wetland Sub-Unit	*Strata* *Heterogeneity* *WildFeat*	*HerbCov* *ShrubCov* *Understory* *TreeCov* *Invasives* *VegCov*	*MicroFeat* *TreeCount* *TotalBA* *LiveBA*			
Resource Specific		*BankHerbCov* *BankVegCov*			*WetWidth*	
Entire Assessment Unit	*HydroConnect* *FlowRestrict* *ActivIntensity* *StressIntensity*	*ActivProportion* *StressProportion*		*Corridors* *BuffIntact*	*HabProx* *BuffIntact* *BuffWidth*	*AUSize* *SysTotal* *LULCArea* *LULCZone*

Data Type

VARIABLE TYPE	Attribute Type	Values	Examples		
Ordinal Data	Areal Cover	Cover Class	*HerbCov* *ShrubCov* *Understory*	*TreeCov* *Invasives* *VegCov*	*BankHerbCov* *BankVegCov*
		Proportion	*ActivProportion*	*StressProportion*	
	Feature Count	Total Count	*Corridor* *WildFeat*	*Strata* *Heterogeneity*	
		Count Per Unit	*Microfeatures*	*TreeCount*	
	Measurement	Size/Area	*LULCArea* *LULCZone*	*AUSize* *SysTotal*	
		Distance/Width	*BuffWidth*	*WetWidth*	*HabProx*
		Depth	*Organic*		
		Basal Area	*TotalBA*	*LiveBA*	
		Percent of Total	*BuffIntact*		
Nominal Data	Ranked Values	Categories or Classes	*Position* *SurficialGeo*	*SoilText* *LULCWeight*	*ActivIntensity* *StressIntensity*
	Presence/ Absence	Features	*HydroConnect*	*FlowRestrict*	

Variable Application Type and Scope

VARIABLE TYPE	Single Model	Multiple Models (no change in scoring)	Multiple Models (model-specific scoring)
Stand-Alone Variable Only	*AUSize*, *Corridor*, *HabProx*, *VegCov*, *BankHerbCov*, *BankVegCov*, *HydroConnect*, *Invasives*		*SoilText*
Both Stand-Alone and Sub-Variable		*HerbCov*, *SurficialGeo*	*Position*, *Organic*, *FlowRestrict*, *WetWidth*
Sub-Variable Component Only	*Strata*, *WildFeat*, *LiveBA*, *LULCArea*, *LULCZone*, *Heterogeneity*, *SysTotal*, *StressProportion*, *StressIntensity*, *ShrubCov*	*MicroFeat*, *TreeCov*, *Understory*, *BuffIntact*, *BuffWidth*, *ActivProportion*, *ActivIntensity*, *TreeCount*, *TotalBA*	

Variable Scoring

SCORING SCALE	Ordinal Data	Nominal Data
0 – 10	*HerbCov*, *ShrubCov*, *Understory*, *TreeCov*, *Invasives*, *TreeCount*, *MicroFeat*, *TotalBA*, *LiveBA*, *BankHerbCov*, *BankVegCov*, *VegCov*, *Corridor*, *BuffIntact*, *BuffWidth*	*HydroConnect*, *LULCWeight*
1 – 10	*ActivProportion*, *StressProportion*, *HabProx*, *AUSize*, *SysTotal*, *WetWidth*	*SurficialGeo*, *Position*, *SoilText*, *FlowRestrict*, *ActivIntensity*, *StressIntensity*

Variables with irregular scoring:

SCALE LESS THAN 10		SCALE VARIES BY MODEL			NOT SCORED
Heterogeneity	0-3	*Organic*	Phosphorus Retention	0-1	*LULCArea*
Strata	1-3		Groundwater Recharge Carbon Sequestration Streamflow Maintenance	1-10	*LULCZone*
WildFeat	0-4				

3 - Composite Variables

A. Description and Calculation of Composite Variables

Buffer

Represents the presence and integrity of undisturbed buffer adjacent to the AU. *Buffer* is a composite variable calculated by combining the sub-variables *BuffIntact* and *BuffWidth* in the following equation:

$$Buffer = \frac{2(BuffIntact) + BuffWidth}{3}$$

Description: Undisturbed adjacent buffer provides physical protection to the plant and wildlife communities in the AU. The integrity of the buffer is described by the relationship between the percentage of the AU that has adjacent intact buffer and the average width of the buffer. Intact buffer is defined as undisturbed area, composed of any habitat type including open water. A wetland that is fully surrounded by buffer that is at least 10m wide will be more protected than one that is only partially surrounded even if the buffer itself is wider.

Sub-Variables: *BuffIntact* is an estimate of the percent of the AU perimeter with at least 10m wide adjacent intact buffer. *BuffWidth* is a measure of the average width of the adjacent buffer. *BuffIntact* is weighted more heavily than *BuffWidth* in the equation for *Buffer*.

Scoring: The equation for *Buffer* generates a value between 0 and 10. The score for *Buffer* = 0 if the assessment unit has less than 5% intact buffer OR the average buffer width is less than 5m.

Application: *Buffer* is utilized as a stand-alone variable in the Plant Community Integrity and Wildlife Habitat Integrity models.

CarbonBiomass

Represents the amount of living biomass storing biological carbon in the AU. *CarbonBiomass* is a composite variable calculated by combining the sub-variables *TreeCov*, *LiveBA* and *Understory* in the following equation:

$$CarbonBiomass = \frac{3(TreeCov) + 2(LiveBA) + Understory}{6}$$

Description: Biological carbon is stored in living vegetation before transferring to the soil within the system as plants die and decay. The amount of biomass available for carbon storage is estimated from the density of vegetation in the wetland. Detritus originating from the canopy and sub-canopy provide the greatest source of plant matter for long-term carbon storage. Carbon stored within tree stems (estimated by basal area) contributes slightly less, and the vegetation in the understory layer contains the least amount of carbon.

Sub-Variables: *TreeCov* is an estimate of the areal cover of vegetation in the tree layer (defined as all live woody plants 6m or taller, regardless of diameter) and is weighted highest of the three sub-variables. *LiveBA* is an estimate of the cross-sectional area of those trees and is weighted slightly lower. *Understory* is an estimate of the areal coverage of vegetation in the understory layer (defined as all woody plants less than 6m in height and all non-woody plants, regardless of height, including mosses and aquatic bed plants) and is weighted the lowest of the three sub-variables.

Scoring: The equation for *CarbonBiomass* generates a value between 0 and 10. The score for *CarbonBiomass* = 0 if the sub-unit has less than 5% tree cover AND the total basal area of live trees is less than 0.0250 AND less than 5% understory cover. *CarbonBiomass* is calculated for EACH Vegetated Wetland Sub-Unit and then weighted by Sub-Unit Area to calculate the variable score. See Appendix E for detailed instructions on weighting Sub-Unit variable calculations.

Application: *CarbonBiomass* is used by only one function, it is utilized as a stand-alone variable in the Carbon Sequestration model.

DETENTION

Represents the capacity of the system to detain water during a storm surge event. *Detention* is a composite variable calculated by combining the sub-variables *WetWidth* and *SysTotal* in the following equation:

$$Detention = \frac{2(WetWidth) + SysTotal}{3}$$

Description: The quantity of surface water that can be temporarily stored within a system, or holding capacity, is a volumetric measure. Because depth is hard to measure accurately during a rapid assessment, wetland area alone (measured in hectares) is used as a proxy for volume. In addition, a wider wetland system will better promote storm surge reduction than a narrow system with the same total area. As distance traveled from the shoreline increases, the additional surface area adds frictional resistance, further dissipating the energy of the incoming storm surge.

Sub-Variables: *WetWidth* and *SysTotal* are variables derived from measures of the entire wetland system (including but not limited to the AU). *WetWidth* is average width of the wetland as measured from the shoreline to the landward wetland edge along transects spaced every 100 meters. *SysTotal* is the area of entire wetland system and is weighted lower than *WetWidth*.

Scoring: The equation for *Detention* generates a value between 0 and 10. The score for *Detention* = 0 if the average width of the wetland system is less than 10 meters.

Application: *Detention* is used by only one function; it is utilized as a stand-alone variable in the Storm Surge Reduction model.

ET

Represents the loss of groundwater that is absorbed by plants through their roots and exits the system as transpiration and/or evaporation. *ET* is a composite variable calculated by combining the sub-variables *TreeCov* and *Understory* in the following equation:

$$ET = \frac{2(TreeCov) + Understory}{3}$$

Description: Evapotranspiration is the combined loss of groundwater through two mechanisms. Some groundwater evaporates into the atmosphere directly from the soil surface. During the growing season, groundwater is also absorbed by plant root systems and released as water vapor from their leaves. The amount of evapotranspiration which occurs at a site depends on the density and type of vegetation present. Trees absorb the greatest quantities of groundwater, but transpiration in vegetation found in the understory also reduces the amount of groundwater available for downstream discharge.

Sub-Variables: *TreeCov* is an estimate of the areal cover of vegetation in the tree layer (defined as all live woody plants 6m or taller, regardless of diameter). *Understory* is an estimate of the areal coverage of vegetation in the understory layer (defined as all woody plants less than 6m in height and all non-woody plants, regardless of height, including mosses and aquatic bed plants) and is weighted lower than the *TreeCov* sub-variable.

Scoring: The equation for *ET* generates a value between 0 and 10. The score for *ET* = 0 if the sub-unit has less than 5% tree cover. *ET* is calculated for EACH Vegetated Wetland Sub-Unit and then weighted by Sub-Unit Area to calculate the variable score. See Appendix E for detailed instructions on weighting Sub-Unit variable calculations.

Application: *ET* is used by only one function; it is utilized as a stand-alone variable in the Streamflow Maintenance model.

EXPORTBIOMASS

Represents the amount of living biomass available for export to downstream organisms. *ExportBiomass* is a composite variable calculated by combining the sub-variables *TreeCov* and *Understory* in the following equation:

$$ExportBiomass = \frac{3(TreeCov) + Understory}{4}$$

Description: Organic matter produced in the wetland is transported to downstream consumers by flow exiting the system. Leaf litter, which provides the greatest amount of exportable biomass, is estimated by assessing tree cover. Additional organic matter available for export originates in the understory layer, which includes vegetative layers below the sub-canopy.

Sub-Variables: *TreeCov* is an estimate of the areal cover of vegetation in the tree layer (defined as all live woody plants 6m or taller, regardless of diameter). *Understory* is an estimate of the areal coverage of vegetation in the understory layer (defined as all woody plants less than 6m in height and all non-woody plants, regardless of height, including mosses and aquatic bed plants) and is weighted lower than the *TreeCov* sub-variable.

Scoring: The equation for *ExportBiomass* generates a value between 0 and 10. The score for *ExportBiomass* = 0 if the sub-unit has less than 5% tree cover. *ExportBiomass* is calculated for EACH Vegetated Wetland Sub-Unit and then weighted by Sub-Unit Area to calculate the variable score. See Appendix E for detailed instructions on weighting Sub-Unit variable calculations.

Application: *ExportBiomass* is used by only one function, it is utilized as a stand-alone variable in the Production Export model.

GWDISCHARGE

Represents the combination of features which enable the movement of groundwater to the soil surface. *GWDischarge* is a composite variable calculated by combining the sub-variables *Position*, *SurficialGeo* and *Organic* in the following equation:

$$GWDischarge = \frac{2(Position) + 2(SurficialGeo) + Organic}{5}$$

Description: Groundwater discharge occurs when water stored in the saturated zone reaches the soil surface, and the hydraulic conductivity of the underlying soil and geology is conducive to transmission of groundwater. The landscape position of the wetland, i.e. the relative elevation of the wetland's position on the landscape, determines the hydraulic gradient and the characteristics of the soil and underlying unconsolidated layers determine the ease with which groundwater moves through the sub-surface.

Sub-Variables: The *GWDischarge* equation is the same as the model for the Groundwater Recharge Function, but the variable scoring is different. *Position* describes the location of the wetland in the landscape. Wetlands located at lower elevations, relative to the surrounding landscape, are better positioned to discharge groundwater. *SurficialGeo* characterizes the permeability of the sub-surface and the ability of groundwater to move upwards from the water table. *Organic* indicates the presence of surface water maintained in the wetland, aiding in the creation and persistence of hydric soils and peat accretion. Thicker organic layers indicate increases in frequency/duration of saturation.

Scoring: The equation for *GWDischarge* generates a value between 1 and 10. *GWDischarge* is calculated separately for each SEA and the results are ranked to determine the variable score. See Appendix F for detailed instructions on ranking SEA variable calculations.

Application: *GWDischarge* is used by only one function, it is utilized as a stand-alone variable in the Streamflow Maintenance model.

HABFEAT

Represents the structural complexity of the AU and the presence of specialized habitat features. *HabFeat* is a composite variable calculated by combining the sub-variables *Strata*, *Heterogeneity* and *WildFeat* in the following equation:

$$HabFeat = Strata + Heterogeneity + WildFeat$$

Description: Wildlife habitat suitability is evaluated as the sum of three measures: vertical vegetation structure, horizontal structural variability, and the presence of specialized habitat features. Vertical structural complexity means food, cover and/or breeding habitat is accessible at different levels throughout the assessment unit. Horizontal structural complexity creates small microhabitats such as canopy openings in a forested area or shade trees in an emergent area. Specialized features create opportunities to support additional life functions such as breeding/nesting habitat provided by hollow trees, rock piles, or vegetated shallows. These characteristics are additive, their absence may limit the habitat suitability for some species but does not decrease the habitat value for all wildlife.

Sub-Variables: *Strata* is the number of plant strata (canopy, sub-canopy, shrub, herb) documented. *Heterogeneity* is the presence and variety of microhabitats (defined as s patches at least $4m^2$ which are of a different type than the sub-unit in which they are located). *WildFeat* is the presence and number of specialized wildlife features observed. The three variables are weighted equally and are added together rather than averaged. See Appendix K for details on calculation of *HabFeat.*

Scoring: *HabFeat* sub-variables are documented for each Vegetated Wetland Sub-Unit and scoring is determined by Sub-Unit type. *Strata* generates a score from 1 to 3, *Heterogeneity* generates a score from 0 to 3, and *WildFeat* generates a score from 0 to 4. The score for *HabFeat* = 1 if the sub-unit has less than the typical number of strata for that sub-unit type AND no microhabitat AND no specialized habitat features. The equation for *HabFeat* generates a value between 1 and 10. *HabFeat* is calculated for EACH Vegetated Wetland Sub-Unit and then weighted by Sub-Unit Area to calculate the variable score. See Appendix E for detailed instructions on weighting Sub-Unit variable calculations.

Application: *HabFeat* is used by only one function, it is utilized as a stand-alone variable in the Wildlife Habitat Integrity model.

HUMANACTIVITY

Represents the impact of recent human activity in or within 100m of the AU. *HumanActivity* is a composite variable calculated by combining the sub-variables *ActivIntensity* and *ActivProportion* in the following equation:

$$HumanActivity = \min_{A \in \{1,\ldots n\}} \sqrt{ActivIntensity_A \times ActivProportion_A}$$

and $A =$ each activity

Description: Anthropogenic stressors in and around wetland habitat have an ongoing effect on species presence and distribution by impacting wildlife behavior and the ability of the wetland to maintain the integrity of the wildlife and plant communities present. *HumanActivity* evaluates the effect of activities within the last two years only, based on the assumption that any response to older activities has already occurred, and the existing community is composed of those species which have adapted to those conditions. The magnitude of disturbance is determined by the relationship between the intensity of the activity and the proportion of the assessment unit which is affected by that activity.

Sub-Variables: *ActivIntensity* describes the intensity of each listed activity uses a rating scale from "no evidence of activity" to "severe impact evident." *ActivProportion* is an estimate of the proportion of the AU impacted by each individual activity. The impact of each activity is evaluated independently by calculating an activity sub-score using the equation above. The sub-score for the activity with the greatest magnitude of disturbance is used as the variable score. See Appendix K for details on calculation of *HumanActivity* sub-scores.

Scoring: The equation for *HumanActivity* generates a value between 1 and 10. The score for *HumanActivity* is equivalent to the LOWEST sub-score, which represents the activity which has the GREATEST magnitude of impact on the AU. An assessment unit with no evidence of human activity within the last 2 years will receive a score of 10.

Application: *HumanActivity* is utilized as a stand-alone variable in the Plant Community Integrity and Wildlife Habitat Integrity models.

LANDCOV

Represents the effect of surrounding land use on the habitat integrity of the AU. *LandCov* is a composite variable calculated by combining the sub-variables *LULCZone*, *LULCArea* and *LULCWeight* in the following equation:

$$LandCov = \sum_{T=1}^{n} \left(\frac{LULCArea_T}{LULCZone}\right)(LULCWeight_T)$$

and $T =$ each LULC type

Description: The effect of adjacent land use on wetland wildlife habitat integrity is a combination of direct and indirect impacts. Fragmentation, noise and light pollution, and vegetation removal all influence breeding, nesting and migration patterns. While the type and degree of impact varies from species to species, habitat integrity generally decreases as development increases in the surrounding landscape.

Sub-Variables: *LULCZone* is the total area of a 500m buffer polygon around the AU. *LULCArea* is the area within that buffer polygon classified as each LULC class. *LULCWeight* is the relative impact coefficient assigned to each LULC class. The relative effect sub-score for each LULC class is calculated by multiplying the percent of the total *LULCZone* occupied by each LULC class by the corresponding *LULCWeight*. An LULC class with GREATER relative impact will have a LOWER *LULCWeight* value. See Appendix K for details on calculation of *LandCov* sub-scores.

The impact of each activity is evaluated independently by calculating an activity sub-score using the equation above. The sub-score for the activity with the greatest magnitude of disturbance is used as the variable score

Scoring: The equation for *LandCov* generates a value between 0 and 10. The score for *LandCov* is the sum of the relative effect sub-scores. The score for *LandCov* will be 0 if the 500m land cover zone is entirely comprised of High Intensity Development.

Application: *LandCov* is used by only one function, it is utilized as a stand-alone variable in the Wildlife Habitat Integrity model.

NITROGENBIOMASS

Represents the amount of living biomass available for uptake and transformation of nitrogen within the AU. *NitrogenBiomass* is a composite variable calculated by combining the sub-variables *HerbCov*, *Understory* and *TreeCov* in the following equation:

$$NitrogenBiomass = \frac{4(HerbCov) + 2(ShrubCov) + TreeCov}{7}$$

Description: Nitrogen transformation occurs primarily through the process of denitrification in herbaceous vegetation. While some nitrogen transformation occurs in large woody plants, wetlands with greater density of rapidly growing herbaceous and shrubaceous vegetation has more potential for nitrogen transformation.

Sub-Variables: *HerbCov* is an estimate of the areal coverage of vegetation in the herbaceous layer (defined as all non-woody plants, regardless of height, including mosses and aquatic bed plants) and is weighted the highest of the sub-variables. *ShrubCov* is an estimate of the areal coverage of vegetation in the shrubaceous layer (defined as all woody plants less than 6m in height). *TreeCov* is an estimate of the areal cover of vegetation in the tree layer (defined as all live woody plants 6m or taller, regardless of diameter) and is weighted lower than the *HerbCov* and *ShrubCov* sub-variables.

Scoring: The equation for *NitrogenBiomass* generates a value between 0 and 10. If the sub-unit has less 5% herbaceous cover AND less than 5% shrubaceous cover AND less than 5% tree cover the score for *NitrogenBiomass* will be 0. *NitrogenBiomass* is calculated for EACH Vegetated Wetland Sub-Unit and then weighted by Sub-Unit Area to calculate the variable score. See Appendix E for detailed instructions on weighting Sub-Unit variable calculations.

Application: *NitrogenBiomass* is used by only one function, it is utilized as a stand-alone variable in the Nitrogen Transformation model.

PLANTSTRESS

Represents the impact of plant community stressors located in or within 100m of the AU. *PlantStress* is a composite variable calculated by combining the sub-variables *StressIntensity* and *StressProportion* in the following equation:

$$PlantStress = \min_{S \in \{1,\ldots n\}} \sqrt{StressIntensity_S \times StressProportion_S}$$

$$\text{and} \quad S = \quad \text{each stressor}$$

Description: Plant community stressors, such as insect pest damage, directly affect species presence/distribution and the ability of the wetland to maintain the integrity of the plant communities present. *PlantStress* evaluates the effect of plant community stressors within the last two years only, based on the assumption that any response to older stressors has already occurred, and the existing community is composed of those species which have adapted to those conditions. The magnitude of disturbance is determined by the relationship between the intensity of the stressor and the proportion of the assessment unit which is affected by that stressor.

Sub-Variables: *StressIntensity* describes the intensity of each listed stressor using a rating scale from "no evidence of stressor" to "severe impact evident." *StressProportion* is an estimate of the proportion of the AU impacted by each individual stressor. The impact of each stressor is evaluated independently by calculating a stressor sub-score using the equation above. The sub-score for the stressor with the greatest magnitude of disturbance is used as the variable score. See Appendix K for details on calculation of *PlantStress* sub-scores.

Scoring: The equation for *PlantStress* generates a value between 1 and 10. The score for *PlantStress* is equivalent to the LOWEST sub-score, which represents the stressor which has the GREATEST magnitude of impact on the AU. An assessment unit with no evidence of plant community stressors within the last 2 years will receive a score of 10.

Application: *PlantStress* is used by only one function, it is utilized as a stand-alone variable in the Plant Community Integrity model.

RETENTIONABILITY

Represents the combination of features which influence the residence time of surface water in the AU. *Retentionability* is a composite variable calculated by combining the sub-variables *Position*, *FlowRestrict* and *VelocityReduct* in the following equation.

$$Retentionability = \frac{3\left(\sqrt[3]{Position \times FlowRestrict^2}\right) + 2(VelocityReduct)}{5}$$

Description: *Retentionability* is a NEWFA specific term which describes the ability of the wetland to restrict and slow the flow of surface water long enough for biogeochemical processes of water quality improvement functions to occur. Landscape context determines the regularity with which surface water enters and exits the system. Structural features provide frictional resistance, decreasing flow velocity. Natural and anthropogenic structures create physical restrictions to the movement of surface water. Because the indicators are the same, the Particulate Retention model is used as a proxy for *Retentionability*.

Sub-Variables: *Position* describes the location of the wetland in the landscape. *FlowRestrict* is used to indicate the presence of structures such as weirs, channels, and culverts that may restrict the movement of surface waters in the wetland. *VelocityReduct* is a composite variable which characterizes biotic and abiotic features which reduce the velocity of surface water in the system. *VelocityReduct* is calculated by combining the sub-variables *MicroFeat*, *Understory* and *StemDensity* in the following equation.

$$\frac{(MicroFeat + Understory + StemDensity) - \min(MicroFeat, Understory, StemDensity)}{2}$$

Scoring: The equation for *Retentionability* generates a value between 1 and 10.

Application: *Retentionability* is used as a stand-alone variable in the Nitrogen Transformation, Phosphorus Retention, Removal/Sequestration of Heavy Metals and Carbon Sequestration models.

STEMDENSITY

Represents the density of tree stems rooted in the AU (both live and standing dead). *StemDensity* is a composite variable calculated by combining the sub-variables *TreeCount* and *TotalBA* in the following equation:

$$StemDensity = \sqrt[3]{TreeCount^2 \times TotalBA}$$

Description: *StemDensity* is a sub-variable component of *VelocityReduct*; it is not used in any other equations. This variable characterizes the role that trees (woody vegetation over 6m tall) play in the slowing of surface water moving through the AU. Tree stem density is described by the relationship between the number of trees present (both live and standing dead) and the total basal area of those trees. An area comprised of more trees of smaller diameter will have a greater effect on surface water flow than areas with larger diameter trees, but fewer in number.

Sub-Variables: *TreeCount* is the number of woody stems at least 6m tall (including standing dead), counted within a representative $10m^2$ plot established in each Vegetated Wetland Sub-Unit. *TotalBA* is an estimate of the cross-sectional area of those trees and is weighted lower than *TreeCount*. *StemDensity* is only calculated as a component of *VelocityReduct*.

Scoring: The equation for *StemDensity* generates a value between 0 and 10. If the sub-unit has no trees in the $10m^2$ plot OR the total basal area is less than 0.0250, the score for *StemDensity* will be 0. *StemDensity* is calculated for EACH Vegetated Wetland Sub-Unit and then weighted by Sub-Unit Area to calculate the variable score. See Appendix E for detailed instructions on weighting Sub-Unit variable calculations.

Application: *StemDensity* is utilized as a sub-variable component of *VelocityReduct* (a composite variable in the Particulate Retention, Surface Water Detention and Storm Surge Reduction models) and as a sub-variable component of *Retentionability* (a composite variable in the Nitrogen Transformation, Phosphorus Retention, Removal/Sequestration of Heavy Metals and Carbon Sequestration models).

VELOCITYREDUCT

Represents the presence and density of biotic features which increase surface roughness and frictional resistance to overland flow through the AU. *VelocityReduct* is a composite variable calculated by combining the sub-variables *Understory*, *StemDensity* and *MicroFeat* in the following equation.

$$\frac{(MicroFeat + Understory + StemDensity) - \min(MicroFeat, Understory, StemDensity)}{2}$$

Description: Features such hummocks, boulders and woody debris increase frictional resistance, thereby decreasing the velocity of overland flow as it moves into and through the system. Tree and understory vegetation provide direct resistance to surface water flow and may also change flow direction which further reduces the velocity. Microtopographical depressions across a wetland add to this "roughness" by providing a small amount of surface water detention, the water detained in these small pools also provides some reduction of surface water velocity. Each of these components can independently reduce flow velocity, a system does not need all three for effective velocity reduction.

Sub-Variables: *MicroFeat* is the number of features which contribute to the overall roughness of the AU averaged along three 30m transects. *Understory* is an estimate of the areal coverage of vegetation in the understory layer (defined as all woody plants less than 6m in height and all non-woody plants, regardless of height, including mosses and aquatic bed plants). *StemDensity* is calculated as described above.

VelocityReduct is calculated by discarding the lowest scoring sub-variable (*MicroFeat*, *Understory*, or *StemDensity*) and finding the average of the remaining two sub-variables.

Scoring: The equation for *VelocityReduct* generates a value between 0 and 10. The score for *VelocityReduct* = 0 if the sub-unit has no microfeatures AND less than 5% understory cover AND there are no trees (or the total basal area is less than 0.0250. *VelocityReduct* is calculated for EACH Vegetated Wetland Sub-Unit and then weighted by Sub-Unit Area to calculate the variable score. See Appendix E for detailed instructions on weighting Sub-Unit variable calculations.

Application: *VelocityReduct* is used as a stand-alone variable in the Particulate Retention, Surface Water Detention and Storm Surge Reduction models. It is also a sub-variable component of *Retentionability* (a composite variable in the Nitrogen Transformation, Phosphorus Retention, Removal/Sequestration of Heavy Metals and Carbon Sequestration models).

B. COMPOSITE VARIABLE LIST AND DEFINITIONS

BUFFER	presence and integrity of undisturbed buffer adjacent to the AU.
CARBONBIOMASS	amount of living biomass storing biological carbon in the AU.
DETENTION	capacity of the system to detain water during a storm surge event.
ET	loss of groundwater that is absorbed by plants through their roots and exits the system as transpiration and/or evaporation.
EXPORTBIOMASS	amount of living biomass available for export to downstream organisms.
GWDISCHARGE	combination of features which enable the movement of groundwater to the soil surface.
HABFEAT	structural complexity of the AU and presence of specialized habitat features.
HUMANACTIVITY	impact of recent human activity occurring in or within 100m of the AU.
LANDCOV	effect of land use within 500m on the habitat integrity of the AU.
NITROGENBIOMASS	amount of living biomass available for the uptake and transformation of nitrogen in the AU.
PLANTSTRESS	impact of plant community stressors located in or within 100m of the AU.
RETENTIONABILITY	combination of features which influence the residence time of surface water in the AU.
STEMDENSITY	density of tree stems rooted in the AU (both live and standing dead).
VELOCITYREDUCT	structure formed by vegetation and microtopographic features which contributes to the roughness of the soil surface and creates frictional resistance to overland flow through the AU.

Chapter 6: Functional Capacity Models

1 - Surface Water Detention

A. Definition and Description of Function

Surface Water Detention is defined as the processes by which flow entering wetlands is intercepted and stored temporarily.

Surface water detention means that water flowing into the wetland, such as stormwater runoff or overbank flooding, is temporarily held in the system and released at a later time. The presence of this function results in moderation of floodwater and/or stormwater flow to downgradient areas, which reduces flood risks and erosion potential.

Detention of surface water is the most ubiquitous function, included in nearly all wetland assessment methods, although there are differing approaches to identifying and naming the function. Comparison of terminology (e.g. surface water storage, floodwater storage, detain precipitation) elucidates some of the different ways that surface water detention can be described and assessed. There are methods which distinguish between short and long-term storage **(Brinson et al., 1995)**, surface and sub-surface detention, or precipitation/stormwater runoff vs. overbank flooding **(Murray & Klimas, 2013)**. NEWFA does not make those distinctions, with two caveats: surface water which is stored below the unsaturated zone is considered in the Groundwater Recharge function and surface water which enters the system as storm surge is considered in the Storm Surge Reduction function.

Some assessment methods use nomenclature that identifies the potential environmental or societal effects of surface water detention (e.g. floodflow alteration, reduction of peak flows, reduction of downstream flooding/erosion). Detention of surface water by wetlands can have important environmental and societal significance, depending on the location of the wetland and the timing of the event. For example, detention of stormwater runoff during or following a precipitation event, dampens the flood wave and flattens the hydrograph, delaying and reducing peak discharge downstream. When detained surface water is eventually released, it will occur at a decreased flow velocity, which reduces downgradient erosion and the risk of flash flooding.

Numerous studies have considered the role of riverine wetlands in the dissipation of flood wave energy and reduction of downstream flood magnitude. Riparian wetlands may serve as temporary holding areas for overbank flow along the stream during flooding events, reducing the volume of water within the stream channel. As flood stage decreases, detained surface water may return to the channel slowly with decreased velocity through low-gradient surface routes or subsurface flow. **(Acreman & Holden, 2013)** As the frequency of flood events in New England increases, surface water detention performs a vital role in decreasing impacts, financially and environmentally throughout the region **(Armstrong et al., 2011)**. Protection of life and property in downstream communities is an important service associated with this function.

In addition to the effect on downstream hydrology, surface water detention facilitates other functions performed by wetlands by increasing residence time and sedimentation rates, which are important components of water quality functions such as particulate retention, nitrogen transformation, and removal/sequestration of heavy metals.

The primary characteristics driving surface water detention are: 1) landscape context, 2) frictional resistance to flow, 3) restricted outflow, and 4) available storage volume.

Landscape context affects surface water detention in several ways. The volume of surface water flowing into the system is governed by climate and geomorphology. The location of a wetland within its watershed determines the likelihood that it will intercept surface water. Wetlands higher in the drainage basin will encounter flow at a lower volume, but higher velocity than wetlands further downstream. Wetlands can detain lower velocity inflow more effectively than flow entering at a higher velocity **(Adamus et al., 1991)**. The relationship between the size of the wetland and the size of the watershed also impacts surface water detention. Basins with higher percentages of lakes and wetlands are collectively more effective at reducing downstream flooding than those with fewer lakes and wetlands. However, an individual wetland in a watershed with fewer wetlands, will have a more significant relative impact **(Tiner, 2003)**. Land use within the watershed may also determine the relative importance of surface water detention. Urbanized watersheds with high percentages of impervious surface have correspondingly high stormwater runoff resulting in an increase in flood magnitude **(Armstrong et al., 2011)**.

The presence of features which restrict flow and create frictional resistance add to the surface water detention capacity. Biotic or abiotic elements may serve as barriers that obstruct channelized flow or create bottlenecks which reduce flow velocity. Dense vegetation increases frictional resistance, decreasing the velocity of overland flow as it moves into and through the system. High velocity floodwaters and stormwater runoff may be further slowed by features which increase surface roughness, such as hummocks and tree fall. **(Adamus et al., 1991)**

The storage capacity of a wetland governs the flow volume which can be detained and includes both surface and sub-surface storage. Surface storage occurs as ponding, which is visually evident, whereas sub-surface storage, realized as soil moisture in the unsaturated zone, is not immediately apparent. Topography and hydrogeomorphology determine the total above ground storage capacity. Wetlands located in depressions, flats, and floodplains have more storage capacity than similarly sized wetlands positioned on a slope or fringing a stream **(Tiner, 2003)**. Total above ground storage volume is determined by the shape of the wetland as well as the presence and height of any outlets and can be calculated geometrically. However, available storage may be reduced if the wetland is already inundated. Sub-surface storage capacity varies as the water table rises and falls seasonally or in response to precipitation events. As a result, the potential surface water detention capacity may be greater than the amount of inflow that can be detained at a specific point in time **(Carter, 1996)**.

The actual rate of surface water detention can be expressed as the volume of water stored per unit area per unit time (m3/ha/time). Independent quantitative measures include use of water level gauges and flow meters upgradient, downgradient, and within the wetland to quantify changes in water level, flow, and velocity. Measures for determining the volume of a wetland include calculating the depth and surface area of the wetland. However, the time and level of effort required by these methods is beyond the scope of a rapid assessment. Therefore, the level of functional capacity must be assessed indirectly using indicators that represent the characteristics which promote surface water detention by wetlands.

B. Assessing Surface Water Detention

The potential that a wetland has to detain surface water is based on its ability to receive surface water and store some portion of it temporarily within the wetland. Indicators of this potential are the landscape position, the presence of biotic and abiotic features that impede flow/reduce velocity, and the size of the wetland. The functional capacity grade for Surface Water Detention is calculated using a model that combines the variables *Position*, *FlowRestrict*, *VelocityReduct*, and *AUSize*, in the following equation:

$$\boldsymbol{FCG_{(SWD)} = \frac{4\left(\sqrt{Position \times FlowRestrict}\right) + VelocityReduct + 2(AUSize)}{7}}$$

Summary of Model

Property	Variables	Description
Landscape Context	*Position*	Location (geomorphic position) of AU on the landscape
Hydrologic Movement	*FlowRestrict*	Presence and characteristics of flow restriction features
	VelocityReduct	Structural reduction of water velocity
	MicroFeat	Presence and density of microtopographic features
	Understory	Areal cover of vegetation in the understory layer
	StemDensity	Density of tree stems (both live and standing dead)
	TreeCount	Total number of tree stems (both live and standing dead)
	TotalBA	Total basal area of tree stems (both live and standing dead)
Holding Capacity	*AUSize*	Size of the assessment unit

$$\boldsymbol{FCG_{(SWD)}} = \frac{\boldsymbol{4\left(\sqrt{Position \times FlowRestrict}\right) + VelocityReduct + 2(AUSize)}}{\boldsymbol{7}}$$

$$VelocityReduct = \frac{(MicroFeat + Understory + StemDensity) - min(\ MicroFeat, Understory, StemDensity)}{2}$$

and $StemDensity = \sqrt[3]{TreeCount^2 \times TotalBA}$

Model Description

Landscape context is characterized by the *Position* variable. *Position* values defined by NEWFA combine topographic location, hydrologic inputs, and/or relationship to a water body to categorize a wetland's geomorphic setting. The *Position* categories are ranked by their relative suitability to receive and detain surface water flowing into the system. However, wetlands always have some degree of topographic and hydrologic variability within the system and some assessment units may span more than one landscape position. The potential for surface water detention does not need to be equivalent at every point in the assessment unit, the functional capacity grade represents the likelihood that surface water detention will occur somewhere within the system. This variability is captured by recording landscape position at each soil examination area and using the highest ranked position value as the variable score to indicate the overall potential for surface water detention.

Movement of surface water within the wetland is characterized by the *FlowRestrict* and *VelocityReduct* variables. *FlowRestrict* values account for the presence of features which obstruct downstream flow entirely (e.g., an abandoned weir) as well as features which create a bottleneck, thus slowing the flow of water through the system (e.g., undersized culverts). *VelocityReduct* is a composite variable which represents the roughness of the system.

The *FlowRestrict* values are ranked by the relative degree with which they restrict the passage of water through the assessment unit. Documentation is not limited to the characteristics of the outlet; all possible features are recorded; restriction or reduction of flow can occur at any point within the system.

The most restrictive feature is ranked the highest and is used as the variable score, representing the location where surface water detention is most likely to occur.

The *VelocityReduct* variable evaluates the presence and density of structural features which decrease the velocity of water moving across the surface of the assessment unit. The sub-variable components of *VelocityReduct* describe structural vegetation characteristics such as the density of the understory layer and tree stem volume, as well as features such as boulders, coarse woody material, and microtopographic changes, all of which create surface irregularities that increase friction, thereby slowing water movement. Variability within the system is captured by computing a *VelocityReduct* sub-score for each vegetated wetland assessment unit and then calculating a weighted average to determine the variable score. See Chapter 5 and Appendix K for detailed discussion of the *VelocityReduct* variable.

The final variable, *AUSize*, evaluates the holding capacity of the wetland. As holding capacity increases, the quantity of surface water that can be detained and the time for which it can be held increases. Volume would be a more accurate indicator of holding capacity but because depth can vary widely and is often challenging to measure accurately in the context of a rapid assessment, the size of the assessment unit (measured in hectares) is used as a proxy for volume. In order to account for a reasonable degree of measurement variability, the size of the assessment unit as calculated is placed into one of seven size classes to determine the variable score.

Variables and Scoring

Position – the landscape context (geomorphic position or location) of the AU.

Indicators: Landscape position is evaluated remotely before the site visit and then confirmed in the field and recorded in Section D-1b of the Data Sheet at EACH Soil Examination Area.

Scoring: Each of the 12 *Position* value options is assigned a numeric score between 1 and 10 (see table below). The user notes the score for landscape position value recorded at each SEA. The SEA value with the HIGHEST score (optimal landscape position for detention of surface water) will determine the variable score.

***Position* Values and Scores (Surface Water Detention)**					
VALUE	SCORE	VALUE	SCORE	VALUE	SCORE
Groundwater Slope	1	Groundwater Depression	10	Marine Fringe	1
Surface Water Slope	1	Surface Water Depression	10	Estuarine Fringe	1
Groundwater Flat	6	River/Stream Fringe	1	Fresh Water Tidal Fringe	1
Surface Water Flat	6	River/Stream Floodplain	6	Lake/Pond Fringe	2

FlowRestrict – the presence and characteristics of features which slow or restrict the passage of surface water through the AU.

Indicators: ALL flow restriction features observed within the AU are documented and recorded in Section E-1 of the Data Sheet during the site visit.

Scoring: Each of the 23 *FlowRestrict* value options is assigned a numeric score between 1 and 10 (see table below). The user notes the score for each flow restriction feature recorded. The value with highest score (most effective at slowing and detaining surface water flow) will determine the variable score.

FlowRestrict Values and Scores (Surface Water Detention)			
VALUE	SCORE	VALUE	SCORE
Open Exchange – Tidal	2	Culvert Present – Receiving Flow	-
Open Exchange – Non-Tidal	1	Culvert >75% of stream width	2
Channel Present – Unrestricted	1	Culvert 50-75% of stream width	4
Human or Beaver Constructed Dam Present	9	Culvert 25-50% of stream width	6
Channel Present – Restricted by Debris Jam	-	Culvert < 25% of stream width	8
Debris spans < 25% of channel width	2	Culvert Present – Not Receiving Flow	-
Debris spans 25-50% of channel width	4	Culvert Partially Blocked by Debris	5
Debris spans 50-75% of channel width	6	Culvert Totally Blocked by Debris	10
Debris spans >75% of channel width	8	Culvert Located too High Above Flow	10
Channel Width Narrowed by Geology/Structure	-	Tide Gate/Weir Present	-
Channel narrows < 25%	1	Operational	5
Channel narrows 25-50%	2	Non-operational (Open)	2
Channel narrows 50-75%	3	Non-operational (Closed)	10
Channel narrows >75%	5	Closed System (No Outlet)	10

VelocityReduct – composite variable that represents the combination of structural vegetation and microtopographic features which contribute to the roughness of the soil surface and create frictional resistance to overland flow through the AU.

Sub-Variables: *VelocityReduct* is calculated by combining the sub-variables *Understory*, *StemDensity* and *MicroFeat* for each vegetated wetland sub-unit in the following equation:

$$\frac{(MicroFeat + Understory + StemDensity) - min(\ MicroFeat, Understory, StemDensity)}{2}$$

MicroFeat is an estimate of the density of microtopographic features which contribute to the roughness of the AU. *Understory* is an estimate of areal cover of vegetation in the understory layer. *StemDensity* is an estimate of the density of tree stems (both live and standing dead) rooted in the AU and is calculated by combining *TreeCount* (the number of trees) and *TotalBA* (total basal area) for each vegetated wetland sub-unit in the equation:

$$StemDensity = \sqrt[3]{TreeCount^2 \times TotalBA}$$

VelocityReduct is calculated by discarding the lowest scoring sub-variable (*MicroFeat*, *Understory*, or *StemDensity*) and finding the average of the remaining two sub-variables. See Appendix K for detailed information about composite variable calculation.

Scoring: The equation for *VelocityReduct* generates a value between 0 and 10. The score for *VelocityReduct* = 0 if the sub-unit has no microfeatures AND less than 5% understory cover AND there are no trees (or the total basal area is less than 0.0250). *VelocityReduct* is calculated for EACH sub-unit then weighted by sub-unit area to determine the variable score. See Appendix E for detailed instructions on sub-unit weighting.

AUSize – the size of the assessment unit.

Indicators: The size of the assessment unit in hectare(s) is calculated using GIS in the office and recorded in Section G-1a of the Data Sheet AFTER the AU boundary has been confirmed in the field and finalized.

Scoring: Each of the seven *AUSize* classes is assigned a numeric score between 1 and 10 (see table below). The score for the applicable size class will determine the variable score.

***AUSize* Values and Scores (Surface Water Detention)**					
SIZE CLASS	SCORE	SIZE CLASS	SCORE	SIZE CLASS	SCORE
< 0.25 hectare	1	4 to < 8 hectares	6	20 to < 40 hectares	9
0.25 to < 2 hectare(s)	2	8 to < 20 hectares	8	≥ 40 hectares	10
2 to < 4 hectares	4				

2 - Groundwater Recharge

A. Definition and Description of Function

Groundwater Recharge is defined as the processes by which wetlands facilitate the movement of surface water into the groundwater system.

Groundwater recharge means that surface water, moves downward via infiltration/percolation through the unsaturated zone to the water table. The presence of this function results in replenishment and supplementation of groundwater storage.

Although the term groundwater is often used to make the distinction between surface water and sub-surface hydrology, not all water below the surface is considered groundwater. This method uses the term groundwater to describe water in the saturated zone. Water in the unsaturated zone is typically referred to as shallow sub-surface flow or interflow, although in practice, it is not possible to make that distinction without long-term testing and monitoring.

Many assessment methods include groundwater recharge as a component of the overarching water storage function **(Hauer et al., 2002; Noble et al., 2002)**. Some methods separate surface and sub-surface storage into separate functions **(Brinson et al., 1995; Noble et al., 2004)**. Framing recharge as sub-surface storage assumes that groundwater moves downward, but not laterally. Because groundwater flow is three dimensional, the location at which recharge occurs may result in sub-surface storage regionally, but not locally.

Recharge occurs when surface water moves into the underlying soil and substrate and reaches the water table, defined as the upper limit of the zone of saturation. Infiltration/percolation of surface water through the unsaturated zone is the result of two components: hydraulic head and hydraulic conductivity. Hydraulic head is the combination of gravity and pressure which causes surface water to move downward into unsaturated pore spaces. Hydraulic conductivity is the ease through which a fluid moves through permeable soil, interstitial spaces or bedrock.

Groundwater recharge and discharge are often discussed concurrently, and some methods describe one recharge/discharge as two sides of the same function **(USACE, 1999)**. While the characteristics that allow water to move through the substrate are the same in both cases, the factors which determine the direction of flow are not. Some wetland systems may have equivalent potential for both recharge and discharge, but many do not. NEWFA evaluates Groundwater Recharge as an independent function and includes discharge as a component of the Streamflow Maintenance function (see next section of this chapter).

The term aquifer is used to refer to groundwater which can be withdrawn and used as a water supply for drinking water, agriculture, or other anthropogenic purposes. Aquifer is a relative concept, tied to local demand and available technology; however, the need for a source of freshwater is universal. As water is withdrawn from an aquifer, groundwater recharge is the mechanism for replenishment. When the rate of withdrawal exceeds the rate of recharge, the aquifer can no longer supply enough water to meet demand. The importance of groundwater recharge fluctuates depending on the current climate conditions and the needs of the local community/ecosystem. **(NRCS, 2010b)**

The primary characteristics driving groundwater recharge are 1) hydraulic gradient and 2) conductivity of the underlying soil, sediment and strata.

The hydraulic gradient determines the direction that water flows, moving down gradient from high to low hydraulic head. When the hydraulic head at the soil surface exceeds that of the water table, groundwater recharge can occur. Hydraulic head has two components, the pressure head and the elevation head. Pressure head is generated by inundation of the soil surface which increases as the mass of surface water increases. Elevation head is generated by gravity and occurs when the wetland soil surface elevation is greater than the height of the water table. In order for groundwater recharge to occur, the wetland must be located such that surface water can accumulate within the system long enough to generate a pressure head gradient. However, when the subsurface is completely saturated, the elevation head is equalized, and recharge will not occur.

Hydraulic head alone is not enough to generate groundwater recharge, the composition of the soil and substrate governs how easily water moves through the subsurface. Soil pore size and geometry determines the permeability of the soil below the wetland. Soils composed of higher percentages of sand sized particles will have higher permeability than clayey or silty soils. However, the transmission of water through different soil and substrate types is better described by the term hydraulic conductivity (or Ksat), which describes the ease with which a fluid moves through the pores of a saturated soil and accounts for fluid viscosity and density in addition to permeability. For example, well decomposed peat has low permeability but higher hydraulic conductivity than a mineral soil with comparable permeability. Organic soil layers were thought to prevent recharge, but studies have shown that they transmit water more rapidly. **(Rawls et al., 2003)**

The actual rate of groundwater recharge can be expressed as the volume of water lost to recharge per unit area per unit time (m3/ha/time). Independent quantitative measures include use of groundwater wells to measure the height of the water table over the course of the year, installation of piezometers to determine potentiometric contours and measuring infiltration rates of soil samples. However, the time and level of effort required by these methods is beyond the scope of a rapid assessment. Therefore, the level of functional capacity must be assessed indirectly using indicators that represent the characteristics which promote groundwater recharge by wetlands.

B. Assessing Groundwater Recharge

The potential that a wetland has to recharge is based on the ability of surface water to infiltrate the soil and reach the water table. Indicators of this potential are the landscape position and the characteristics of the underlying soils and geology. The functional capacity grade for Groundwater Recharge is calculated using a model that combines the variables *Position*, *SurficialGeo* and *Organic* in the following equation:

$$FCG_{(GWR)} = \frac{2(Position) + 2(SurficialGeo) + Organic}{5}$$

Summary of Model

Property	Variables	Description
Landscape Context	*Position*	Location (geomorphic position) of AU on the landscape
Hydraulic Conductivity	*SurficialGeo*	Origin/composition of unconsolidated geologic deposits
	Organic	Thickness of organic soil layer(s) if present
$FCG_{(GWR)} = \frac{2(Position) + 2(SurficialGeo) + Organic}{5}$		

Note: Groundwater Recharge is calculated separately for each Soil Examination Area.

Model Description

Geomorphology or landscape context is characterized by the *Position* variable. *Position* values defined by NEWFA combine topographic location, hydrologic inputs and/or relationship to a water body to categorize a wetland's geomorphic setting. The *Position* categories are ranked by their relative suitability to receive and detain surface water so that enough pressure head builds up to allow percolation/infiltration to occur.

Hydraulic conductivity is characterized by the *SurficialGeo* and *Organic* variables. *SurficialGeo* values defined by NEWFA combine size/type/composition/sorting of materials in each layer and method of deposition to categorize the unconsolidated geologic deposits beneath the wetland. *Organic* values are defined either by the thickness of organic soil layers or the mineral soil texture when there is no organic soil layer thicker than 4cm. The *SurficialGeo* and *Organic* categories are ranked by their relative permeability and hydraulic conductivity which governs the ease with which groundwater can be transmitted.

Some assessment units may span more than one landscape position, surficial deposit or soil type. This variability is captured by recording landscape position, surficial geology and organic layer thickness at each soil examination area, calculating Groundwater Recharge separately for each area and selecting the highest score as the FCG. Because wetlands always have some degree of topographic and hydrologic variability within the system, the likelihood of groundwater recharge does not need to be equivalent at every point in the assessment unit. The functional capacity grade represents the overall potential for groundwater recharge within the system.

Variables and Scoring

Position – the landscape context (geomorphic position or location) of the AU.

Indicators: Landscape position is evaluated remotely before the site visit and then confirmed in the field and recorded in Section D-1b of the Data Sheet at EACH Soil Examination Area.

Scoring: Each of the 12 *Position* value options is assigned a numeric score between 1 and 10 (see table below). The user notes the score for landscape position value recorded at each SEA.

***Position* Values and Scores (Groundwater Recharge)**					
VALUE	SCORE	VALUE	SCORE	VALUE	SCORE
Groundwater Slope	1	Groundwater Depression	5	Marine Fringe	4
Surface Water Slope	2	Surface Water Depression	10	Estuarine Fringe	6
Groundwater Flat	4	River/Stream Fringe	8	Fresh Water Tidal Fringe	6
Surface Water Flat	8	River/Stream Floodplain	8	Lake/Pond Fringe	10

SurficialGeo – the origin and composition of the unconsolidated deposits below the soil surface

Indicators: Surficial geology is evaluated remotely before the site visit and then confirmed in the field and recorded in Section D-1a of the Data Sheet at EACH Soil Examination Area.

Scoring: Each of the 14 *SurficialGeo* value options is assigned a numeric score between 1 and 10 (see table below). The user notes the score for the surficial geology value recorded at each SEA.

SurficialGeo Values and Scores (Groundwater Recharge)					
SURFICIAL VALUE	SCORE	SURFICIAL VALUE	SCORE	SURFICIAL VALUE	SCORE
Lodgment Till	2	Coarse-Grained Alluvium	10	Shallow Bedrock	1
Melt-Out Till	9	Fine-Grained Alluvium	1	Coastal Sands	10
Mixed Glacial Materials	5	Colluvium	9	Inland Organic Materials	5
Stratified Coarse Materials	10	Dense Anthropogenic	2	Tidally-Flooded Organic Materials	5
Stratified Fine Materials	1	Loose Anthropogenic	9		

<u>Organic</u> – estimate of the amount of organic material below the soil surface.

Indicators: Organic layer thickness is measured in the field and recorded in Section D-2c of the Data Sheet at EACH Soil Examination Area.

Scoring: Each of the six *Organic* class value options is assigned a score between 1 and 10 (see table below). The user notes the score for the organic layer thickness class recorded at each SEA. When there is no organic layer thicker than 4cm, the texture class of the uppermost mineral soil layer is selected as the SEA attribute value.

Organic Classes and Scores (Groundwater Recharge)						
THICKNESS	CLASS	SCORE	THICKNESS	CLASS	TOP MINERAL LAYER	SCORE
> 130 cm	Deep Organic	10	0 – 4 cm	No Organic Layer	Mucky Mineral	2
41 – 130 cm	Shallow Organic	8			Loamy or Clayey Mineral	1
5 – 40 cm	Limited Organic	6			Sandy Mineral	4

3 - Streamflow Maintenance

A. Definition and Description of Function

Streamflow Maintenance is defined as the processes by which wetlands support streamflow during low flow periods.

Streamflow maintenance means that groundwater discharge supplements streamflow in downgradient streams, maintaining baseflow in between precipitation events. The presence of this function results in a stabilization of stream hydrology, volume and temperature.

Streamflow, the water flowing within a stream channel, is the main mechanism by which water moves, providing habitat and supplying water to plants, wildlife and humans in the watershed. In addition to the role of streamflow in the hydrologic cycle, the quantity of water in any stream segment affects the movement of sediment, availability of nutrients and concentration of pollutants, playing an important role in both local and regional water quality. Streamflow originates from numerous sources including stormwater runoff, snowmelt, shallow sub-surface flow, and groundwater discharge.

Groundwater discharge is a relatively stable source of streamflow, in addition to being the primary hydrologic control for many wetlands. **(Winter, 2007)** Discharge occurs when the water table intersects the land surface and groundwater becomes surface water. In many instances groundwater discharges directly into a stream channel, in other cases terrestrial seeps or springs transmit water through a wetland before becoming streamflow. The maintenance of streamflow by groundwater discharge during times of low precipitation has long been considered an important function of many wetlands.

Groundwater recharge and discharge are often discussed concurrently, and some methods describe one recharge/discharge as two sides of the same function **(USACE, 1999)**. While the characteristics that allow water to move through the substrate are the same in both cases, the factors which determine the direction of flow are not and they provide different ecosystem services. NEWFA does not consider groundwater discharge to be an independent function, but a variable within the streamflow maintenance function.

The primary characteristics/processes governing streamflow maintenance are: 1) discharge of groundwater, 2) landscape context, and 3) degree of evapotranspiration.

The potential for streamflow maintenance is driven by presence of characteristics that promote groundwater discharge in wetlands. Groundwater discharge will occur when the saturated zone reaches the soil surface, and the hydraulic conductivity of the underlying soil and geology is conducive to transmission of groundwater. The relationship between groundwater discharge and wetlands is circular. Groundwater discharge is a common characteristic of wetlands because wetlands tend to form in locations where the water table is high and saturation by groundwater promotes the development of hydric soils and the growth of hydrophytic vegetation.

Groundwater discharge alone does not promote streamflow maintenance. The landscape position of a wetland drives the likelihood of groundwater discharge, but the wetlands without connectivity to the stream network cannot contribute to stream baseflow. Several studies have demonstrated headwater wetlands have a direct effect on stream flow. Comparison of stream flow at reaches above and below hillside seeps, which are typically classified as groundwater slopes, show a measurable increase in stream discharge rates, particularly during periods of low flow **(Morley et al., 2011; Roulet, 1990)**.

Streamflow maintenance is also limited by the degree of which evapotranspiration occurs in the wetland. Vegetation absorbs groundwater through the root system. Water moves upward through the plant until reaching the leaves where the water evaporates through transpiration. The effect of evapotranspiration on streamflow maintenance depends on the density and type of vegetation in a wetland, especially trees which can absorb large quantities of groundwater.

The actual rate of streamflow maintenance can be expressed as the volume of water discharged per unit area per unit time (m3/ha/time). Independent quantitative measures include the installation of piezometers and shallow groundwater monitoring wells and stream level gauges to record fluctuations of each over time, in order to observe groundwater discharge from wetlands supporting baseline flow of a downgradient stream. However, the time and level of effort required by these methods is beyond the scope of a rapid assessment. Therefore, the level of functional capacity must be assessed indirectly using indicators that represent the characteristics which promote streamflow maintenance by wetlands.

B. Assessing Streamflow Maintenance

The potential that a wetland has to maintain streamflow is based on the likelihood that discharged groundwater will reach the stream network. Indicators of this potential are capacity for groundwater discharge and amount of evapotranspiration likely to occur. The functional capacity grade for Streamflow Maintenance is calculated using a model that combines the variables *GWDischarge* and *ET* in the following equation:

$$\boldsymbol{FCG_{(SfM)} = GWDischarge - \left(\frac{ET}{5}\right)}$$

Summary of Model

Property	Variables	Description
Landscape Context	Applicability	Wetland is connected to stream network
Hydrology	*GWDischarge*	Capacity to discharge groundwater to the soil surface
	Position	Location (geomorphic position) of AU on the landscape
	SurficialGeo	Origin and composition of underlying geologic layers
	Organic	Thickness of organic soil layer(s) if present
	ET	Loss of groundwater to evapotranspiration
	TreeCov	Areal cover of vegetation in the tree layer
	Understory	Areal cover of vegetation in the understory layer

$$\boldsymbol{FCG_{(SfM)} = GWDischarge - \left(\frac{ET}{5}\right)}$$

$$GWDischarge = \frac{2(Position) + 2(SurficialGeo) + Organic}{5}$$

$$ET = \frac{2(TreeCov) + Understory}{3}$$

Model Description

The model for Streamflow Maintenance is comprised of two variables which represent the probability of groundwater discharge and degree of evapotranspiration. Landscape context is evaluated in the determination of applicability rather than as a variable in the model.

Applicability of the Streamflow Maintenance function is dependent on connectivity between the wetland and the stream network. One or more streams must be positioned to receive flow from the assessment unit at least periodically. Applicability is evaluated in Part B of the data sheet and the model is not calculated if the assessment unit does not meet the criteria. Detailed criteria for applicability are outlined in Appendix G.

GWDischarge is a composite variable which evaluates the likelihood that water in the saturated zone will reach the soil surface. The sub-variable components of *GWDischarge* describe the landscape context, characteristics of the underlying surficial geology and the presence/thickness of organic soil material in the wetland. The equation and sub-variables are the same as those used to assess the Groundwater Recharge function and while both equations use the same scoring for *SurficialGeo* and *Organic*, the scoring for *Position* is different. The *SurficialGeo* and *Organic* sub-variable categories are ranked by their relative permeability and hydraulic conductivity which governs the ease with which groundwater can be transmitted, using the same scoring as the model for groundwater recharge. However, the *Position* categories are ranked by the relative likelihood that the saturated zone will intersect with the soil surface at least periodically, which produces different scoring than groundwater recharge.

Some assessment units may span more than one landscape position, surficial deposit or soil type. This variability is captured by recording landscape position, surficial geology and organic layer thickness at each soil examination area and calculating *GWDischarge* separately for each location. Because wetlands always have some degree of topographic and hydrologic variability within the system, the likelihood of groundwater discharge does not need to be equivalent at every point in the assessment unit. The soil examination area with the highest *GWDischarge* score represents the overall potential for groundwater discharge within the system and is used as the variable score. See Chapter 5 and Appendix K for detailed discussion of the *GWDischarge* variable.

ET is a composite variable which evaluates the amount of discharged groundwater removed from the system by plant uptake. During the growing season, groundwater is absorbed by plants through their roots and subsequently exits the system as transpiration and/or evaporation. The amount of evapotranspiration which occurs at a site depends on the density and type of vegetation present. Higher rates of evapotranspiration result in a reduction of discharged groundwater available for stream flow maintenance downstream. Variability within the system is captured by computing an *ET* sub-score for each vegetated wetland assessment unit and then calculating a weighted average to determine the variable score. See Chapter 5 and Appendix K for detailed discussion of the *ET* variable.

Variables and Scoring

GWDischarge - composite variable that represents the combination of features which enable the movement of groundwater to the soil surface.

Sub-Variables: *GWDischarge* is calculated by combining the sub-variables *Position*, *SurficialGeo* and *Organic* in the following equation for each SEA:

$$GWDischarge = \frac{2(Position) + 2(SurficialGeo) + Organic}{5}$$

Position is the landscape context or geomorphic position of the AU. *SurficialGeo* describes the origin and composition of the unconsolidated deposits below the soil surface. *Organic* is an estimate of the amount of organic material below the soil surface and is weighted lower than the other two sub-variables. See Appendix K for detailed information about composite variable calculation.

Scoring: The equation for *GWDischarge* generates a value between 1 and 10. *GWDischarge* is calculated for EACH SEA and the highest SEA score is used as the variable value. See Appendix F for detailed instructions on SEA variables.

ET – composite variable that represents the loss of groundwater that is absorbed by plants through their roots and exits the system as transpiration and/or evaporation.

Sub-Variables: *ET* is calculated by combining the sub-variables *TreeCov* and *Understory* for each vegetated wetland sub-unit in the following equation:

$$ET = \frac{2(TreeCov) + Understory}{3}$$

TreeCov is an estimate of the areal cover of vegetation in the tree layer (defined as all live woody plants 6m or taller, regardless of diameter). *Understory* is an estimate of the areal coverage of vegetation in the understory layer (defined as all woody plants less than 6m in height and all non-woody plans, regardless of height, including mosses and aquatic bed plants) and is weighted lower than the *TreeCov* sub-variable. See Appendix K for detailed information about composite variable calculation.

Scoring: The equation for *ET* generates a value between 0 and 10. The score for *ET* = 0 if the sub-unit has less than 5% tree cover. *ET* is calculated for EACH sub-unit then weighted by sub-unit area to determine the variable score. See Appendix E for detailed instructions on sub-unit weighting.

4 - Storm Surge Reduction

A. Definition and Description of Function

Storm Surge Reduction is defined as the processes by which wetlands reduce the amplitude and magnitude of storm generated surges.

Storm surge reduction means that the shoreward momentum of storm-generated waves and tidal flows is slowed and diminished. The presence of this function results in decreased volume and velocity of water moving inland during storm events.

Storm surge refers to water levels over and above the predicted astronomical tides and is primarily caused by storm generated winds, although high tides and low atmospheric pressure will increase the magnitude of storm-generated surges. During any single storm event, changes in storm intensity, speed, and angle of approach will affect the magnitude of storm surge.

Storm surge reduction is a subset of surface water detention; however, the driving forces are different enough to warrant evaluation separately. In contrast to typical downgradient flow, storm surge occurs when water is pushed upslope against gravity by wind and tidal forces. Some assessment methods combine storm surge reduction with shoreline stabilization as components of a broader shoreline protection function. However, shoreline stabilization is governed primarily by characteristics which promote sediment anchoring, which are different from the characteristics necessary to attenuate waves and high energy tidal flow. It is feasible that a wetland system might have high potential for storm surge reduction and low potential for shoreline stabilization, therefore NEWFA evaluates them as separate functions.

While storm surge is often associated with impacts to coastal communities from hurricanes, this phenomenon can result from non-tropical storms as well and may occur in the Great Lakes and other large open water bodies. In addition to creating threats to human life and livelihood, storm surge events often result in devastating damage to property and infrastructure. Numerous studies have attempted to quantify role that wetlands play in reducing the economic impact of storm surge **(Barbier, 2015; Barbier et al., 2013; Narayan et al., 2017)**. However, the wetland potential for storm surge reduction exists independent of the social or economic value of the existing nearshore communities and property.

Storm surge reduction is highly dependent on the characteristics of each event. Storms with equivalent wind velocity, but even slight differences in wind direction, may produce dramatically different waves due to the relationship between fetch and wave height. Modeling has shown that there is a non-linear relationship between surge attenuation and variables such as wave amplitude, storm duration, and event frequency **(Wamsley et al., 2010)**. Studies conducted in response to specific storm events have shown that they degree of protection afforded by a specific wetland is highly variable and context-dependent **(Garzon et al., 2019; Lathrop et al., 2019)**. However meta-analysis of wave attenuation by wetlands demonstrates that the presence of wetlands generally reduces wave heights, property damage, and human deaths. **(Gedan et al., 2010; Shepard et al., 2011)**

The primary characteristics/processes by which wetlands reduce storm surge are 1) landscape context and 2) frictional resistance.

The spatial relationship between a wetland and a water body subject to storm surge is the primary determinant in the storm surge reduction function. Wetlands fringing marine, estuarine or large lacustrine systems all have the potential to attenuate storm surge. Even wetland systems not immediately abutting a water body may reduce storm surge depending on the direction of flow, but as storm surge moves further inland, wetland influence changes to surface water detention rather than storm surge reduction. Other geomorphic characteristics that influence the actual degree of wave attenuation include the elevation of the wetland system relative to mean storm high water and the slope and character of the shore.

Storm surge reduction is also dependent on the size of the wetland system, primarily as a measure of available surface area. Areal extent serves as a proxy for temporary storage, larger wetlands can attenuate a larger volume of water. However, a wetland system's ability to reduce the velocity of surface water is a more important factor in storm surge reduction. High vegetation density and microtopographic features within wetlands increases surface roughness creating frictional resistance to storm surge. Larger wetland areas, including inland as well as fringing wetlands along the coastline, enhance storm surge reduction by surface area to interact with overland storm surge. Wider wetlands increase the distance over which storm surge must travel which results in greater frictional resistance and velocity reduction than long fringing wetlands.

The actual rate of storm surge reduction can be expressed as the precent reduction in wave height per unit area (m/ha). Independent quantitative measures include hydraulic monitoring of wave action and water levels in transects perpendicular to the shoreline during a storm surge event. However, the time and level of effort required by these methods is beyond the scope of a rapid assessment. Therefore, the level of functional capacity must be assessed indirectly using indicators that represent the characteristics which promote the reduction of storm surge by wetland systems.

B. Assessing Storm Surge Reduction

The potential that a wetland has to reduce storm surge is based on its ability to attenuate storm driven waves and tidal flow. Indicators of this potential are landscape position, size/width of the wetland, and presence of features which create frictional resistance to flow. The functional capacity grade for Storm Surge Reduction is calculated using a model that combines the variables *Detention* and *VelocityReduct* in the following equation:

$$\boldsymbol{FCG_{(SSR)} = \frac{4(Detention) + VelocityReduct}{5}}$$

Summary of Model

Property	Variables	Description
Landscape Context	Applicability	Wetland is adjacent to an open water feature
Holding Capacity	*Detention*	Capacity to detain water during storm surge event
	WetWidth	Average width of wetland system (not limited to the AU)
	SysTotal	Area of entire wetland system (not limited to the AU)
Hydrologic Movement	*VelocityReduct*	Structural reduction of water velocity
	MicroFeat	Presence and density of microtopographic features
	Understory	Areal cover of vegetation in the understory layer
	StemDensity	Density of tree stems (both live and standing dead)
	TreeCount	Total number of tree stems (both live and standing dead)
	TotalBA	Total basal area of tree stems (both live and standing dead)

$$\boldsymbol{FCG_{(SSR)} = \frac{4(Detention) + VelocityReduct}{5}}$$

$$Detention = \frac{2(WetWidth) + SysTotal}{3}$$

$$VelocityReduct = \frac{(MicroFeat + Understory + StemDensity) - min(\ MicroFeat, Understory, StemDensity)}{2}$$

$$\text{and } \ StemDensity = \sqrt[3]{TreeCount^2 \times TotalBA}$$

Model Description

The model for Storm Surge Reduction is comprised of two variables which represent the holding capacity of the wetland system and the presence of features that reduce surface water velocity. Landscape context is evaluated in the determination of applicability rather than as a variable in the model.

Applicability of the Storm Surge Reduction function is dependent on the presence and proximity of a water body which might be subject to a storm surge event at least occasionally. Applicability is evaluated in Part B of the data sheet and the model is not calculated if the assessment unit does not meet the criteria. Detailed criteria for applicability are outlined in Appendix G.

Detention is a composite variable which evaluates the holding capacity of the wetland. Complexes of abutting salt and freshwater wetland are considered separate assessment units. However, because the potential for storm surge reduction does not end at the assessment unit boundary, the sub-variable components of *Detention* evaluate the holding capacity of the entire wetland system. As holding capacity increases, the degree to which storm surge can be attenuated by the wetland also increases. Volume would be a more accurate indicator of holding capacity but because depth can vary widely and is often challenging to measure accurately in the context of a rapid assessment, area is used as a proxy for volume. In addition to system area, the shape of the wetland is accounted for by the *WetWidth* sub-variable. Because storm surge moves directionally inland, a wider wetland system will allow for greater storm surge reduction than a narrow system with the same total area, by increasing the distance over which attenuation can occur.

VelocityReduct is a composite variable which evaluates the presence and density of structural features which decrease the velocity of water moving across the surface of the wetland system. The sub-variable components of *VelocityReduct* describe structural vegetation characteristics such as the density of the understory layer and tree stem volume, as well as features such as boulders, coarse woody material, and microtopographic changes, all of which create surface irregularities that increase friction, thereby slowing water movement. Variability within the system is captured by computing a *VelocityReduct* sub-score for each vegetated wetland assessment unit and then calculating a weighted average to determine the variable score. See Chapter 5 and Appendix K for detailed discussion of the *VelocityReduct* variable.

Variables and Scoring

Detention – composite variable that represents the capacity of the system to detain water during a storm surge event.

Sub-Variables: *Detention* is calculated by combining the sub-variables *WetWidth* and *SysArea* in the following equation:

$$Detention = \frac{2(WetWidth) + SysTotal}{3}$$

WetWidth is the average width of the wetland as measured from the shoreline to the landward wetland edge along transects spaced every 100 meters. *SysTotal* is the area of entire wetland system (including but not limited to the assessment unit) and is weighted lower than *WetWidth*. See Appendix K for detailed information about composite variable calculation.

Scoring: The equation for *Detention* generates a value between 0 and 10. The score for *Detention* = 0 if the average width of the wetland system is less than 10 meters.

VelocityReduct – composite variable that represents the combination of structural vegetation and microtopographic features which contribute to the roughness of the soil surface creating frictional resistance to overland flow through the AU.

Sub-Variables: *VelocityReduct* is calculated by combining the sub-variables *Understory*, *StemDensity* and *MicroFeat* for each vegetated wetland sub-unit in the following equation:

$$\frac{(MicroFeat + Understory + StemDensity) - min(\ MicroFeat, Understory, StemDensity)}{2}$$

MicroFeat is an estimate of the density of microtopographic features which contribute to the roughness of the AU. *Understory* is an estimate of areal cover of vegetation in the understory layer. *StemDensity* is an estimate of the density of tree stems (both live and standing dead) rooted in the AU and is calculated by combining *TreeCount* (the number of trees) and *TotalBA* (total basal area) for each vegetated wetland sub-unit in the equation:

$$StemDensity = \sqrt[3]{TreeCount^2 \times TotalBA}$$

VelocityReduct is calculated by discarding the lowest scoring sub-variable (*MicroFeat*, *Understory*, or *StemDensity*) and finding the average of the remaining two sub-variables. See Appendix K for detailed information about composite variable calculation.

Scoring: The equation for *VelocityReduct* generates a value between 0 and 10. The score for *VelocityReduct* = 0 if the sub-unit has no microfeatures AND less than 5% understory cover AND there are no trees (or the total basal area is less than 0.0250). *VelocityReduct* is calculated for EACH sub-unit then weighted by sub-unit area to determine the variable score. See Appendix E for detailed instructions on sub-unit weighting.

5 - Shoreline Stabilization

A. Definition and Description of Function

Shoreline Stabilization is defined as the processes by which wetlands dampen erosive forces and strengthen the cohesiveness of shoreline sediments.

Shoreline stabilization means that the energy of incoming waves, currents and vessel wakes is absorbed by fringing wetlands and shoreline soil/sediments are held in place. The presence of this function results in the deceleration of shoreline recession and decreased nearshore sedimentation.

The shoreline, defined as the linear feature where a water body interfaces with the land, is continuously affected by the force of water in motion. Erosion of soil, sand and sediment occurs regularly in response. The role that wetlands play in reducing shoreline loss has been evaluated and investigated for decades **(Knutson & W. W. Woodhouse, 1983)**. The function has often referred to by terms like erosion reduction **(Carter, 1996)** and shoreline protection **(Atcheson et al., 1979)** which describe the outcome, but not the actual function performed by the wetland. The function is more accurately described as shoreline anchoring **(Stone et al., 2015)**, but NEWFA uses Shoreline Stabilization as the function name to account for the simultaneous processes of sediment anchoring and the dissipation of erosive forces.

Enormous investments have been made into structural defenses to protect coastal communities and property. Studies have shown that salt marsh is a key defense against shoreline loss **(Gracia et al., 2018)**. However, shoreline erosion is not limited to coastal areas, it can occur along the edge of any water body where erosive wave action occurs frequently enough to wear away soils, sands, and rocks. Erosive wave-action can result from normal tidal flow, be wind-driven or storm-induced, or be human-made by motorized vessel traffic. Shoreline stabilization protects against loss of land and infrastructure along the water's edge and reduces turbidity in nearby waters.

The primary characteristics/processes by which wetlands stabilize the shoreline are 1) landscape context, 2) dissipation of energy and 3) anchoring of sediments.

Shoreline stabilization describes the processes by which vegetated wetlands promote sediment deposition, increase marsh elevations through below ground production, and stabilize marsh sediments. All wetlands located on the shore of an open water body may play a role in the stabilization of the shoreline, however the magnitude of and vulnerability to erosive energy depends on fetch distance, water depth, regularity of nearby boat traffic as well as the slope and aspect of the shoreline.

The erosive energy of waves and currents is greatly reduced by the frictional resistance of dense vegetation cover. Plants in wetlands act as a buffer by dissipating the water's energy and providing mechanical stabilization of soil. Plant roots create a net-like structure within the soil surface increasing soil resistance to the shear stress caused by flowing water. Greater vegetation density within the wetland provides more roots to stabilize the soil, protecting it from erosion **(Shepard et al., 2011)**.

The actual rate of shoreline stabilization can be expressed as net hectares of marsh gained or lost/year/km of coastline (m3/ha/time). Independent quantitative measures include placing markers along the wetland/waterbody perimeter and measuring any amount of shoreline recession over time. However, the time and level of effort required by these methods is beyond the scope of a rapid assessment. Therefore, the level of functional capacity must be assessed indirectly using indicators that represent the characteristics which promote shoreline stabilization by wetlands.

B. Assessing Shoreline Stabilization

The potential that a wetland has to stabilize the shoreline is based on its ability attenuate erosive forces and anchor shoreline sediment. Indicators of this potential are landscape position, width of the wetland, and density of vegetation along the shoreline. The functional capacity grade for Storm Surge Reduction is calculated using a model that combines the variables *WetWidth* and *VegCov* in the following equation:

$$\boldsymbol{FCG_{(ShS)}} = \sqrt{\boldsymbol{WetWidth} \times \boldsymbol{VegCov}}$$

Summary of Model

Property	Variables	Description
Landscape Context	Applicability	Wetland is contiguous with the shoreline of an open water body
Vegetation Structure	*WetWidth*	Average width of wetland system (not limited to the AU)
	VegCov	Overall vegetation cover
$\boldsymbol{FCG_{(ShS)}} = \sqrt{\boldsymbol{WetWidth} \times \boldsymbol{VegCov}}$		

Model Description

The model for Shoreline Stabilization is comprised of two variables which represent the surface area of the system and vegetation cover. Landscape context is evaluated in the determination of applicability rather than as a variable in the model.

Applicability of the Shoreline Stabilization function is dependent on the presence and proximity of a water body whose shoreline may be subject to erosive wave action. Applicability is evaluated in Part B of the data sheet and the model is not calculated if the assessment unit does not meet the criteria. Detailed criteria for applicability are outlined in Appendix G.

The variable *VegCov* evaluates the overall vegetation cover. Areas of bare ground, lacking vegetation will be the more vulnerable to erosive forces. The *VegCov* variable assesses the percentage of the wetland which is lacking any vegetation. Wetlands with a higher percentage of bare ground receive a lower score for *VegCov.*

WetWidth evaluates the width of the wetland, by averaging a series of transects perpendicular to the shoreline spaced every 100m. Since the dampening effect increases as the width of the wetland increases, wetlands with a higher average width receive a higher score for *WetWidth*.

Variables and Scoring

WetWidth – the average width of the wetland system as measured from the shoreline.

Indicators: The distance between the shoreline and the landward edge of the wetland system is measured every 100m along transects perpendicular to the shoreline using GIS in the office AFTER the wetland system extent has been confirmed in the field and finalized. The average width is calculated and recorded in Section G-7c of the Data Sheet.

Scoring: Each of the six *WetWidth* classes is assigned a numeric score between 0 and 10 (see table below). The score for the applicable width class will determine the variable score.

***WetWidth* Values and Scores (Shoreline Stabilization)**					
WIDTH CLASS	SCORE	WIDTH CLASS	SCORE	WIDTH CLASS	SCORE
< 5 meter(s)	0	10 to < 15 meters	4	20 to < 25 meters	8
5 to < 10 meters	2	15 to < 20 meters	6	≥ 25 meters	10

VegCov – estimate of the extent of vegetation cover of any type throughout the AU.

Indicators: Vegetation cover is evaluated by recording the cover class that best corresponds to the areal extent of any UNVEGETATED areas (defined as areas with less than 5% vegetation cover) in Section C-1b(5) of the Data Sheet at EACH Vegetated Wetland Sub-Unit in the field.

Scoring: Each of the ten *VegCov* unvegetated area classes is assigned a numeric score between 0 and 10 (see table below). Lower classes of unvegetated areas imply higher vegetation cover and receive higher scores. The user notes the score for the class recorded at each Sub-Unit. The Sub-Unit scores are weighted by area to determine the variable score used to calculate the FCG. See Appendix E for detailed instructions on sub-unit weighting.

***VegCov* Classes and Scores (Shoreline Stabilization)**					
UNVEGETATED AREA	SCORE	UNVEGETATED AREA	SCORE	UNVEGETATED AREA	SCORE
None	10	16 – 25%	8	75 – 84%	2
<1% (Trace)	10	26 – 39%	7	85 – 95%	1
1 – 4%	10	40 – 60%	5	> 95%	0
5 – 15%	9	61 – 74%	3		

6 - Bank Stabilization

A. Definition and Description of Function

Bank Stabilization is defined as the processes by which wetlands stabilize and protect streambanks from erosion.

Bank stabilization means that the terrain bordering a river or stream is strengthened against the erosive forces of flowing water and gravity. The presence of this function results in reduced sediment loading downgradient.

The role that wetlands play in both shoreline and streambank stabilization are often assessed simultaneously. However, shoreline erosion is primarily due to wave and tidal energy exerting force perpendicular to the wetland and bank erosion is due to flowing water exerting force parallel to the wetland. Because the erosional forces are not equivalent, the functional indicators are different and NEWFA assesses Shoreline Stabilization and Bank Stabilization as separate functions.

Streambank erosion is a natural process that occurs when the forces exerted by flowing water exceed the resisting forces of bank materials and vegetation. Urbanization, increased surface runoff and other watershed scale changes, can intensify the frequency and magnitude of flooding, causing an increase in the likelihood of erosive flow. Anthropogenic activities such as animal grazing or vegetation removal can also contribute to streambank erosion by compromising streambank structure.

Stream bank instability and associated sedimentation are major issues of environmental concern due to their detrimental effects on agricultural land, infrastructure, and natural resources. In addition to immediate impacts such as the loss of land and damage to road crossings, bank erosion is a major source of downstream sedimentation. Increased sediment loads in streams lead to sediment infill in lakes, natural or constructed, and delta and bay areas along coastlines. Sediment pollution affects the overall ecological health of aquatic resources, by decreasing water quality, primary productivity and faunal species richness.

The primary characteristics/processes driving streambank stabilization are 1) landscape context, 3) frictional resistance, and 3) anchoring of sediments.

Landscape context plays a critical role in the streambank stabilization potential of wetlands. There is a circular relationship between the presence of wetlands along the banks of a stream and that wetlands ability to stabilize the bank against erosive forces. Because streambank erosion often results in catastrophic failure of the bank, any wetland currently located along a stream must have provided some resistance to the forces exerted by flowing water.

Other watershed scale factors can affect the potential of riparian wetlands to provide on-going bank stabilization. Nearby land use may drive an increase in the frequency and magnitude of stream flow, overpowering the stabilizing forces provided by adjacent wetlands. The likelihood of streambank erosion or slope failure also increases as the elevation and slope of the streambank increases.

Wetland plants counter these forces by absorbing energy, slowing the near-bank velocity of flowing water, and providing stability to the soils with their extensive root systems. Vegetation along streambanks provides frictional resistance to flow, and serves as buffer by trapping sediment, redirecting flow decreasing flow velocity. **(Hecker et al., 2019)** As flow velocity decreases, the cohesiveness of stream bank sediments is able to provide increased resistance to erosion.

A particular soil's resistance to erosion depends on its cohesiveness and particle size. Sandy soils have low cohesion, and their particles are small enough to be entrained by velocity flows of 2 or 3 feet per second. **(NRCS, 1996)** However, wetland soils are likely to have a greater fraction of fines and organic matter.

Vegetation plays a critical role in bank stabilization by anchoring sediments with roots. As plants grow, their roots elongate vertically and horizontally within the soil and increase in diameter. The roots create a net-like structure within the soil surface that reduces erosion by increasing soil resistance to the shear stress caused by flowing water.**(Simon & Collison, 2002)**

Erosion due to ice scour may also be minimized by the presence of vegetation. Ice accelerates streambank erosion through damaging cycles of freezing and thawing. Vegetation reduces these cycles by maintaining the temperature of bank sediments, preventing ice from forming and encouraging faster thawing.**(NRCS, 1996)**

Independent quantitative measures include monitoring bank erosion over time by installing monitoring devices in areas with different vegetation densities along wetland streambanks. However, the time and level of effort required by these methods is beyond the scope of a rapid assessment. Therefore, the level of functional capacity must be assessed indirectly using indicators that represent the characteristics which promote streambank stabilization by wetlands.

B. Assessing Bank Stabilization

The potential that a wetland has to stabilize the streambank is based on its ability to decrease near bank flow velocity and anchor streambank sediment. Indicators of this potential are landscape position and the density of vegetation along the streambank. The functional capacity grade for Bank Stabilization is calculated using a model that combines the variables *BankHerbCov* and *BankVegCov* in the following equation:

$$\boldsymbol{FCG_{(BkS)}} = \frac{\boldsymbol{BankHerbCov + BankVegCov}}{\boldsymbol{2}}$$

Summary of Model

Property	Variables	Description
Landscape Context	Applicability	Wetland is located along a stream with one or more vertical banks
Vegetation Structure	*BankHerbCov*	Areal cover of herbaceous vegetation on the streambank
	BankVegCov	Overall vegetation cover on the streambank

$$\boldsymbol{FCG_{(BkS)}} = \frac{\boldsymbol{BankHerbCov + BankVegCov}}{\boldsymbol{2}}$$

Model Description

The model for Bank Stabilization is comprised of two variables which represent the characteristics of vegetation along the bank. Landscape context is evaluated in the determination of applicability rather than as a variable in the model.

Applicability of the Bank Stabilization function is dependent on the presence and proximity of a stream with at least one vertical bank which is vulnerable to erosion. Applicability is evaluated in Part B of the data sheet and the model is not calculated if the assessment unit does not meet the criteria. Detailed criteria for applicability are outlined in Appendix G.

Vegetation type and structure is characterized by the *BankVegCov* and *BankHerbCov* variables. Areas lacking vegetation are particularly vulnerable to erosive forces. Dense vegetation serves to anchor sediment and herbaceous vegetation creates the most stabilizing root mat. *BankHerbCov* evaluates the density of non-woody vegetation along the streambank, whereas *BankVegCov* the evaluates the percentage of the streambank which is lacking vegetation of any type.

Variables and Scoring

BankHerbCov – estimate of the areal cover of herbaceous vegetation on the streambank.

Indicators: Areal cover of herbaceous vegetation (defined as all non-woody plants, regardless of height, including mosses and aquatic bed plants) within 10m of the streambank edge is recorded by cover class in Section E-5b(1) of the Data Sheet.

Scoring: Each of the ten *BankHerbCov* cover classes is assigned a numeric score between 0 and 10 (see table below). The score for the applicable cover class is used to calculate the FCG.

***BankHerbCov* Classes and Scores (Bank Stabilization)**							
COVER CLASS	SCORE	COVER CLASS	SCORE	COVER CLASS	SCORE	COVER CLASS	SCORE
None	0	5 – 15%	1	40 – 60%	5	85 – 95%	9
<1% (Trace)	0	16 – 25%	2	61 – 74%	7	> 95%	10
1 – 4%	0	26 – 39%	3	75 – 84%	8		

BankVegCov – estimate of the extent of vegetation cover of any type on the stream bank.

Indicators: Vegetation cover on the streambank is evaluated by recording the cover class that best corresponds to the areal extent of any UNVEGETATED areas (defined as areas with less than 5% vegetation cover) within 10m of the streambank edge in Section E-5b(2) of the Data Sheet.

Scoring: Each of the ten *BankVegCov* unvegetated area classes is assigned a numeric score between 0 and 10 (see table below). Lower classes of unvegetated areas imply higher vegetation cover and receive higher variable scores. The score for the applicable class is used to calculate the FCG.

***BankVegCov* Classes and Scores (Bank Stabilization)**					
UNVEGETATED AREA	SCORE	UNVEGETATED AREA	SCORE	UNVEGETATED AREA	SCORE
None	10	16 – 25%	8	75 – 84%	2
<1% (Trace)	10	26 – 39%	7	85 – 95%	1
1 – 4%	10	40 – 60%	5	> 95%	0
5 – 15%	9	61 – 74%	3		

7 - Particulate Retention

A. Definition and Description of Function

Particulate Retention is defined as the processes by which wetlands slow runoff and intercept particulate matter from the water column.

Particulate retention means that waterborne sediment and suspended solids are removed from inflowing surface water and retained within the system. The presence of this function results in a reduction of particulate matter flowing to downgradient waters, reducing turbidity, sedimentation and generally improving downstream water quality.

Although the processes governing particulate retention function are very similar to those governing surface water detention, they are not the same function and are assessed separately. The term detention implies that storage is short-term, whereas retention refers to long-term, theoretically permanent storage in the system. Surface water only needs to remain in the system long enough to delay peak discharge downstream, reducing the risk of flash flooding. Temporary removal of particulates from surface flow, however, does not improve water quality in the long term. Particulates must be retained in the system indefinitely to reduce downstream sediment pollution.

Sediment pollution affects the overall ecological health of aquatic resources, by decreasing water quality, primary productivity and faunal species richness. In addition to reducing turbidity and lowering concentrations of suspended solids, retention of particulate matter facilitates other water quality functions. Water quality functions occur when nutrients or toxicants are transported into the wetland, primarily by surface water, and then detained long enough for storage or alteration of those substances to occur. Particulate retention thereby results in an overall reduction of potential pollutants in downgradient waters. **(Bernard et al., 1996)**

The primary processes driving retention of particulates are: 1) sediment/particulate transport, 2) sedimentation/settling and 3) filtration/entrapment.

Geomorphic position influences the movement of surface water through the system. Surface water flowing into the wetland must enter with enough velocity to transport sediment and suspended solids. Wetlands located in depressions and floodplains are best situated to receive sediment laden input waters **(Tiner, 2003)**. Wetlands located on slopes are less likely to retain particulates because they do not impound surface water, resulting in a relatively short residence time for deposition to occur. Systems with restricted outlets will retain particulates most effectively, however wetlands may also have internal features which impede surface water flow and facilitate retention of particulates.

Sediment deposition begins to occur when the force of gravity overcomes the transport capacity of runoff. As flow velocity decreases, particulate matter begins to settle on the substrate below. The velocity at which sedimentation and settling occurs is inversely correlated with particle size. Larger particles will drop out of the water column more readily than fine particles which may remain suspended until flow velocity is reduced to zero.

In addition to particulate retention due to deposition, wetlands have characteristics which impede surface water flow and trap particulates. Closed systems or those with restricted outlet prevent throughflow and will likely retain all incoming particulates. Internal structural features and dense vegetation also facilitate particulate retention by slowing flow velocity and trapping entrained particulate matter.

The actual rate of particulate retention can be expressed as the amount of particulates retained per unit area over a specified period of time (e.g., g/m2 per year). Independent quantitative measures include long term monitoring of sediment accretion or measurements of particulate and suspended solid levels upgradient and downgradient of the wetland system. Approaches to measure sediment accretion typically involve measuring changes in elevation relative to a marker horizon or collecting and weighing sediment samples. These methods calculate change over time and require installation of a fixed measurement apparatus and multiple field visits at pre-determined time intervals, ranging from daily to annually. Sediment accretion rates can also be determined by comparing concentrations of the radioisotope cesium-137 (137Cs) at different depths throughout a soil core **(Lane & Autrey, 2017)**. Water samples collected at the inflow and outflow points can be tested to assess whether levels of suspended solids are decreased as flow exits the system. However, the time and level of effort required by these methods is beyond the scope of a rapid assessment. Therefore, the level of functional capacity must be assessed indirectly using indicators that represent the characteristics which promote particulate retention by wetlands.

B. Assessing Particulate Retention

The potential that a wetland has to retain particulates is based on its ability to receive incoming surface water and reduce flow velocity such that sedimentation and settling can occur within the wetland. Indicators of this potential are landscape position and the presence of biotic and abiotic features that impede flow/reduce velocity. The functional capacity grade for Particulate Retention is calculated using a model that combines the variables *Position*, *FlowRestrict*, and *VelocityReduct* in the following equation:

$$\boldsymbol{FCG_{(PaR)} = \frac{3\left(\sqrt[3]{Position \times FlowRestrict^2}\right) + 2(VelocityReduct)}{5}}$$

Summary of Model

Property	Variables	Description
Landscape Context	*Position*	Geomorphic position of the AU
Hydrologic Movement	*FlowRestrict*	Presence and characteristics of flow restriction features
	VelocityReduct	Structural reduction of water velocity
	MicroFeat	Microtopographic feature density
	Understory	Areal cover of vegetation in the understory layer
	StemDensity	Density of tree stems (both live and standing dead)
	TreeCount	Total number of tree stems (both live and standing dead)
	TotalBA	Total basal area of tree stems (both live and standing dead)

$$\boldsymbol{FCG_{(PaR)} = \frac{3\left(\sqrt[3]{Position \times FlowRestrict^2}\right) + 2(VelocityReduct)}{5}}$$

$$VelocityReduct = \frac{(MicroFeat + Understory + StemDensity) - min(\,MicroFeat, Understory, StemDensity)}{2}$$

and $StemDensity = \sqrt[3]{TreeCount^2 \times TotalBA}$

Model Description

The model for Particulate Retention is comprised of three variables which represent the landscape context and the presence of features that impede flow/reduce velocity.

Landscape context is characterized by the *Position* variable. *Position* values defined by NEWFA combine topographic location, hydrologic inputs and/or relationship to a water body to categorize a wetland's geomorphic setting. The *Position* categories are ranked by their relative suitability to receive and detain surface water flowing into the system long enough for settling and sedimentation to occur. However, wetlands always have some degree of topographic and hydrologic variability within the system and some assessment units may span more than one landscape position. The potential for particulate retention does not need to be equivalent at every point in the assessment unit, the functional capacity grade represents the likelihood that particulate retention will occur somewhere within the system. This variability is captured by recording landscape position at each soil examination area and using the highest ranked position value as the variable score to indicate the overall potential for particulate retention.

Movement of surface water within the wetland is characterized by the *FlowRestrict* and *VelocityReduct* variables. *FlowRestrict* values account for the presence of features which obstruct downstream flow entirely (e.g., an abandoned weir) as well as features which create a bottleneck, thus slowing the flow of water through the system (e.g., undersized culverts). *VelocityReduct* is a composite variable which represents the roughness of the system.

The *FlowRestrict* values are ranked by the relative degree with which they restrict the passage of water through the assessment unit. All possible features are recorded, documentation is not limited to the characteristics of the outlet. Restriction or reduction of flow can occur at any point within the system. The most restrictive feature is ranked the highest and is used as the variable score, representing the location where sediment deposition is most likely to occur.

The *VelocityReduct* variable evaluates the presence and density of structural features which decrease the velocity of water moving across the surface of the assessment unit. The sub-variable components of *VelocityReduct* describe structural vegetation characteristics such as density of the understory layer and tree stem volume, as well as features such as boulders, coarse woody material, and microtopographic changes, all of which create surface irregularities that increase friction, thereby slowing water movement. Variability within the system is captured by computing a *VelocityReduct* sub-score for each vegetated wetland assessment unit and then calculating a weighted average to determine the variable score. See Chapter 5 and Appendix K for detailed discussion of the *VelocityReduct* variable.

Variables and Scoring

Position – the landscape context (geomorphic position or location) of the AU.

Indicators: Landscape position is evaluated remotely before the site visit and then confirmed in the field and recorded in Section D-1b of the Data Sheet at EACH Soil Examination Area.

Scoring: Each of the 12 *Position* value options is assigned a numeric score between 1 and 10 (see table below). The user notes the score for landscape position value recorded at each SEA. The SEA value with the HIGHEST score (optimal landscape position to retain particulates) will determine the variable score.

Position **Values and Scores (Particulate Retention)**					
VALUE	SCORE	VALUE	SCORE	VALUE	SCORE
Groundwater Slope	1	Groundwater Depression	10	Marine Fringe	1
Surface Water Slope	1	Surface Water Depression	10	Estuarine Fringe	5
Groundwater Flat	5	River/Stream Fringe	1	Fresh Water Tidal Fringe	5
Surface Water Flat	5	River/Stream Floodplain	7	Lake/Pond Fringe	2

FlowRestrict – the presence and characteristics of features which slow or restrict the passage of surface water through the AU.

Indicators: ALL flow restriction features observed within the AU are documented and recorded in Section E-1 of the Data Sheet during the site visit.

Scoring: Each of the 23 *FlowRestrict* value options is assigned a numeric score between 1 and 10 (see table below). The user notes the score for each flow restriction feature recorded. The value with highest score (most effective at slowing/reducing water flow and retaining particulates) will determine the variable score.

FlowRestrict **Values and Scores (Particulate Retention)**			
VALUE	SCORE	VALUE	SCORE
Open Exchange – Tidal	2	Culvert Present – Receiving Flow	-
Open Exchange – Non-Tidal	1	Culvert >75% of stream width	2
Channel Present – Unrestricted	1	Culvert 50-75% of stream width	4
Human or Beaver Constructed Dam Present	9	Culvert 25-50% of stream width	6
Channel Present – Restricted by Debris Jam	-	Culvert < 25% of stream width	8
Debris spans < 25% of channel width	3	Culvert Present – Not Receiving Flow	-
Debris spans 25-50% of channel width	5	Culvert Partially Blocked by Debris	5
Debris spans 50-75% of channel width	7	Culvert Totally Blocked by Debris	10
Debris spans >75% of channel width	9	Culvert Located too High Above Flow	10
Channel Width Narrowed by Geology/Structure	-	Tide Gate/Weir Present	-
Channel narrows < 25%	2	Operational	5
Channel narrows 25-50%	3	Non-operational (Open)	2
Channel narrows 50-75%	4	Non-operational (Closed)	10
Channel narrows >75%	6	Closed System (No Outlet)	10

VelocityReduct – composite variable that represents the combination of structural vegetation and microtopographic features which contribute to the roughness of the soil surface, creating frictional resistance to overland flow through the AU.

Sub-Variables: *VelocityReduct* is calculated by combining the sub-variables *Understory*, *StemDensity* and *MicroFeat* for each vegetated wetland sub-unit in the following equation:

$$\frac{(MicroFeat + Understory + StemDensity) - min(\ MicroFeat, Understory, StemDensity)}{2}$$

MicroFeat is an estimate of the density of microtopographic features which contribute to the roughness of the AU. *Understory* is an estimate of areal cover of vegetation in the understory layer. *StemDensity* is an estimate of the density of tree stems (both live and standing dead) rooted in the AU and is calculated by combining *TreeCount* (the number of trees) and *TotalBA* (total basal area) for each vegetated wetland sub-unit in the equation:

$$StemDensity = \sqrt[3]{TreeCount^2 \times TotalBA}$$

VelocityReduct is calculated by discarding the lowest scoring sub-variable (*MicroFeat*, *Understory*, or *StemDensity*) and finding the average of the remaining two sub-variables. See Appendix K for detailed information about composite variable calculation.

Scoring: The equation for *VelocityReduct* generates a value between 0 and 10. The score for *VelocityReduct* = 0 if the sub-unit has no microfeatures AND less than 5% understory cover AND there are no trees (or the total basal area is less than 0.0250). *VelocityReduct* is calculated for EACH sub-unit then weighted by sub-unit area to determine the variable score. See Appendix E for detailed instructions on sub-unit weighting.

8 - Nitrogen Transformation

A. DEFINITION AND DESCRIPTION OF FUNCTION

Nitrogen Transformation is defined as the processes by which wetlands remove and transform excess nitrogen in the water column.

Nitrogen transformation means that nitrogen entering the system in surface water and runoff is cycled through forms useable by plants and microorganisms and/or transformed into nitrogen gas. The presence of this function results in decreased nitrogen loadings and improved water quality in downstream waters.

Atmospheric nitrogen is absorbed and converted by plants supply a key nutrient for vegetation, recycled as detritus, and eventually returned to the atmosphere in a series of biogeochemical reactions known as the nitrogen cycle. Cycling of nitrogen and other nutrients is fundamental to the support of net primary production and the general maintenance of water quality. Wetland ecosystems contain unique biologic and chemical processes which facilitate nitrogen cycling.

Although almost every wetland assessment method addresses water quality improvement, each method takes a slightly different approach. Many HGM guidebooks evaluate water quality improvement as one overarching function such as "biogeochemical processes" **(Noble et al., 2002)** or "remove, convert, and sequester dissolved substances" **(Gilbert et al., 2006)**. Some methods assess cycling of nutrients **(Murray & Klimas, 2013)** while others consider the function to be the ability of the wetland to remove nutrients from the water column **(Stone et al., 2015)**. The characteristics necessary for removal/retention/transformation/sequestration are different depending on whether the substance in question is nitrogen, phosphorus, carbon or an element such as heavy metals. For this reason, NEWFA evaluates each of those in a separate function.

Nutrients like nitrogen and phosphorus are essential for plant growth, however, there has been an increase in nutrients entering aquatic systems via runoff or groundwater as a result of anthropogenic activities. Excess nutrients, primarily due to the use of fertilizers in agricultural or residential applications, become pollutants when they are concentrated in the aquatic environment. **(Wurtsbaugh et al., 2019)** Waters with high levels of nitrogen contamination are likely to become eutrophic, particularly in slow flowing bodies of water **(Dodds & Smith, 2016)**. Eutrophication can lead to the rapid growth of algae, other phytoplankton, and cyano-bacteria and can result in an overgrowth that decreases dissolved oxygen levels **(Harper, 1992)**. Low dissolved oxygen levels negatively impact fish health, result in fish kills and other organism mortality, reduce submerged aquatic vegetation as well as spawning habitat, and increase invasive species or predation **(Anderson, D.M. et al., 2008)**.

The primary processes by which wetlands remove and transform nitrogen from surface water are: a) sedimentation, 2) plant uptake, and 3) denitrification.

Longer surface water residence time facilitates nitrogen transformation by increasing sedimentation and sorption of dissolved and suspended nitrogen from the water column **(Madsen et al.; Saunders & Kalff, 2001)**. Residence time is primarily driven by geomorphic setting, however high vegetation density also increases residence time by slowing the rate of outflow.

High vegetation density also means increased availability of biomass for nitrogen uptake. The rate of plant uptake varies with different forms of nitrogen. Most plant species readily absorb inorganic nitrogen in the forms of ammonium and nitrates produced when organic nitrogen is released plant tissue products through microbially mediated decomposition **(White, J.R. & Reddy, 2009)**. Inorganic nitrogen also can be absorbed for growth as nitrite in some cases but is not a preferred source of nitrogen for most plants **(Yu & Ehrenfeld, 2009)**. Agricultural runoff and wastewater primarily contribute ammonium and nitrates to the system. Nitrite is typically found in very low concentrations because it is readily oxidized to nitrate through nitrification. **(Britto & Kronzucker, 2013)** Organic nitrogen in living biomass is only temporarily contained, burial of detrital biomass in wetlands with high rates of peat/sediment accretion may result in longer-term retention of nitrogen. **(Saunders & Kalff, 2001)**.

Although sedimentation and plant uptake do not directly result in a net decrease of nitrogen to downstream waters, they facilitate the process of denitrification in which nitrogen is completely removed from the aquatic environment. During denitrification nitrates are transformed into nitrogen gas transferring nitrogen to the atmosphere through chemical reduction by anaerobic bacteria **(Saunders & Kalff, 2001)**. Nitrogen transformation through denitrification heavily depends on the anaerobic conditions near the soil surface in a wetland system, which slows decomposition. In aerobic conditions, ammonification will occur during decomposition, transforming organic nitrogen back into ammonium and denitrification will not occur **(Saunders & Kalff, 2001)**. Although ammonification is an important component of nutrient cycling, only the actual removal of nitrogen from the system will result in reduced downstream nitrogen loading.

The actual rate of nitrogen transformation can be expressed as the amount of nitrogen removed or retained per unit area during a specified period of time (m3/ha/time). Independent quantitative measures include sampling ammonium and nitrate concentrations of input and output water over time to calculate an average change in concentrations (usually ppm or mg/L). However, the time and level of effort required by these methods is beyond the scope of a rapid assessment. Therefore, the level of functional capacity must be assessed indirectly using indicators that represent the characteristics which promote nitrogen transformation by wetlands.

B. Assessing Nitrogen Transformation

The potential that a wetland has to transform nitrogen is based on its ability to remove and utilize excess nitrogen in incoming surface water. Indicators of this potential are surface water residence time and amount of available biomass. The functional capacity grade for Nitrogen Transformation is calculated using a model that combines the variables *Retentionability* and *NitrogenBiomass* in the following equation:

$$\boldsymbol{FCG_{(Ntr)} = \frac{2(Retentionability) + NitrogenBiomass}{3}}$$

Summary of Model

Property	Variables	Description
Retention Time	*Retentionability*	Ability to retain water & dissolved or particulate matter
	Position	Location (geomorphic position) of AU on the landscape
	FlowRestrict	Presence and characteristics of flow restriction features
	VelocityReduct	Structural reduction of water velocity
	MicroFeat	Microtopographic feature density
	Understory	Areal cover of vegetation in the understory layer
	StemDensity	Density of tree stems (both live and standing dead)
	TreeCount	Total number of tree stems (both live and standing dead)
	TotalBA	Total basal area of tree stems (both live and standing dead)
Living Biomass	*NitrogenBiomass*	Biomass available for nitrogen transformation
	HerbCov	Areal cover of vegetation in the herbaceous layer
	ShrubCov	Areal cover of vegetation in the shrubaceous layer
	TreeCov	Areal cover of vegetation in the tree layer

$$\boldsymbol{FCG_{(Ntr)} = \frac{2(Retentionability) + NitrogenBiomass}{3}}$$

$$Retentionability = \frac{3\left(\sqrt[3]{Position \times FlowRestrict^2}\right) + 2(VelocityReduct)}{5}$$

$$VelocityReduct = \frac{(MicroFeat + Understory + StemDensity) - min(\ MicroFeat, Understory, StemDensity)}{2}$$

and $StemDensity = \sqrt[3]{TreeCount^2 \times TotalBA}$

$$NitrogenBiomass = \frac{2(HerbCov) + 2(Understory) + TreeCov}{5}$$

Model Description

The model for Nitrogen Transformation is comprised of two variables which represent surface water residence time and characteristics of the vegetation present in the wetland.

The *Retentionability* variable is a composite variable which evaluates surface water residence time in the wetland. *Retentionability* is a NEWFA specific term, defined as the capacity of a wetland to restrict and slow the flow of surface water long enough for one or more water quality related biogeochemical processes to occur. The sub-variable components of *Retentionability* describe the landscape context and the presence of biotic and abiotic features that impede flow/reduce velocity. Because these sub-variables mirror the indicators used to evaluate retention of particulates, the score for *Retentionability* is equivalent to the FCG for the Particulate Retention function. The velocity reduction component of *Retentionability* influences the rate of sedimentation as surface water moves into and through the wetland. Increased sedimentation promotes the anaerobic conditions which facilitate biogeochemical cycling in wetlands. Longer residence time results in increased nitrogen uptake and transformation through denitrification. See Chapter 5 and Appendix K for detailed discussion of the *Retentionability* variable.

Vegetation type and structure is characterized by the *NitrogenBiomass* variable. *NitrogenBiomass* is a composite variable which represents the amount of biomass available for uptake and transformation of nitrogen within the assessment unit. The sub-variable components of *NitrogenBiomass* describe the composition of the plant community and the relative importance of herbs, shrubs and trees. Variability within the system is captured by computing a *NitrogenBiomass* sub-score for each vegetated wetland assessment unit and then calculating a weighted average to determine the variable score. See Chapter 5 and Appendix K for detailed discussion of the *NitrogenBiomass* variable.

Variables and Scoring

Retentionability – composite variable that represents the combination of features which influence the residence time of surface water in the AU.

Sub-Variables: Retentionability is calculated by combining the sub-variables *Position*, *FlowRestrict* and *VelocityReduct* in the following equation:

$$Retentionability = \frac{3\left(\sqrt[3]{Position \times FlowRestrict^2}\right) + 2(VelocityReduct)}{5}$$

Position is the landscape context or geomorphic position of the AU. *FlowRestrict* describes the presence and characteristics of features which slow or restrict the passage of surface water through the AU. *VelocityReduct* is a composite variable that represents the combination of structural vegetation and microtopographic features which contribute to the roughness of the soil surface and create frictional resistance to overland flow through the AU. *VelocityReduct* is calculated by combining the sub-variables *Understory*, *StemDensity* and *MicroFeat* for each vegetated wetland sub-unit in the following equation:

$$\frac{(Understory + StemDensity + MicroFeat) - \min(Understory, StemDensity, MicroFeat)}{2}$$

Scoring: The equation for *Retentionability* generates a value between 1 and 10. See Appendix K for detailed information about composite variable calculation and scoring.

NitrogenBiomass – composite variable that represents the amount of living biomass available for uptake and transformation of nitrogen within the AU.

Sub-Variables: *NitrogenBiomass* is calculated by combining the sub-variables *HerbCov*, *ShrubCov* and *TreeCov* for each vegetated wetland sub-unit in the following equation:

$$NitrogenBiomass = \frac{4(HerbCov) + 2(ShrubCov) + TreeCov}{5}$$

HerbCov is an estimate of the areal cover of vegetation in the herbaceous layer (defined as all non-woody plants including mosses and aquatic bed plants) and is weighted the highest of the sub-variables. *ShrubCov* is an estimate of the areal coverage of vegetation in the shrubaceous layer (defined as all woody plants less than 6m in height). *TreeCov* is an estimate of the areal cover of vegetation in the tree layer (defined as all live woody plants 6m or taller, regardless of diameter) and is weighted lower than the *HerbCov* and *ShrubCov* sub-variables. See Appendix K for detailed information about composite variable calculation.

Scoring: The equation for *NitrogenBiomass* generates a value between 0 and 10. If the sub-unit has less 5% herbaceous cover AND less than 5% shrubaceous cover AND less than 5% tree cover the score for *NitrogenBiomass* will be 0. *NitrogenBiomass* is calculated for EACH sub-unit then weighted by sub-unit area to determine the variable score. See Appendix E for detailed instructions on sub-unit weighting.

9 - Phosphorus Retention

A. Definition and Description of Function

Phosphorus Retention is defined as the processes by which wetlands remove and bind excess phosphorus in the water column.

Phosphorus retention means that particulate/dissolved organic phosphorus and inorganic phosphates are immobilized and retained within the wetland. The presence of this function results in decreased phosphorus loadings in downgradient waters.

Naturally occurring phosphorus has multiple sources, including parent geologic material, and may enter the system in both dissolved and particulate forms. While phosphorus is a key nutrient for plant growth, only dissolved inorganic phosphorus is considered bioavailable, whereas organic and particulate phosphorus forms generally must undergo transformations to inorganic forms before being considered bioavailable. The cycling of phosphorus and other nutrients is a fundamental to the support of net primary production and the general maintenance of water quality. Wetland ecosystems contain unique biologic and chemical processes which facilitate these processes.

Because both organic and inorganic phosphorus exist in both particulate and dissolved forms, each governed by different retention mechanisms, it is important to reemphasize that NEWFA assesses that the potential for phosphorus retention, rather than current retention, which will depend on which form is present at any given moment.

Although almost every wetland assessment method addresses functions related to water quality, each method takes a slightly different approach. Many HGM guidebooks evaluate water quality improvement as one overarching function such as “biogeochemical processes” **(Noble et al., 2002)** or “remove, convert, and sequester dissolved substances” **(Gilbert et al., 2006)**. Some methods assess the cycling of nutrients **(Murray & Klimas, 2013)** as a component of water quality maintenance, however NEWFA assesses the remediation/improvement of water quality by focusing on the processes that prevent the downstream transport of nutrients by removing them from the water column completely. The characteristics necessary for removal/retention/transformation/sequestration are different depending on whether the substance in question is nitrogen, phosphorus, carbon or an element such as heavy metals. For this reason, NEWFA evaluates each of those in a separate function.

High concentrations of phosphorus result in overgrowth and subsequent increased rates of decay which leads to O_2 depletion (eutrophication). Frequent use of fertilizers for large-scale agricultural practices in both wetland and non-wetland areas is a major source of phosphorus contaminated runoff. This runoff can degrade water quality and cause eutrophication in downgradient waters if phosphorus levels become too high **(Badiou et al., 2018)**.

The primary processes driving phosphorus retention are: 1) sedimentation and 2) soil adsorption/precipitation and 3) uptake by plants/microbes.

Particulate phosphorus is initially detained during particle entrapment and sedimentation. When surface water enters the system, if flow velocity decreases sufficiently, settling of particulate phosphorus will occur. However, sedimentation alone is only sufficient temporarily, additional biogeochemical processes are necessary to prevent remobilization during subsequent high flows. **(Craft, 1996)**

The primary mechanism for inorganic phosphorus retention is through adsorption to clay and silt sized particles in mineral soils. Soil with high concentrations of aluminum, iron, or calcium will form insoluble compounds depending on soil pH. Acidic soils promote the precipitation of iron (Fe-P) and aluminum (Al-P) phosphates, whereas calcium phosphates (Ca-P) more commonly occur in soils with pH values above 8.0. **(Richardson & Vaithiyanathan, 2009)**

Soluble forms of phosphorus are retained through assimilation into the tissues of flora and fauna, adsorption onto soil mineral and organic matter surfaces, and chemical precipitation of Fe- and Ca-bound P **(Richardson, 1985)**. Periphyton phosphorus uptake is quickly performed by phytoplankton and algae in the water column **(Dodds, 2003; Richardson, 1985)**. Rooted plant uptake mainly occurs through absorption of available phosphorus in soil pore water **(Richardson, 1985)**. Long-term retention of phosphorus is also achieved through peat accretion, the process by which organic phosphorus is buried and accumulated because anaerobic conditions slow microbial decomposition rates **(Craft, 1996; Richardson, 1985)**.

The actual rate of Phosphorus Retention can be expressed as the amount of phosphorus removed or retained per unit area over a specified period of time (e.g., g/m^2 per year). Independent quantitative measures include mass balance approaches where water column phosphorus concentrations (mol L-1) are monitored upgradient and downgradient of a wetland over time to quantify phosphorus retention. However, the time and level of effort required by these methods is beyond the scope of a rapid assessment. Therefore, the level of functional capacity must be assessed indirectly using indicators that represent the characteristics which promote phosphorus retention by wetlands.

B. ASSESSING PHOSPHORUS RETENTION

The potential that a wetland has to retain phosphorus is based its ability to remove and immobilize phosphorus in the water column. Indicators of this potential are residence time of surface water, amount of clay and organic matter present in soils for sorption. The functional capacity grade for Phosphorus Retention is calculated using a model that combines the variables *Retentionability, SoilText* and *Organic* in the following equation:

$$FCG_{(PRt)} = \frac{3(Retentionability) + 2(SoilText)}{5} + Organic$$

Summary of Model

Property	Variables	Description
Retention Time	*Retentionability*	Ability to retain water & dissolved or particulate matter
	Position	Location (geomorphic position) of AU on the landscape
	FlowRestrict	Presence and characteristics of flow restriction features
	VelocityReduct	Structural reduction of water velocity
	MicroFeat	Microtopographic feature density
	Understory	Areal cover of vegetation in the understory layer
	StemDensity	Density of tree stems (both live and standing dead)
	TreeCount	Total number of tree stems (both live and standing dead)
	TotalBA	Total basal area of tree stems (both live and standing dead)
	MicroFeat	Microtopographic feature density
Soil Characteristics	*SoilText*	Proportion of different sized soil particles in each soil layer
	Organic	Thickness of organic soil layer(s) if present

$$\boldsymbol{FCG_{(PRt)} = \frac{3(Retentionability) + 2(SoilText)}{5} + Organic}$$

$$Retentionability = \frac{3\left(\sqrt[3]{Position \times FlowRestrict^2}\right) + 2(VelocityReduct)}{5}$$

$$VelocityReduct = \frac{(MicroFeat + Understory + StemDensity) - min(\ MicroFeat, Understory, StemDensity)}{2}$$

and $StemDensity = \sqrt[3]{TreeCount^2 \times TotalBA}$

Note: Phosphorus Retention is calculated separately for each Soil Examination Area.

Model Description

The model for Phosphorus Retention is comprised of three variables which represent surface water residence time, and the characteristics of the soils present in the wetland.

The *Retentionability* variable is a composite variable which evaluates surface water residence time in the wetland. *Retentionability* is a NEWFA specific term, defined as the capacity of a wetland to restrict and slow the flow of surface water long enough for one or more water quality related biogeochemical processes to occur. The sub-variable components of *Retentionability* describe the landscape context and the presence of biotic and abiotic features that impede flow/reduce velocity. Because these sub-variables mirror the indicators used to evaluate retention of particulates, the score for *Retentionability* is equivalent to the FCG for the Particulate Retention function. The velocity reduction component of *Retentionability* influences the rate of sedimentation as surface water moves into and through the wetland. Increased sedimentation promotes the anaerobic conditions which facilitate biogeochemical cycling in wetlands. Longer residence time correlates with increased presence of clay/silt particles which facilitate the retention of phosphorus through adsorption. See Chapter 5 and Appendix K for detailed discussion of the *Retentionability* variable.

The *SoilText* and *Organic* variables characterize the soils. *SoilText* values are defined by the relative proportions of sand, silt, and clay in mineral soils and/or the degree of peat decomposition in organic soils. *Organic* values are defined either by the thickness of organic soil layers or mineral soil texture when there is no organic soil layer thicker than 4cm. Most phosphorus is retained through adsorption to silt/clay particulates or to organic material in the soils. Assessment units with clayey soils will receive the highest *SoilText* scores, followed by fine-textured loamy soils. The presence of organic soil material is accounted for by scoring mucky modified mineral soils slightly higher. Organic soils are slightly less effective and are scored lower than fine-grained mineral soils, but higher than sandy soils. Very thick organic layers, which contain a very high volume of organic soil material, are accounted for by the *Organic* variable.

Wetlands always have some degree of topographic and hydrologic variability within the system and some assessment units may span more than one soil type. The potential for phosphorus retention does not need to be equivalent at every point in the assessment unit, the functional capacity grade represents the likelihood that phosphorus retention will occur somewhere within the system. This variability is captured by recording soil texture and organic layer thickness at each soil examination area, calculating Phosphorus Retention separately for each area and selecting the highest score as the FCG.

Variables and Scoring

Retentionability – composite variable that represents the combination of features which influence the residence time of surface water in the AU.

Sub-Variables: Retentionability is calculated by combining the sub-variables *Position*, *FlowRestrict* and *VelocityReduct* in the following equation:

$$Retentionability = \frac{3\left(\sqrt[3]{Position \times FlowRestrict^2}\right) + 2(VelocityReduct)}{5}$$

Position is the landscape context or geomorphic position of the AU. *FlowRestrict* describes the presence and characteristics of features which slow or restrict the passage of surface water through the AU. *VelocityReduct* is a composite variable that represents the combination of structural vegetation and microtopographic features which contribute to the roughness of the soil surface, creating frictional resistance to overland flow through the AU. *VelocityReduct* is calculated by combining the sub-variables *Understory*, *StemDensity* and *MicroFeat* for each vegetated wetland sub-unit in the following equation:

$$\frac{(Understory + StemDensity + MicroFeat) - \min(Understory, StemDensity, MicroFeat)}{2}$$

Scoring: The equation for *Retentionability* generates a value between 1 and 10. See Appendix K for detailed information about composite variable calculation and scoring.

SoilText – the relative proportions of sand, silt, and clay in mineral soils and/or the degree of peat decomposition in organic soils

Indicators: Soil texture classes present in the soil profile are recorded in Section D-2b(2)of the Data Sheet at EACH Soil Examination Area in the field. There are 3 organic soil classes (based on degree of peat decomposition), 5 mineral soil texture classes (based on the relative proportions of sand, silt, and clay) and 4 mucky-modified soil texture classes (for loamy and sandy soils).

Scoring: Each of the 12 *SoilText* class value options is assigned a numeric score between 1 and 10 (see table below). The user notes the score for every texture class recorded at the SEA.

***SoilText* Classes and Scores (Phosphorus Retention)**					
VALUE	SCORE	VALUE	SCORE	VALUE	SCORE
Organic: Fibric (Peat)	2	Loamy (Fine Texture)	7	Loamy (Coarse Texture)	3
Organic: Hemic (Mucky Peat)	4	+ mucky modifier	8	+ mucky modifier	4
Organic: Sapric (Muck)	6	Loamy (Medium Texture)	5	Sandy Loam or Sandy	1
Clayey Texture	10	+ mucky modifier	6	+ mucky modifier	2

<u>*Organic*</u> – estimate of the amount of organic material below the soil surface.

Indicators: Organic layer thickness is measured in the field and recorded in Section D-2c of the Data Sheet at EACH Soil Examination Area.

Scoring: Each of the six *Organic* class value options is assigned a score of either 0 or 1 (see table below). The user notes the score for the organic layer thickness class recorded at each SEA. When there is no organic layer thicker than 4cm, the texture class of the uppermost mineral soil layer is selected as the SEA attribute value.

***Organic* Classes and Scores (Phosphorus Retention)**						
THICKNESS	CLASS	SCORE	THICKNESS	CLASS	TOP MINERAL LAYER	SCORE
> 130 cm	Deep Organic	1	0 – 4 cm	No Organic Layer	Mucky Mineral	0
41 – 130 cm	Shallow Organic	0			Loamy or Clayey Mineral	0
5 – 40 cm	Limited Organic	0			Sandy Mineral	0

10 - Removal/Sequestration of Heavy Metals

A. Definition and Description of Function

Removal/Sequestration of Heavy Metals is defined as the processes by which wetlands remove heavy metals from the water column and bind them in situ.

Removal and sequestration of heavy metals means that metal ions bound to sediment and/or transported in surface water as suspended solids or soluble compounds are immobilized and retained within the wetland system. The presence of this functions results in a reduction in heavy metal pollution in downgradient waters.

The ability of wetlands to immobilize heavy metals is well acknowledged and assessed in some form by most methods. Several methods use more general nomenclature such as "remove and sequester elements and compounds" **(Wilder & Roberts, 2002)**. Some methods use the broader term toxicant or include additional pollutants, such as toxic organics **(Hruby et al., 1999; Hruby et al., 2000)** or pathogens **(USACE, 1993)** as components of the same function. Those categories are overly expansive for the purposes of this method, therefore NEWFA specifies the removal and sequestration of heavy metals as the function being assessed.

While heavy metals do exist naturally in the environment, anthropogenic inputs can result in toxic concentrations. Metals commonly found in the aquatic environment include arsenic, cadmium, chromium, copper, lead, inorganic mercury, nickel, selenium and zinc. The primary source of metals is via stormwater runoff and sediment from roadways, parking lots, waste disposal sites and land where fertilizers and pesticides have been applied. Sediment disturbed and redistributed by dredging and construction may contain high concentrations of metals from past land uses. Atmospheric contaminants from non-point or stack releases also enter waterways through direct wet and dry deposition or indirectly through overland storm water runoff. In colder climates, snow disposal sites may act as seasonal sources for metals associated with atmospheric deposition, road use and snow management.

It is important to note that the unique chemistry of each individual metal, means that many wetlands may have the potential for removal and sequestration of some metals, but not others. In addition, the biogeochemical endpoint varies for each metal from "sequestration" which implies long-term accumulation to permanent loss.

The primary processes driving removal and sequestration of heavy metals are: 1) sedimentation, 2) adsorption, 3) precipitation, and 4) plant uptake.

Most heavy metals are transported in runoff adsorbed to sediment particles and are detained in wetlands the same mechanisms that promote deposition and retention of particulates. Sequestration time increases through burial in wetlands that experience accretion by additional sedimentation or peat accumulation. Sedimentation may also be dependent on other mechanisms, such as adsorption and precipitation, to aggregate metals into larger particles before deposition can occur. The characteristics that support particulate retention in wetlands also promote sedimentation.

Adsorption occurs when heavy metals bind to the negatively ionized surfaces of clay and organic matter through electrostatic attraction. Metal adsorption can occur in the water column during transport or after sedimentation in systems with soils with a high clay or organic matter fraction. Precipitation occurs when heavy metals adsorb to sediment and soil containing iron, aluminum, or manganese forming insoluble compounds through oxidation/reduction reactions. Heavy metal precipitates and adsorbed metal ions will remain immobilized in the system as long as the soils remain undisturbed.

The actual rate of Removal/Sequestration of Heavy Metals can be expressed as the quantity of heavy metals removed or retained per unit area over a specified period of time (e.g., g/m^2 per year). Independent quantitative measures include the calculation of sequestration efficiency based on changes in metal concentration in a specific medium through instrumental analysis involving the collection and preparation of samples and use of specialized, highly sensitive laboratory equipment. However, the time and level of effort required by these methods is beyond the scope of a rapid assessment. Therefore, the level of functional capacity must be assessed indirectly using indicators that represent the characteristics which promote removal and sequestration of heavy metals by wetlands.

B. Assessing Removal/Sequestration of Heavy Metals

The potential that a wetland to remove and sequester heavy metals is a result of both the retention of particulates which may contain heavy metals and the characteristics of the soil and vegetation which facilitate the binding of those heavy metal particles, removing them from the water column. Indicators of this potential are residence time of surface water, amount of clay and organic matter present in soils and amount of vegetation available for uptake. The functional capacity grade for Removal/ Sequestration of Heavy Metals is calculated using a model that combines the variables *Retentionability, SoilText* and *HerbCov* in the following equation:

$$\boldsymbol{FCG_{(HMe)}} = \frac{\mathbf{4}(\boldsymbol{Retentionability}) + \mathbf{2}(\boldsymbol{SoilText}) + \boldsymbol{HerbCov}}{\mathbf{7}}$$

Summary of Model

Property	Variables	Description
Retention Time	*Retentionability*	Ability to retain water & dissolved or particulate matter
	Position	Location (geomorphic position) of AU on the landscape
	FlowRestrict	Presence and characteristics of flow restriction features
	VelocityReduct	Structural reduction of water velocity
	MicroFeat	Microtopographic feature density
	Understory	Areal cover of vegetation in the understory layer
	StemDensity	Density of tree stems (both live and standing dead)
	TreeCount	Total number of tree stems (both live and standing dead)
	TotalBA	Total basal area of tree stems (both live and standing dead)
	MicroFeat	Microtopographic feature density
Soil/Vegetation Interface	*SoilText*	Proportion of different sized soil particles in each soil layer
	HerbCov	Areal cover of vegetation in the herbaceous layer

$$\boldsymbol{FCG_{(HMe)} = \frac{4(Retentionability) + 2(SoilText) + HerbCov}{7}}$$

$$Retentionability = \frac{3\left(\sqrt[3]{Position \times FlowRestrict^2}\right) + 2(VelocityReduct)}{5}$$

$$VelocityReduct = \frac{(MicroFeat + Understory + StemDensity) - min(\ MicroFeat, Understory, StemDensity)}{2}$$

and $StemDensity = \sqrt[3]{TreeCount^2 \times TotalBA}$

Model Description

The model for Removal/Sequestration of Heavy Metals is comprised of three variables which represent surface water residence time, soil types and the characteristics of the vegetation present in the wetland.

The *Retentionability* variable is a composite variable which evaluates surface water residence time in the wetland. *Retentionability* is a NEWFA specific term, defined as the capacity of a wetland to restrict and slow the flow of surface water long enough for one or more water quality related biogeochemical processes to occur. The sub-variable components of *Retentionability* describe the landscape context and the presence of biotic and abiotic features that impede flow/reduce velocity. Because these sub-variables mirror the indicators used to evaluate retention of particulates, the score for *Retentionability* is equivalent to the FCG for the Particulate Retention function. The velocity reduction component of *Retentionability* influences the rate of sedimentation as surface water moves into and through the wetland. Increased sedimentation promotes the anaerobic conditions which facilitate biogeochemical cycling in wetlands. Longer residence time results in increased sedimentation of metals in particulate form and allow dissolved or suspended metals to be retained through plant uptake or soil adsorption within the wetland. See Chapter 5 and Appendix K for detailed discussion of the *Retentionability* variable.

The *SoilText* variable characterizes the soils. *SoilText* values are defined by the relative proportions of sand, silt, and clay in mineral soils and/or the degree of peat decomposition in organic soils. Heavy metals in particulate form are removed from surface water through sedimentation and adsorption to silt/clay particulates or to organic soil material. Assessment units with clayey soils will receive the highest *SoilText* scores, followed by fine-textured loamy soils. The presence of organic soil material is accounted for by scoring mucky modified mineral soils slightly higher. Organic soils are slightly less effective and are scored lower than fine-grained mineral soils, but higher than sandy soils.

Wetlands always have some degree of topographic and hydrologic variability within the system and some assessment units may span more than one soil type. The potential for heavy metal removal/sequestration does not need to be equivalent at every point in the assessment unit, the functional capacity grade represents the likelihood that removal and sequestration of heavy metals will occur somewhere within the system. This variability is captured by recording soil texture at each soil examination area and using the highest ranked *SoilText* value as the variable score to indicate the overall potential for Removal/Sequestration of Heavy Metals.

Vegetation type and structure is characterized by the *HerbCov* variable. *HerbCov* evaluates the density of non-woody vegetation as indicator of herbaceous biomass in the assessment unit. Herbaceous vegetation is particular effective at removing heavy metals through plant uptake, due to relatively rapid growth, although longer term sequestration is limited to bioaccumulation of metals in perennial vegetation. Variability within the system is captured by recording areal coverage of the herbaceous layer at each vegetated wetland assessment unit and then calculating a weighted average to determine the variable score.

Variables and Scoring

Retentionability – composite variable that represents the combination of features which influence the residence time of surface water in the AU.

Sub-Variables: Retentionability is calculated by combining the sub-variables *Position*, *FlowRestrict* and *VelocityReduct* in the following equation:

$$Retentionability = \frac{3\left(\sqrt[3]{Position \times FlowRestrict^2}\right) + 2(VelocityReduct)}{5}$$

Position is the landscape context or geomorphic position of the AU. *FlowRestrict* describes the presence and characteristics of features which slow or restrict the passage of surface water through the AU. *VelocityReduct* is a composite variable that represents the combination of structural vegetation and microtopographic features which contribute to the roughness of the soil surface and create frictional resistance to overland flow through the AU. *VelocityReduct* is calculated by combining the sub-variables *Understory*, *StemDensity* and *MicroFeat* for each vegetated wetland sub-unit in the following equation:

$$\frac{(Understory + StemDensity + MicroFeat) - \min(Understory, StemDensity, MicroFeat)}{2}$$

Scoring: The equation for *Retentionability* generates a value between 1 and 10. See Appendix K for detailed information about composite variable calculation and scoring.

<u>*SoilText*</u> – the relative proportions of sand, silt, and clay in mineral soils and/or the degree of peat decomposition in organic soils

Indicators: Soil texture classes present in the soil profile are recorded in Section D-2b(2)of the Data Sheet at EACH Soil Examination Area in the field. There are 3 organic soil classes (based on degree of peat decomposition), 5 mineral soil texture classes (based on the relative proportions of sand, silt, and clay) and 4 mucky-modified soil texture classes (for loamy and sandy soils).

Scoring: Each of the 12 *SoilText* class value options is assigned a numeric score between 1 and 10 (see table below). The user notes the score for every texture class recorded at the SEA. The SEA value with the HIGHEST score (highest content of clay and/or organic matter) is used as Variable score to calculate the FCG.

***SoilText* Classes and Scores (Removal/Sequestration of Heavy Metals)**					
VALUE	SCORE	VALUE	SCORE	VALUE	SCORE
Organic: Fibric (Peat)	2	Loamy (Fine Texture)	8	Loamy (Coarse Texture)	3
Organic: Hemic (Mucky Peat)	8	+ mucky modifier	9	+ mucky modifier	6
Organic: Sapric (Muck)	10	Loamy (Medium Texture)	5	Sandy Loam or Sandy	1
Clayey Texture	10	+ mucky modifier	7	+ mucky modifier	5

<u>*HerbCov*</u> – estimate of the areal cover of vegetation in the herbaceous layer.

Indicators: Areal cover of vegetation in the herbaceous layer (defined as all non-woody plants, regardless of height, including mosses and aquatic bed plants) is recorded by cover class in Section C-1b(1) of the Data Sheet at EACH Vegetated Wetland Sub-Unit in the field.

Scoring: Each of the ten *HerbCov* classes is assigned a numeric score between 0 and 10 (see table below). The user notes the score for the cover class recorded at each Sub-Unit. The Sub-Unit scores are weighted by area to determine the variable score used to calculate the FCG.

***HerbCov* Classes and Scores (Removal/Sequestration of Heavy Metals)**							
COVER CLASS	SCORE	COVER CLASS	SCORE	COVER CLASS	SCORE	COVER CLASS	SCORE
None	0	5 – 15%	1	40 – 60%	5	85 – 95%	9
<1% (Trace)	0	16 – 25%	2	61 – 74%	7	> 95%	10
1 – 4%	0	26 – 39%	3	75 – 84%	8		

11 - Carbon Sequestration

A. Definition and Description of Function

Carbon Sequestration is defined as the processes by which wetlands store carbon.

Carbon Sequestration means that carbon entering the system in atmospheric, dissolved or particulate form is retained and immobilized. The presence of this function results in a net gain of carbon removed from the atmosphere or water column and stored in the wetland.

Carbon cycling is a key ecosystem process, and a function included in many assessment methods. Carbon is removed from the atmosphere by plants during respiration and temporarily stored as plant biomass until it becomes part of the detrital pool during senescence. Detrital biomass not directly utilized by primary consumers is converted to soil organic matter, which is then either transported out of the system in dissolved or suspended form (see Production Export function), returned to the atmosphere as carbon dioxide and methane gas during decomposition, or accumulates as a component of the underlying soils. Carbon sequestration refers to the carbon which is buried in situ as soil organic matter when the rate of accumulation and burial exceeds the rate of decomposition.

Concerns over the global impact of increasing greenhouse gases has created a new industry producing capture credits to offset carbon emissions. Because most carbon capture technology is expensive, ecosystems that naturally sequester carbon have been identified as a low-cost alternative **(Villa & Bernal, 2018)**. Wetlands have been widely recognized as systems which store carbon. However, because wetlands also release greenhouse gases back into the atmosphere, numerous studies have attempted to quantify the balance between methane gas emission and carbon storage by wetlands **(Mitsch et al., 2012; Mitsch & Mander, 2018; Nag et al., 2017)**. Results show that while wetlands may actually be a carbon source in the short term, extrapolation over a longer time horizon indicates that many wetlands are a net carbon sink **(Brix et al., 2001; Mitsch et al., 2012; Whiting & Chanton, 2001)**.

The primary characteristics/processes by which wetlands retain and sequester carbon are 1) primary production and 2) soil organic matter accumulation.

Wetlands have relatively high levels of primary productivity. During primary production plants utilize atmospheric carbon dioxide as a source for plant growth generating biomass. At any point in time, the amount live vegetation is an indicator of carbon stored as biomass. Carbon contained in vegetation is only stored as long as those plants are alive; woody plants provide longer term storage than herbaceous vegetation. As plant biomass dies, carbon stores are transferred to the soil surface as woody debris, leaf litter and other detrital matter. Some detritus will be transported out of the system, some portion will begin to decompose, and some portion will become buried.

In wetlands, anaerobic conditions caused by prolonged periods of soil inundation or saturation decreases the rate of carbon degradation, slowing the release of carbon dioxide. Although decomposing organic material can increase the release of carbon as methane gas, the slow rate of decomposition combined with high productivity results in accumulation and burial of detrital matter as peat. Soil inundation also increases sediment deposition which in turns correlates to higher rates of carbon sequestration **(McCarty & Ritchie, 2002)**.

The actual rate of carbon sequestration can be expressed gain or loss of carbon over time (m3/ha/time). Independent quantitative measures include documenting the rate of carbon accumulation within the wetland using a mass balance approach. Monitoring the rate of aboveground and belowground biomass accumulation, soil, and plant respiration, and determining rates of soil carbon flux. However, the time and level of effort required by these methods is beyond the scope of a rapid assessment. Therefore, the level of functional capacity must be assessed indirectly using indicators that represent the characteristics which promote carbon sequestration by wetlands.

B. Assessing Carbon Sequestration

The potential that a wetland has to sequester carbon is based on its ability to retain particulate carbon and accumulate soil organic matter. Indicators of this potential are residence time of surface water, presence and thickness of organic soil layers and amount of biomass. The functional capacity grade for Carbon Sequestration is calculated using a model that combines the variables *Retentionability, Organic* and *CarbonBiomass* in the following equation:

$$\boldsymbol{FCG_{(CSq)}} = \frac{\boldsymbol{Retentionability + 3(Organic) + 2(CarbonBiomass)}}{\boldsymbol{6}}$$

Summary of Model

Property	Variables	Description
Retention Time	*Retentionability*	Ability to retain water & dissolved or particulate matter
	Position	Location (geomorphic position) of AU on the landscape
	FlowRestrict	Presence and characteristics of flow restriction features
	VelocityReduct	Structural reduction of water velocity
	MicroFeat	Microtopographic feature density
	Understory	Areal cover of vegetation in the understory layer
	StemDensity	Density of tree stems (both live and standing dead)
	TreeCount	Total number of tree stems (both live and standing dead)
	TotalBA	Total basal area of tree stems (both live and standing dead)
Soil Characteristics	*Organic*	Thickness of organic soil layer(s) if present
Living Biomass	*CarbonBiomass*	Biomass component of carbon storage
	TreeCov	Areal cover of vegetation in the tree layer
	LiveBA	Basal area of live tree stems rooted in the AU
	Understory	Areal cover of vegetation in the understory layer

$$\boldsymbol{FCG_{(CSq)}} = \frac{\boldsymbol{Retentionability + 3(Organic) + 2(CarbonBiomass)}}{\boldsymbol{6}}$$

$$Retentionability = \frac{3\left(\sqrt[3]{Position \times FlowRestrict^2}\right) + 2(VelocityReduct)}{5}$$

$$VelocityReduct = \frac{(MicroFeat + Understory + StemDensity) - \min(MicroFeat, Understory, StemDensity)}{2}$$

and $StemDensity = \sqrt[3]{TreeCount^2 \times TotalBA}$

$$CarbonBiomass = \frac{3(TreeCov) + 2(LiveBA) + Understory}{6}$$

Model Description

The model for Carbon Sequestration is comprised of three variables which represent surface water residence time, accumulation of organic carbon, and the characteristics of the vegetation present in the wetland.

The *Retentionability* variable is a composite variable which evaluates surface water residence time in the wetland. *Retentionability* is a NEWFA specific term, defined as the capacity of a wetland to restrict and slow the flow of surface water long enough for one or more water quality related biogeochemical processes to occur. The sub-variable components of *Retentionability* describe the landscape context and the presence of biotic and abiotic features that impede flow/reduce velocity. Because these sub-variables mirror the indicators used to evaluate retention of particulates, the score for *Retentionability* is equivalent to the FCG for the Particulate Retention function. The velocity reduction component of *Retentionability* influences the rate of sedimentation as surface water moves into and through the wetland. Increased sedimentation promotes the anaerobic conditions which facilitate biogeochemical cycling in wetlands. Longer residence time facilitates the sequestration of dissolved or suspended carbon through the formation of organic soils. See Chapter 5 and Appendix K for detailed discussion of the *Retentionability* variable.

Accumulation of organic carbon is characterized by the *Organic* variable. *Organic* values are defined either by the thickness of organic soil layers or mineral soil texture when there is no organic soil layer thicker than 4cm and are ranked by their relative amount of soil organic matter contained in the underlying soil. Organic soil layers thicker than 130 cm indicate the greatest potential for long-term carbon sequestration and will generate the highest score for the *Organic* variable. However, wetlands always have some degree of topographic and hydrologic variability within the system and some assessment units may span more than one landscape position. The potential for carbon sequestration does not need to be equivalent at every point in the assessment unit, the functional capacity grade represents the likelihood that carbon sequestration will occur somewhere within the system. This variability is captured by recording organic layer thickness at each soil examination area and using the highest ranked *Organic* value as the variable score to indicate the overall potential for carbon sequestration.

Vegetation type and structure is characterized by the *CarbonBiomass* variable. *CarbonBiomass* is a composite variable which represents the amount of biomass available for assimilation and storage of atmospheric carbon. The sub-variable components of *CarbonBiomass* describe the composition of the plant community and the relative importance of tree canopy cover, woody stem density, and understory vegetation. Variability within the system is captured by computing a *CarbonBiomass* sub-score for each vegetated wetland assessment unit and then calculating a weighted average to determine the variable score. See Chapter 5 and Appendix K for detailed discussion of the *CarbonBiomass* variable.

Variables and Scoring

Retentionability – composite variable that represents the combination of features which influence the residence time of surface water in the AU.

Sub-Variables: Retentionability is calculated by combining the sub-variables *Position*, *FlowRestrict* and *VelocityReduct* in the following equation:

$$Retentionability = \frac{3\left(\sqrt[3]{Position \times FlowRestrict^2}\right) + 2(VelocityReduct)}{5}$$

Position is the landscape context or geomorphic position of the AU. *FlowRestrict* describes the presence and characteristics of features which slow or restrict the passage of surface water through the AU. *VelocityReduct* is a composite variable that represents the combination of structural vegetation and microtopographic features which contribute to the roughness of the soil surface and create frictional resistance to overland flow through he AU. *VelocityReduct* is calculated by combining the sub-variables *Understory*, *StemDensity* and *MicroFeat* for each vegetated wetland sub-unit in the following equation:

$$\frac{(Understory + StemDensity + MicroFeat) - \min(Understory, StemDensity, MicroFeat)}{2}$$

Scoring: The equation for *Retentionability* generates a value between 1 and 10. See Appendix K for detailed information about composite variable calculation and scoring.

<u>*CarbonBiomass*</u> – composite variable that represents the amount of living biomass storing biological carbon in the AU.

Sub-Variables: *CarbonBiomass* is calculated by combining the sub-variables *TreeCov, LiveBA* and *Understory* for each vegetated wetland sub-unit in the following equation.

$$CarbonBiomass = \frac{3(TreeCov) + 2(LiveBA) + Understory}{6}$$

TreeCov is an estimate of the areal cover of vegetation in the tree layer (defined as all live woody plants 6m or taller, regardless of diameter) and is weighted highest of the three sub-variables. *LiveBA* is an estimate of the total cross-sectional area of all live tree stems rooted in the AU. *Understory* is an estimate of the areal coverage of vegetation in the understory layer (defined as all woody plants less than 6m in height and all non-woody plans, regardless of height, including mosses and aquatic bed plants) and is weighted lower than the *TreeCov* and *LiveBA* sub-variables. See Appendix K for detailed information about composite variable calculation.

Scoring: The equation for *CarbonBiomass* generates a value between 0 and 10. The score for *CarbonBiomass* = 0 if the sub-unit has less than 5% tree cover AND the total basal area of live trees is less than 0.0250 AND less than 5% understory cover. *CarbonBiomass* is calculated for EACH sub-unit then weighted by sub-unit area to determine the variable score. See Appendix E for detailed instructions on sub-unit weighting.

<u>*Organic*</u> – estimate of the amount of organic material below the soil surface.

Indicators: Organic layer thickness is measured in the field and recorded in Section D-2c of the Data Sheet at EACH Soil Examination Area.

Scoring: Each of the six *Organic* class value options is assigned a score of either 0 or 1 (see table below). The user notes the score for the organic layer thickness class recorded at each SEA. When there is no organic layer thicker than 4cm, the texture class of the uppermost mineral soil layer is selected as the SEA attribute value. The SEA value with the HIGHEST score (highest carbon content) will determine the variable score.

***Organic* Classes and Scores (Carbon Sequestration)**						
THICKNESS	CLASS	SCORE	THICKNESS	CLASS	TOP MINERAL LAYER	SCORE
> 130 cm	Deep Organic	10	0 – 4 cm	No Organic Layer	Mucky Mineral	4
41 – 130 cm	Shallow Organic	8			Loamy or Clayey Mineral	2
5 – 40 cm	Limited Organic	6			Sandy Mineral	1

12 - Production Export

A. Definition and Description of Function

Production Export is defined as the processes by which wetlands produce and facilitate the transfer of organic matter to other aquatic ecosystems.

Production export means that organic detritus produced in the wetland becomes available as food for aquatic and terrestrial organisms in adjacent or downstream systems. The presence of this function results in the establishment of an energy source for primary consumers, strengthening connected food webs.

Some methods consider the export of other nutrients besides carbon in their assessment or simply include production export as a component of the broader process of nutrient cycling in general. NEWFA focuses on the export of carbon specifically, but the assumption can be made that other nutrients are following the same transport pathways when available.

The role of wetlands in providing food for both wildlife and humans is both an ecological function and an economic benefit. Estuaries and tidal marshes provide habitat for many animal species harvested by humans as a food source **(McHugh, 1976)**. Freshwater wetlands provide habitat for many plant species that serve as important food sources for animals interacting within these systems. Acorns from oak trees, wild rice, cattails, and duck potatoes are just a few of the important plants found throughout wetlands in the U.S **(Stafford et al., 2006)**. For many of the grain/seed producing plants native to wetlands, hydrologic movement of surface water serves an important role in transporting these and other food sources to downgradient areas within the watershed where they may be consumed by organisms **(Adamus et al., 1991)**. Organic carbon is the primary source of energy for microbial food webs and forms the base of the detrital food web supporting primary consumers in the aquatic ecosystem **(Heck et al., 1995)**. Wetlands’ production of large amounts of detritus provides a crucial food source for micro and macro invertebrates within the wetland system.

The primary characteristics/processes driving production export are: 1) primary productivity and 2) hydrologic connectivity.

Primary productivity is the rate at which plants produce biomass. Biomass is the accumulation of energy which is harnessed from sunlight and stored by green vegetation through photosynthesis. Energy which is not lost to the atmosphere through respiration, excretion or heat loss is stored as plant biomass. The portion of stored energy which is not utilized to support plant growth and reproduction becomes available as a food source for primary consumers either as live plant tissue or detritus.

Hydrologic connectivity to aquatic systems determines whether biomass produced in the wetland can be readily transported to other locations within the watershed. Wetlands with a high level of connectivity with other bodies of water can export detritus more effectively than a wetland where the exchange of surface water is limited.

The actual rate of production export can be expressed as the mass of carbon exported per unit area per unit time (g/m2/year). Independent quantitative measures include calculation of net annual primary productivity by measurements of standing stock of living and/or dead biomass, annual accumulation of organic matter and annual decomposition of organic matter. However, the time and level of effort required by these methods is beyond the scope of a rapid assessment. Therefore, the level of functional capacity must be assessed indirectly using indicators that represent the characteristics which promote production export by wetlands.

B. Assessing Production Export

The potential that a wetland has for production export is based on its production of plant biomass and the presence of an aquatic pathway to move that material to other aquatic systems. Indicators of this potential are current biomass estimates and hydrologic connectivity to other aquatic systems. The functional capacity grade for Production Export is calculated using a model that combines the variables *HydroConnect, FlowRestrict* and *ExportBiomass* in the following equation:

$$\boldsymbol{FCG_{(PEx)}} = \frac{\sqrt[3]{\boldsymbol{HydroConnect} \times \boldsymbol{FlowRestrict^2}} + \boldsymbol{2(ExportBiomass)}}{\boldsymbol{3}}$$

Summary of Model

Property	Variables	Description
Hydrologic Movement	*HydroConnect*	Hydrologic connections to other aquatic systems
	FlowRestrict	Presence and characteristics of flow restriction features
Living Biomass	*ExportBiomass*	Biomass available for export
	TreeCov	Areal cover of vegetation in the tree layer
	Understory	Areal cover of vegetation in the understory layer

$$\boldsymbol{FCG_{(PEx)}} = \frac{\sqrt[3]{\boldsymbol{HydroConnect} \times \boldsymbol{FlowRestrict^2}} + \boldsymbol{2(ExportBiomass)}}{\boldsymbol{3}}$$

$$ExportBiomass = \frac{3(TreeCov) + Understory}{4}$$

Model Description

The model for Production Export is comprised of three variables which represent the characteristics of the vegetation and hydrologic connectivity to other aquatic systems.

Vegetation type and structure is characterized by the <u>*ExportBiomass*</u> variable. *ExportBiomass* is a composite variable which represents the amount of living plant biomass available for export to downstream organisms as detritus. The sub-variable components of *ExportBiomass* describe the composition of the plant community and the relative importance of tree canopy cover and understory vegetation. Variability within the system is captured by computing a *ExportBiomass* sub-score for each vegetated wetland assessment unit and then calculating a weighted average to determine the variable score. See Chapter 5 and Appendix K for detailed discussion of the *ExportBiomass* variable.

Hydrologic transport is characterized by the <u>*HydroConnect*</u> and <u>*FlowRestrict*</u> variables. *HydroConnect* values describe the presence and degree of connectivity between the assessment unit and other downstream aquatic resources. *FlowRestrict* values account for the presence of features which obstruct downstream flow entirely (e.g., an abandoned weir) as well as features which create a bottleneck, thus slowing the flow of water through the system (e.g., undersized culverts).

HydroConnect is a variable that assesses the level of connection the wetland assessment unit has with other aquatic systems. Higher levels of connection, and therefore exchange, the wetland has with other aquatic systems increases the functional score given for *HydroConnect*. Contiguity with flowing aquatic systems or marine bodies receive higher scores than wetlands contiguous with ponds, etc.

FlowRestriction is a variable that accounts for wetland features limiting the exchange of surface water within the watershed. Wetlands that have features severely limiting the flow of surface water receive lower scores than wetlands with unrestricted surface water flow.

The *FlowRestrict* values are ranked by the relative degree with which they permit the passage of water through the assessment unit. All possible features are recorded, documentation is not limited to the characteristics of the outlet. Restriction or reduction of flow can occur at any point within the system. The least restrictive feature is ranked the highest and is used as the variable score, representing the greatest likelihood of production export.

Variables and Scoring

HydroConnect – the presence and characteristics of hydrologic connections between the AU and other aquatic systems.

Indicators: ALL hydrologic connections observed are documented and recorded in Section E-2 of the Data Sheet during the site visit.

Scoring: Each of the 20 *HydroConnect* value options is assigned a numeric score between 0 and 10 (see table below). The user notes the score for each hydrologic connection recorded. The value with highest score (most connectivity) will determine the variable score.

***HydroConnect* Values and Scores (Production Export)**					
VALUE	SCORE	VALUE	SCORE	VALUE	SCORE
Contiguous w/ Ocean	10	Tidal Restricted	10	Overbank Flooding Into AU	0
Contiguous w/ Bay	10	Tidal Unrestricted	10	Overbank Flooding Out	4
Contiguous w/ Estuary	10	Perennial at Inlet	0	Overland Flow Into AU	0
Contiguous w/ Tidal Creek	10	Perennial at Outlet	10	Overland Flow Out	4
Contiguous with River	10	Intermittent at Inlet	0	No Hydrologic Connections	0
Contiguous with Stream	7	Intermittent at Outlet	7		
Contiguous with Lake	5	Periodic at Inlet	0		
Contiguous with Pond	1	Periodic at Outlet	4		

FlowRestrict – the presence and characteristics of features which slow or restrict the passage of surface water through the AU.

Indicators: ALL flow restriction features observed within the AU are documented and recorded in Section E-1 of the Data Sheet during the site visit.

Scoring: Each of the 23 *FlowRestrict* value options is assigned a numeric score between 0 and 10 (see table below). The user notes the score for each flow restriction feature recorded. The value with the lowest score (greatest restriction on export) will determine the variable score.

***FlowRestrict* Values and Scores (Production Export)**			
VALUE	SCORE	VALUE	SCORE
Open Exchange – Tidal	9	Culvert Present – Receiving Flow	-
Open Exchange – Non-Tidal	10	Culvert >75% of stream width	9
Channel Present – Unrestricted	10	Culvert 50-75% of stream width	7
Human or Beaver Constructed Dam Present	1	Culvert 25-50% of stream width	6
Channel Present – Restricted by Debris Jam	-	Culvert < 25% of stream width	4
Debris spans < 25% of channel width	8	Culvert Present – Not Receiving Flow	-
Debris spans 25-50% of channel width	6	Culvert Partially Blocked by Debris	5
Debris spans 50-75% of channel width	5	Culvert Totally Blocked by Debris	0
Debris spans >75% of channel width	3	Culvert Located too High Above Flow	0
Channel Width Narrowed by Geology/Structure	-	Tide Gate/Weir Present	-
Channel narrows < 25%	9	Operational	5
Channel narrows 25-50%	7	Non-operational (Open)	9
Channel narrows 50-75%	6	Non-operational (Closed)	0
Channel narrows >75%	4	Closed System (No Outlet)	0

ExportBiomass – composite variable that represents the amount of living biomass available for export to downstream organisms.

Sub-Variables: *ExportBiomass* is calculated by combining the sub-variables *HerbCov*, *Understory* and *TreeCov* for each vegetated wetland sub-unit in the following equation.

$$ExportBiomass = \frac{3(TreeCov) + Understory}{4}$$

TreeCov is an estimate of the areal cover of vegetation in the tree layer (defined as all live woody plants 6m or taller, regardless of diameter). *Understory* is an estimate of the areal coverage of vegetation in the understory layer (defined as all woody plants less than 6m in height and all non-woody plans, regardless of height, including mosses and aquatic bed plants) and is weighted lower than the *TreeCov* sub-variable. See Appendix K for detailed information about composite variable calculation.

Scoring: The equation for *ExportBiomass* generates a value between 0 and 10. The score for *ExportBiomass* = 0 if the sub-unit has less than 5% tree cover. *ExportBiomass* is calculated for EACH sub-unit then weighted by sub-unit area to determine the variable score. See Appendix E for detailed instructions on sub-unit weighting.

13 - Plant Community Integrity

A. DEFINITION AND DESCRIPTION OF FUNCTION

Plant Community Integrity is defined as the processes by which wetlands maintain a healthy, native plant community typical of the regional geomorphic and climatic conditions.

Plant Community Integrity means that the existing community is able to withstand environmental variability and disturbance. The presence of this function results in the endurance of the extant plant community composition.

The term integrity is commonly to describe the health of a system in comparison to the undisturbed reference state. Integrity typically uses the historic community composition and structure as the baseline for comparison. The term integrity as used in NEWFA describes a system's ability to endure and recover from disturbances, whether natural and anthropogenic; the baseline for comparison is the current community. This concept is also known as system resilience.

The ability of a plant community to recover its structure, processes, and functioning after a disturbance, such as a wildfire or drought, is a key aspect of its resilience. The structure and composition of the wetland plant community is a factor in almost every other function provided by wetlands. Vegetation creates frictional resistance, dissipating energy to reduce flow velocity, which facilitates functions such as surface water detention, storm surge reduction and particulate retention. Roots anchor soil and substrate, reducing erosion and promoting the shoreline and bank stabilization functions. Plant growth and decomposition produces biomass for production export, nutrient cycling, and provision of food and habitat for wildlife. Changes in the plant species composition and structure can affect the entire suite of physical, chemical, and biological functions provided by a wetland system. A resilient plant community can continue to perform vital ecological functions like nutrient cycling, soil stabilization, and providing habitat, even under stress. **(Golet et al., 1993)**

The primary characteristics driving plant community integrity are: 1) current vegetation composition and 2) presence/impact of stressors.

Plant community composition and structure is primarily governed by site hydrology. Survival and growth of individual plant species are directly influenced by variables such as the height of the water table, fluctuations in root zone saturation, and frequency and duration of inundation. The vegetation composition is demonstrative of current conditions and zonation within an individual aquatic resource in the result of local level variation. **(Clément & Proctor, 2009)** There is also a clear correlation between nutrient availability and productivity. **(Bedford et al., 1999)** The health and composition of the vegetation is a good indicator of current conditions, but more speculative as an indicator of resilience in response to future conditions.

Invasive plants are species which have been introduced to a new ecosystem by human activity, either intentionally or accidentally, and are not naturally part of that environment. They possess prolific reproduction mechanisms and can move aggressively into new areas, monopolizing resources like light, water, and space and outcompeting the native flora. High abundance of invasive plants negatively affects a wetland's ability to maintain the integrity of the plant community. A healthy, diverse plant community is better able to resist invasions by non-native species by outcompeting them or limiting their abundance. **(Hager, 2004)**

The presence of invasives is evidence of anthropogenic disturbance in or near the resource of interest. Many invasive plants were initially introduced through the horticulture industry. Human activities such as gardening, land clearing or construction can facilitate natural seed dispersal mechanisms, through contaminated soil relocation or disposal of vegetation. **(White, R.J. et al., 2014)** Infestation by invasive plant species can be reduced by the presence of buffer, which is an area of undisturbed land which provides a physical barrier between anthropogenic land uses and a natural resource. **(Castelle et al., 1994)**

Human activities such as tree clearing, trash dumping, or active recreational may all effect the resilience of the resource. Non-anthropogenic stressors such as drought, salinity, pests, or diseases also negatively impact plant health and growth. A resilient plant community should be able to respond and adapt to some stressors, especially if only a small portion of the resource is directly impacted, however widespread stressors with a greater magnitude of disturbance will ultimately result in altered community composition, decrease plant diversity and overall decline in ecosystem health and function. **(Golet et al., 1993)**

Independent quantitative measures include long term monitoring of a wetland's plant community by performing botanical surveys on a semi-annual basis over several years. However, the time and level of effort required by these methods is beyond the scope of a rapid assessment. Therefore, the level of functional capacity must be assessed indirectly using indicators that represent the characteristics which promote wetland plant community integrity.

B. ASSESSING PLANT COMMUNITY INTEGRITY

The potential that a wetland has for plant community integrity is based on its ability to maintain and support characteristic diversity and abundance of vegetation in the wetland. Indicators of this potential are characteristics of the surrounding landscape, the effect of internal stressors, and the composition of the existing plant community. The functional capacity grade for Plant Community Integrity is calculated using a model that combines the variables *Buffer, HumanActivity, PlantStress* and *Invasives* in the following equation:

$$\boldsymbol{FCG_{(PCI)} = \sqrt[3]{Buffer \times min(HumanActivity, PlantStress) \times Invasives}}$$

Summary of Model

Property	Variables	Description
Landscape Characteristics	*Buffer*	Presence and integrity of adjacent undisturbed buffer
	BuffIntact	Percent of AU perimeter with intact buffer
	BuffWidth	Average width of adjacent undisturbed buffer
Stressors	*HumanActivity*	Impact of recent human activity on habitat integrity
	ActivIntensity	Presence and intensity of recent human activity
	ActivProportion	Proportion of AU impacted by recent human activity
	PlantStress	Impact of plant community stressors on habitat integrity
	StressIntensity	Presence and intensity of plant community stressors
	StressProportion	Proportion of AU impacted by plant community stressors
Plant Community	*Invasives*	Areal cover of invasive/aggressive plant species

$$\boldsymbol{FCG_{(PCI)} = \sqrt[3]{Buffer \times min(HumanActivity, PlantStress) \times Invasives}}$$

$$Buffer = \frac{2(BuffIntact) + BuffWidth}{30}$$

$$HumanActivity = \min_{A\in\{1,\ldots n\}} \sqrt{ActivIntensity_A \times ActivProportion_A} \quad \text{and} \quad A = \text{each activity}$$

$$PlantStress = \min_{S\in\{1,\ldots n\}} \sqrt{StressIntensity_S \times StressProportion_S} \quad \text{and} \quad S = \text{each stressor}$$

Model Description

Buffer is a composite variable which characterizes the degree to which adjacent undisturbed land provides physical protection to the plant community in the AU. The sub-variable components describe the percent of the perimeter with intact buffer and the average width of that buffer. Intact buffer is defined as undisturbed area, composed of any habitat type including open water. The presence of a narrower, but more complete buffer will generate a higher variable score than a discontinuous wider buffer.

Internal stressors are characterized by the *HumanActivity* and *PlantStress* variables. These variables only evaluate the effect of recent or ongoing stressors, based on the assumption that any response to older stressors has already occurred, and the existing community is composed of those species which have adapted to those conditions. *HumanActivity* is a composite variable which evaluates degree of disturbance resulting from one or more anthropogenic activities in or near the assessment unit. *PlantStress* is a similar composite variable which evaluates disturbance resulting from stressors such as insect pest damage which directly affect the presence/distribution of species in the vegetative community. Sub-variables representing the intensity of each stressor and the proportion of the assessment unit which is affected by that stressor are combined to calculate an individual magnitude of disturbance for each human activity and plant community stressor. The model is calculated by using the stressor with the lowest score, representing the highest magnitude of disturbance and reducing the overall Plant Community FCG.

Invasives is a variable that describes the degree to which the plant community is composed of invasive species. Similar to *HumanActivity* and *PlantStress*, areal cover of invasive species is inversely scored so that high invasive species density reduces the overall Plant Community FCG.

Variables and Scoring

Buffer – composite variable that represents the presence and integrity of undisturbed buffer adjacent to the AU.

Sub-Variables: *Buffer* is calculated by combining the sub-variables *BuffIntact* and *BuffWidth* in the following equation:

$$Buffer = \frac{2(BuffIntact) + BuffWidth}{30}$$

BuffIntact is an estimate of the percent of the AU perimeter with intact buffer (defined as undisturbed area at least 10m wide, composed of any habitat type including open water). *BuffWidth* is a measure of the average width of the adjacent buffer. *BuffIntact* is weighted more heavily than *BuffWidth* in the equation for *Buffer*. See Appendix K for detailed information about composite variable calculation.

Scoring: The equation for *Buffer* generates a value between 0 and 10. The score for *Buffer* = 0 if the assessment unit has less than 5% intact buffer OR the average buffer width is less than 5m.

HumanActivity - composite variable that represents the impact of recent human activity in or within 100m of the AU.

Sub-Variables: *HumanActivity* is calculated by combining the sub-variables *ActivIntensity* and *ActivProportion* in the following equation:

$$HumanActivity = \min_{A \in \{1,\ldots n\}} \sqrt{ActivIntensity_A \times ActivProportion_A}$$

ActivIntensity describes the presence and intensity of recent human activity in or near the AU and *ActivProportion* estimates the proportion of the AU impacted by each activity. The magnitude of each activity (sub-score) is calculated individually using the equation above. The score for *HumanActivity* is equivalent to the LOWEST sub-score, which represents the activity which has the GREATEST impact on the AU. See Appendix K for detailed information about composite variable calculation.

Scoring: The equation for *HumanActivity* generates a value between 1 and 10. An assessment unit with no evidence of human activity within the last 2 years will receive a score of 10.

PlantStress - composite variable that represents the impact of plant community stressors located in or within 100m of the AU.

Sub-Variables: *PlantStress* is calculated by combining the sub-variables *StressIntensity* and *StressProportion* in the following equation:

$$PlantStress = \min_{S \in \{1,\ldots n\}} \sqrt{StressIntensity_S \times StressProportion_S}$$

StressIntensity describes the presence and intensity of plant community stressors in or near the AU and *StressProportion* estimates the proportion of the AU impacted by each stressor. The magnitude of each stressor (sub-score) is calculated individually using the equation above. The score for *PlantStress* is equivalent to the LOWEST sub-score, which represents the stressor which has the GREATEST impact on the AU. See Appendix K for detailed information about composite variable calculation.

Scoring: The equation for *PlantStress* generates a value between 1 and 10. An assessment unit with no evidence of plant community stressors within the last 2 years will receive a score of 10.

<u>*Invasives*</u> – estimate of the areal cover of invasive/aggressive plant species

Indicators: Areal cover of invasive/aggressive plant species (see list in Appendix I) is recorded by cover class in Section C-1b(6) of the Data Sheet at EACH Vegetated Wetland Sub-Unit in the field.

Scoring: Each of the ten *Invasives* cover classes is assigned a numeric score between 0 and 10 (see table below). The user notes the score for the cover class recorded at each Sub-Unit. The Sub-Unit scores are weighted by area to determine the variable score used to calculate the FCG.

***Invasives* Classes and Scores (Plant Community Integrity)**							
COVER CLASS	SCORE	COVER CLASS	SCORE	COVER CLASS	SCORE	COVER CLASS	SCORE
None	10	5 – 15%	7	40 – 60%	2	85 – 95%	1
<1% (Trace)	10	16 – 25%	5	61 – 74%	2	> 95%	0
1 – 4%	9	26 – 39%	3	75 – 84%	1		

14 - Wildlife Habitat Integrity

A. Definition and Description of Function

Wildlife Habitat Integrity is defined as the processes by which wetlands maintain a healthy, native faunal community typical of the regional geomorphic, vegetative, and climatic conditions.

Wildlife habitat integrity means that the characteristics of the wetland and surrounding area maintain the habitat needs for one or more species of native fauna. The presence of this function results in a resilient faunal community.

The term integrity is commonly to describe the health of a system in comparison to the undisturbed reference state. Integrity typically uses the historic community composition and structure as the baseline for comparison. The term integrity as used in NEWFA describes a system's ability to endure and recover from disturbances, whether natural and anthropogenic; the baseline for comparison is the current community. This concept is also known as system resilience.

The term wildlife refers all to non-domesticated living organisms that exist and survive in their natural habitat without direct human intervention, providing their own food and shelter. While the term often brings to mind free-ranging terrestrial vertebrates like mammals and birds, it technically includes all animal life, from insects and amphibians to fish and reptiles. It is important to note that non-native wildlife are considered invasive species.

Wildlife habitat is any area which provides essential elements for survival for one or more native faunal species. All species require food, water, shelter, and space to reproduce and provide for their offspring. Some wildlife species are able to take advantage of a range of habitat types, while others are more restrictive in their habitat requirements. Highly specialized species often have adaptations which allow them to take advantage of areas which may be inhospitable to other wildlife.

Fauna which require an aquatic or semi-aquatic environment for at least one of their life needs, are often referred to as wetland-dependent wildlife. Species which are wetland-dependent are not typically adapted to thrive in all wetland types. Suitable habitat for fully-aquatic species (e.g., fish) is completely different from habitat for mostly terrestrial species (e.g. moose). A wetland may have critical habitat importance for a narrowly defined assemblage of highly specialized species, such as caddisflies, while providing none of the habitat requirements for another groups like shorebirds.

Approaches to the assessment of the wildlife habitat potential of a wetland may include evaluation of species abundance/diversity; habitat provision for threatened and endangered species; the effect of historical human or environmental disturbances; current condition; or ecosystem resilience to future stressors. In addition, wildlife habitat potential can be assessed as one function or split out by faunal groups into multiple functions. For example, the Highway Methodology Supplement **(USACE, 1999)** considers Fish and Shellfish Habitat as a separate function from Wildlife Habitat, and creates a third function for Endangered Species. The Washington State methods assess General Habitat Suitability and then evaluate habitat for up to specific faunal groups as separate functions: Invertebrates; Amphibians; Anadromous Fish; Resident Fish; Wetland-associated/Aquatic Birds; and Wetland-associated/Aquatic Mammals **(Hruby et al., 1999; Hruby et al., 2000)**. NEWFA identifies one function, Wildlife Habitat Integrity, which assesses the ability of the wetland to generally provide habitat to a variety of fauna, without identifying individual groups of species.

In addition to supporting commercial and non-commercial fisheries, wetland wildlife habitat is important for revenue-producing recreational activities like birdwatching, hunting, and kayaking. Justification for protecting wetlands as wildlife habitat began to appear in the mid-20th century, spurred by the decline of migratory waterfowl. Massachusetts passed the nation's first wetlands protection laws in the early 1960s, officially listing listed "wildlife habitat" and "fisheries" among the public interests that wetlands serve. **(M.G.L. c. 131, § 40).** The 1971 Rhode Island Wetlands Protection Act includes wildlife habitat in the declaration of intent, stating "freshwater wetlands and buffers are among the most valuable of all wildlife habitats and are high-value recreational areas as well".

The primary characteristics driving Wildlife Habitat Integrity are: 1) heterogeneity/structural complexity, 2) habitat connectivity, 3) protection from stressors.

Habitat heterogeneity is defined as the variation in environmental conditions, resource composition, and structural complexity within an area. Structural complexity refers to the degree of three-dimensional variation within the ecosystem. Vegetation layering provides vertical complexity, interspersion of vegetation forms provides horizontal complexity. Increased complexity creates a greater variety of niches and resources, allowing different species to thrive concurrently. The presence of canopy openings, small water features and topographic variation all contribute to the structural complexity and heterogeneity of a site. Increased habitat heterogeneity can lead to greater resource partitioning, more complex food webs, and the establishment of refugia for species, contributing to ecosystem stability and resilience. Habitat heterogeneity supports habitat resilience by creating diverse niches and resources that generally support higher species richness and biodiversity. **(Cody, 1981)**

Habitat connectivity is the physical and functional connection between areas of natural habitat that allows wildlife to move between them to find food, water, shelter, and breeding sites, which is essential for maintaining biodiversity, population health, and ecosystem resilience. Connected landscapes, or wildlife corridors, allow animals to move, find resources, and adapt to environmental changes. Habitat corridors are strips of natural land that connect fragmented ecosystems, allowing wildlife to move safely between larger habitat areas to find food, water, and mates. These corridors are crucial for maintaining genetic diversity in isolated populations, facilitating species migration, and supporting ecosystem health. Human activities like urbanization, agriculture, and resource extraction destroy and break up natural spaces, making it harder for wildlife to find food, water, and shelter. Land use in the region determines the degree of fragmentation and habitat loss and is a major contributor to declining wildlife health and overall prevalence. **(Ernst, 2014)**

Direct disturbance is another significant human-induced stressor on wildlife, impacting both their behavior and physiology. It encompasses a wide range of human activities, from recreational pursuits to infrastructure development and industrial operations, that disrupt an animal's normal life and can cause chronic stress. Direct physical interactions like approaching a nesting bird, handling farm animals aversively, or vehicle-wildlife collisions can have immediate, negative consequences. Human-generated noise from transportation (roads, aircraft, boats), industry, and other activities can interfere with animal communication, mask the sounds of predators or prey, and cause physiological stress. Artificial lights at night can disrupt the feeding and mating patterns of nocturnal animals, causing significant behavioral stress. Even activities such as hiking, off-road vehicle use, boating, and wildlife viewing can trigger flight responses, increase vigilance, and lead to avoidance of otherwise suitable habitats. **(Markovchick-Nicholls et al., 2008)**

Prolonged stress can compromise an animal's immune function, reduce reproductive success, and negatively affect body condition. Animals, especially those not habituated to human presence, perceive humans as potential predators, triggering a "fight-or-flight" response that elevates stress hormones, which can cause severe health problems, alter brain chemistry, lead to abnormal behaviors, and ultimately shorten an animal's lifespan. The cumulative impact of multiple anthropogenic stressors in and around wetland habitat have an ongoing effect on species presence and distribution and decrease the overall maintenance of wildlife habitat integrity.

Independent quantitative measures include conducting regular faunal surveys to measure changes in species composition and abundance over time. However, the time and level of effort required by these methods is beyond the scope of a rapid assessment. Therefore, the level of functional capacity must be assessed indirectly using indicators that represent the characteristics which promote wetland wildlife habitat integrity.

B. Assessing Wildlife Habitat Integrity

The potential that a wetland has for wildlife habitat integrity is based on its ability to maintain and support typical diversity and abundance of native fauna in the wetland. Indicators of this potential are characteristics of the surrounding landscape, connectivity and proximity to other habitat areas, the effect of internal stressors, and habitat heterogeneity/complexity. The functional capacity grade for Wildlife Habitat Integrity is calculated using a model that combines the variables *Buffer, LandCov, HabProx, Corridor, HumanActivity* and *HabFeat* in the following equation:

$$\boldsymbol{FCG_{(WHI)} = \frac{4(Buffer) + 2(LandCov) + HabProx + Corridor + HumanActivity + HabFeat}{10}}$$

Summary of Model

Property	Variables	Description
Landscape Characteristics	*Buffer*	Presence and integrity of adjacent undisturbed buffer
	BuffIntact	Percent of AU perimeter with intact buffer
	BuffWidth	Average width of adjacent undisturbed buffer
	LandCov	Effect of surrounding land use
	LULCZone	Area of 500m zone in which land use is evaluated
	LULCArea	Area within 500m zone classified as each LULC type
	LULCWeight	Relative impact of each LULC type
	HabProx	Distance to nearest block of similar wetland habitat
	Corridor	Connections to other undisturbed habitat blocks
Stressors	*HumanActivity*	Impact of recent human activity on habitat integrity
	ActivIntensity	Presence and intensity of recent human activity
	ActivProportion	Proportion of AU impacted by recent human activity
Habitat Characteristics	*HabFeat*	Structural complexity and presence of habitat features
	Strata	Number of vegetation strata present
	Heterogeneity	Presence and type of microhabitats
	WildFeat	Presence and number of specialized habitat features

$$\boldsymbol{FCG_{(WHI)}} = \frac{\boldsymbol{4(Buffer) + 2(LandCov) + HabProx + Corridor + HumanActivity + HabFeat}}{\boldsymbol{10}}$$

$$Buffer = \frac{2(BuffIntact) + BuffWidth}{30}$$

$$LandCov = \sum_{T=1}^{n} \left(\frac{LULCArea_T}{LULCZone}\right)(LULCWeight_T) \quad \text{and} \quad T = \text{each land use type}$$

$$HumanActivity = \min_{A \in \{1,\dots n\}} \sqrt{ActivIntensity_A \times ActivProportion_A} \quad \text{and} \quad A = \text{each activity}$$

$$HabFeat = Strata + Heterogeneity + WildFeat$$

Model Description

Buffer is a composite variable which characterizes the degree to which adjacent undisturbed land provides physical protection to the wildlife community in the AU. The sub-variable components describe the percent of the perimeter with intact buffer and the average width of that buffer. Intact buffer is defined as undisturbed area, composed of any habitat type including open water. The presence of a narrower, but more complete buffer will generate a higher variable score than a discontinuous wider buffer. The presence of adjacent buffer lessens the effect of anthropogenic activities on nearby land.

LandCov is a composite variable that describes the effect of land use in the area surrounding the assessment unit. Fragmentation, noise and light pollution, and vegetation removal all influence breeding, nesting and migration patterns. While the type and degree of impact varies from species to species, habitat integrity generally decreases as development increases in the surrounding landscape.**(Brown & Vivas, 2005)**

Internal stressors are characterized by the *HumanActivity* and *PlantStress* variables. These variables only evaluate the effect of recent or ongoing stressors within the wetland, based on the assumption that any response to older stressors has already occurred, and the existing community is composed of those species which have adapted to those conditions. *HumanActivity* is a composite variable which evaluates degree of disturbance resulting from one or more anthropogenic activities in or near the assessment unit. *PlantStress* is a similar composite variable which evaluates disturbance resulting from stressors such as insect pest damage which directly affect the presence/distribution of species in the vegetative community. Sub-variables representing the intensity of each stressor and the proportion of the assessment unit which is affected by that stressor are combined to calculate an individual magnitude of disturbance for each human activity and plant community stressor. The model is calculated by using the stressor with the lowest score, representing the highest magnitude of disturbance and reducing the overall Plant Community FCG.

Habitat connectivity is characterized by the *HabProx* and *Corridor* variables. Connectivity has a strong positive correlation with species abundance and distribution. Metrics addressing landscape connectivity/fragmentation vary widely in general approach and complexity; this model includes two relatively simple measures. *HabProx* accounts for the amount of habitat available in the region and *Corridor* accounts for the ability of species to move between resource areas.

The *HabFeat* variable is a composite variable which evaluates the structural complexity of the assessment unit habitat. The sub-variable components of *HabFeat* describe degree of layering in the vegetation, interspersion of small habitat patches and the presence of features which satisfy specialized habitat requirements for one or more wildlife species. These characteristics are additive, their absence may limit the habitat suitability for some species but does not decrease the habitat value for all wildlife. Variability within the system is captured by computing a *HabFeat* sub-score for each vegetated wetland assessment unit and then calculating a weighted average to determine the variable score. See Chapter 5 for detailed discussion of the *HabFeat* variable.

Wildlife habitat suitability is evaluated as the sum of three measures: vertical vegetation structure, horizontal structural variability, and the presence of specialized habitat features. Vertical structural complexity means food, cover and/or breeding habitat is accessible at different levels throughout the assessment unit. Horizontal structural complexity creates small microhabitats such as canopy openings in a forested area or shade trees in an emergent area. Specialized features create opportunities to support additional life functions such as breeding/nesting habitat provided by hollow trees, rock piles, or vegetated shallows. These characteristics are additive, their absence may limit the habitat suitability for some species but does not decrease the habitat value for all wildlife.

Variables and Scoring

Buffer – composite variable that represents the presence and integrity of undisturbed buffer adjacent to the AU.

Sub-Variables: *Buffer* is calculated by combining the sub-variables *BuffIntact* and *BuffWidth* in the following equation:

$$Buffer = \frac{2(BuffIntact) + BuffWidth}{30}$$

BuffIntact is an estimate of the percent of the AU perimeter with intact buffer (defined as undisturbed area at least 10m wide, composed of any habitat type including open water). *BuffWidth* is a measure of the average width of the adjacent buffer. *BuffIntact* is weighted more heavily than *BuffWidth* in the equation for *Buffer*. See Appendix K for detailed information about composite variable calculation.

Scoring: The equation for *Buffer* generates a value between 0 and 10. The score for *Buffer* = 0 if the assessment unit has less than 5% intact buffer OR the average buffer width is less than 5m.

LandCov – composite variable that represents the effect of surrounding land use on the habitat integrity of the AU.

Sub-Variables: *LandCov* is calculated by combining the sub-variables *LULCArea, LULCZone* and *LULCWeight* in the following equation:

$$LandCov = \sum_{T=1}^{n} \left(\frac{LULCArea_T}{LULCZone}\right)(LULCWeight_T)$$

LULCZone is the area within 500m of the AU in which land use is evaluated. *LULCArea* is the area within the adjacent land use zone which is classified as each LULC type. *LULCWeight* is the relative impact coefficient assigned to each LULC type. See Appendix K for detailed information about composite variable calculation.

Scoring: The equation for *LandCov* generates a value between 0 and 10. If the 500m land cover zone is entirely comprised of High Intensity Development, the score for *LandCov* will be 0.

HabProx – the proximity of the nearest similar wetland habitat block.

Indicators: The distance between the AU and the nearest block of similar wetland habitat is measured in the office using GIS and recorded in Section G-5b of the Data Sheet AFTER the AU boundary has been confirmed in the field and finalized.

Scoring: Each of the five *HabProx* classes is assigned a numeric score between 1 and 10 (see table below). The score for the appropriate size class is used to calculate the FCG.

***HabProx* Classes and Scores (Wildlife Habitat Integrity)**					
DISTANCE CLASS	SCORE	DISTANCE CLASS	SCORE	DISTANCE CLASS	SCORE
< 100 meters	10	200 to < 300 meters	5	≥ 500 meters	1
100 to < 200 meters	8	300 to < 500 meters	3		

Corridor – the degree of habitat connectivity between the AU and other undisturbed habitat blocks.

Indicators: The presence of any corridors between the AU and other undisturbed habitat blocks is evaluated in the office using GIS and recorded in Section G-5a of the Data Sheet AFTER the AU boundary has been confirmed in the field and finalized.

Scoring: Each of the three *Corridor* classes is assigned a numeric score between 1 and 10 (see table below). The score for the appropriate class is used to calculate the FCG.

***Corridor* Values and Scores (Wildlife Habitat Integrity)**					
# of CORRIDORS	SCORE	# of CORRIDORS	SCORE	# of CORRIDORS	SCORE
None	0	One	7	Two or More	10

<u>*HumanActivity*</u> - composite variable that represents the impact of recent human activity in or within 100m of the AU.

Sub-Variables: *HumanActivity* is calculated by combining the sub-variables *ActivIntensity* and *ActivProportion* in the following equation:

$$HumanActivity = \min_{A \in \{1,\ldots n\}} \sqrt{ActivIntensity_A \times ActivProportion_A}$$

ActivIntensity describes the presence and intensity of recent human activity in or near the AU and *ActivProportion* estimates the proportion of the AU impacted by each activity. The magnitude of each activity (sub-score) is calculated individually using the equation above. The score for *HumanActivity* is equivalent to the LOWEST sub-score, which represents the activity which has the GREATEST impact on the AU. See Appendix K for detailed information about composite variable calculation.

Scoring: The equation for *HumanActivity* generates a value between 1 and 10. An assessment unit with no evidence of human activity within the last 2 years will receive a score of 10.

<u>*HabFeat*</u> – composite variable that represents the structural complexity of the AU and the presence of specialized habitat features.

Sub-Variables: *HabFeat* is calculated by combining the sub-variables *Strata, Heterogeneity* and *WildFeat* for each vegetated wetland sub-unit in the following equation:

$$HabFeat = Strata + Heterogeneity + WildFeat$$

Strata is the number of vegetation strata present as an indication of vertical structural complexity. *Heterogeneity* is the presence and type of microhabitats as a measure of horizontal variability throughout the AU. *WildFeat* is the presence and number of specialized habitat features within the AU. See Appendix K for detailed information about composite variable calculation.

Scoring: The equation for *HabFeat* generates a value between 1 and 10. The score for *HabFeat* = 1 if the sub-unit has less than the typical number of strata for that sub-unit type AND no microhabitat AND no specialized habitat features. *HabFeat* is calculated for EACH sub-unit then weighted by sub-unit area to determine the variable score. See Appendix E for detailed instructions on sub-unit weighting.

Glossary

A

Abiotic — Not living. Deposition of suspended sediments on floodplains is an abiotic process. Compare to *Biotic*.

Ablation till — See *Till.*

Absolute cover — See *Cover.*

Abutting — Bordering, directly touching, shares a boundary. Compare to *Bisecting, Bordering, Contiguous*.

Adsorption — The attraction and adhesion of a layer of ions from an aqueous solution to the solid mineral surface with which it is in contact.

Aeolian — Outdated term. See *Eolian*.

Aerobic — A condition in which molecular oxygen is present in the environment or processes occurring in the presence of free molecular oxygen. Compare to *Anaerobic*. See also *Oxic*.

Alluvial — Pertaining to material or processes associated with transportation and/or subaerial deposition by concentrated running water.

Alluvium — Unconsolidated material, such as gravel, sand, silt, clay, and various mixtures of these, deposited on land by running water. See also *Surficial geology.*

Anaerobic — A condition in which molecular oxygen is virtually absent from the environment. Processes which require oxygen and/or depend on the activity of obligate aerobic bacteria will not occur. Compare to *Aerobic*. See also *Anoxic*.

Anoxic — Devoid of molecular oxygen. Compare to *Oxic*. See also *Anaerobic*.

Anthropogenic — Arising from human activity. See also *Human-altered material, Human-transported material, Surficial geology*.

Aquatic bed vegetation — Plants that grow principally on or below the surface of the water, either attached to the substrate or floating freely. Requires surface water for optimum growth and reproduction. Includes submerged or floating-leaved rooted vascular plants, free-floating vascular plants, submergent mosses, and algae. Compare to *Emergent vegetation*. See also *Hydrophyte, Submerged vegetation*.

> **Floating-leaved plants** — Rooted, herbaceous hydrophytes with some leaves which float on the water surface, e.g., white water lily (*Nymphaea odorata*), floating-leaved pondweed (*Potamogeton natans*). Plants such as yellow water lily (*Nuphar luteum*) which sometimes have leaves raised above the surface are either considered floating-leaved plants or emergents, depending on their growth habit at a particular site.
>
> **Free-Floating plants** — Plants that float at or just beneath the water surface without attachment to the substrate e.g., water hyacinth (*Eichhornia crassipes*) or common duckweed (*Lemna minor*); free-floating aquatic species are transported freely by wind and water currents.

Aquatic bed wetland — Wetland composed primarily of aquatic bed vegetation: Term used in vegetation-based classification. Compare to *Emergent wetland, Scrub-shrub wetland, Forested wetland*

> **Aquatic Bed Microhabitat** — See *Microhabitat.*

Aquatic Bed Wetland (Cowardin) — See *Class (Cowardin).*

Aquatic resource — Refers to ecological systems where the regular or occasional presence of water is the dominant factor determining the characteristics of the site. Aquatic resources include wetlands, rivers, streams, lakes, ocean, estuary, bays, and other deepwater habitats.

Aquiclude — A soil or rock layer that is incapable of transmitting significant quantities of water under ordinary hydraulic gradients. Compare to *Aquifer, Aquitard.* See also *Groundwater*

Aquifer — A geological formation or structure that stores and/or transmits significant quantities of water under ordinary hydraulic gradients to wells or springs. Use of the term is usually restricted to those water-bearing formations capable of yielding water in sufficient quantity to constitute a usable supply for human use. See also *Groundwater, Water table*.

Confined aquifer — Groundwater under greater than atmospheric pressure due to layers of impermeable material both above and below it. When the aquifer is penetrated by a well, the water will rise above the top of the aquifer. See also *Aquiclude, Aquitard*.

Unconfined aquifer — An aquifer whose upper water surface (water table) is at atmospheric pressure and thus is able to rise and fall.

Aquitard — A layer of soil or rock that slows the downward flow of water but does not prevent the flow of water to or from an adjacent aquifer and is capable of perching water above it. It does not readily yield water to wells or springs but may serve as a storage unit for groundwater. Compare to *Aquiclude, Aquifer*. See also *Groundwater*

Areal cover — In vegetation sampling, a measure of dominance that defines the degree to which aboveground portions of plants (leaves and stems) cover the ground surface when viewed from above (areal cover). Typically estimated by vegetative layer. See also *Cover class, Layer*.

Absolute cover — In vegetation sampling, the percentage of the ground surface that is covered by the aerial portions of a plant species when viewed from above. Due to overlapping plant canopies, the sum of absolute cover values for all species in a community or stratum may exceed 100 percent. Compare to *Relative cover*.

Relative cover — In vegetation sampling, the percentage of the ground surface that is covered by the aerial portions of a plant species when viewed from above, divided by the total coverage of all species in that stratum, expressed as a percent. Relative cover values for all species in a community or stratum will total 100 percent. Compare to *Absolute cover*.

Assessment sub-unit (ASU) — Defined by NEWFA as a sub-division of an assessment unit for data collection purposes; based on changes in vegetation structure. Compare to *Soil examination area*. See also *Vegetated Wetland Sub-Unit, Non-Wetland Sub-Unit*.

Assessment unit (AU) — The unit of evaluation; the area in which functional capacity is being assessed for one or more wetland functions. The assessment unit may be an entire wetland or a portion of a wetland system.

B

Bank (Bank Stabilization) — See *Resource Specific Function (RSF).*

Basal area — The cross-sectional area of a tree trunk, generally measured at breast height (4.5 ft above the ground level) and measured outside the bark. It is a measure of stand density, commonly expressed in square feet.

Basal till — See *Till.*

Baseflow — The portion of streamflow that is derived from natural storage of precipitation that percolates to ground water and moves slowly through substrate before reaching the channel. Baseflow sustains streamflow during periods of little or no precipitation and is the average stream discharge during low flow conditions. Natural base flow is sustained largely by groundwater discharges. in contrast to rapid runoff from direct rainfall or snowmelt. See also *Groundwater, Streamflow.*

Bay — A coastal embayment of variable size and shape that is always opens to the sea through an inlet or other features, larger than a cove.

Beach — A gently sloping zone, typically with a concave profile, of unconsolidated material extending landward from the low-water line to the place where there is a definite change in material or physiographic form (such as a cliff) or to the line of permanent vegetation (usually the effective limit of the highest storm waves); a shore of larger water bodies, formed and washed by waves and currents and usually covered by sand and gravel (e.g., a foredune, cliff, or bank).

Bed and banks —In the context of the CWA, "bed and banks" define the channel of a stream or river shaped by the regular flow of water. These physical features indicate enough water flow to form a channel. See also *Channel*, *Conveyance, Ditch, Stream, River.*

> **Bed** — The base of the active channel, distinguished as having a lower aver-age side gradient than the adjacent banks.
>
> **Banks** — The sides of the channel that hold the water, a break in slope between the edge of the bed and the surrounding terrain. Typically associated with a steeper side gradient than the adjacent channel bed, floodplain, or valley bottom.

Bedrock — The solid rock that that is exposed at the land surface or that underlies the soil and other unconsolidated material surface materials such as soil, alluvium, gravel or rock fragments.

> **Shallow Bedrock** — See *Surficial geology.*

Berm — Any stretch of land that forms a kind of shelf above or along a river, train tracks, or highway. Also, a nearly horizontal or landward-sloping portion of a beach formed by the deposition of sediment by storm waves. Berms can be natural or artificial in origin. Compare to *Dike*, *Levee*.

Bidirectional flow — See *Flowing water.*

Biodiversity — The number and relative abundance of all species within a given area. Includes plants, animals (including humans), fungi and microorganisms along with their individual variations and the interactions between them.

Biogenic — Derived or originating from living material, as peat.

Biogeochemical — The interaction and integration of biological and geochemical processes.

Biotic — Refers to living processes or entities. Compare to *Abiotic.*

Bisecting — Divide into two, usually equal, parts. Compare to *Abutting, Bordering, Contiguous.*

Bluff — A high bank or bold headland, with a broad, precipitous, sometimes rounded cliff face overlooking a plain or body of water.

Bordering — Bordering, directly touching, shares a boundary. Compare to *Abutting, Bisecting, Contiguous.*

Brackish — Waters typically found in the upper extent of estuaries and the lower reaches of large rivers. Normally a mixture of fresh water and sea water. These waters typically have a saline content of greater than 0.5 parts per thousand. See also *Salinity, Saltwater.*

Buffer — An area abutting the resource of interest, typically vegetated; that reduces adverse impacts of nearby land uses.

C

Canopy — See *Strata.*

Capillary fringe — see *Water table.*

Channel — An open landscape feature, either naturally or artificially created, distinguished by a recognizable path which conveys water at least periodically, or which forms a connecting link between two bodies of standing water and is distinguished by a recognizable path marked by, in some cases subtle, bed and banks. See also *Bed and banks, Conveyance, Ditch, Stream, River.*

Clastic — Pertaining to rock or sediment composed mainly of fragments derived from preexisting rocks or minerals and moved from their place of origin. The term indicates sediment sources that are both within and outside the depositional basin.

Class (**Cowardin)** — The highest taxonomic unit below the Subsystem level in the Cowardin classification. It describes the general appearance of the habitat in terms of either the dominant life form of the vegetation or the physiography and composition of the substrate—features that can be recognized without the aid of detailed environmental measurements. Compare to *Vegetated wetland sub-unit*. See also *Cowardin classification, Dominant life form, System (Cowardin), Vegetated wetland sub-unit.*

> **Aquatic Bed (Cowardin)** — Includes wetlands and deepwater habitats where plants that grow principally on or below the surface of the water (i.e., surface plants or submergents) are the uppermost life form layer with at least 30 percent areal coverage.
>
> **Emergent Wetland (Cowardin)** — Wetland class where emergent plants—i.e., erect, rooted, herbaceous hydrophytes, excluding mosses and lichens—are the dominant life form. This vegetation is present for most of the growing season in most years. These wetlands are usually dominated by perennial plants. Emergent wetlands include marshes and wet meadows.
>
> **Scrub-Shrub Wetland (Cowardin)** — Wetland class where woody plants less than 6 m (20 ft) tall are the dominant life form. The "shrub" life form actually includes true shrubs, young specimens of tree species that have not yet reached 6 m in height, and woody plants (including tree species) that are stunted because of adverse environmental conditions.
>
> **Forested Wetland (Cowardin)** — Wetland class where trees are the dominant life form. Trees are defined as woody plants at least 6 m (20 ft) in height. Shrubs often form a second layer beneath the forest canopy, with a layer of herbaceous plants growing beneath the shrubs.

Closed system — See *Hydrologic exchange.*

Coarse woody material — Large pieces of downed wood such as logs, rootwads, and limbs. May be on the ground or in/near a body of water. Large woody debris serves to slow surface water flows, contain surface inundation, and provides habitat structure for fish and other aquatic organisms. See also *Microfeatures*.

Codominant — Two or more species providing about equal areal cover which, in combination, control the environment. See also *Dominant*.

Colluvium — See *Surficial geology.*

Component — See *Soil map unit.*

Concentration — See *Redoximorphic features.*

Condition — Health of a resource; the relative ability of an aquatic resource to support and maintain a community of organisms having a species composition, diversity, and functional organization comparable to a reference resource. Compare to *Functions, Services.* See also *Reference condition.*

Connectivity — Refers to the presence or absence of barriers to biotic (animals and plants) and/or abiotic (water and nutrients) migration, both into and out of a specific wetland system. See also *Corridor*, *Hydrologic exchange*.

> **Habitat connectivity** — The structures on the landscape that facilitate movement of living organisms between patches of their habitat that are found across the landscape. The movement can occur either within the lifetime of an organism or over a period of generations. The purpose of facilitating movement is to maintain viable populations that allow species and communities of species to persist in time. Connectivity can be achieved via a continuous and linear habitat feature (as in a corridor) or discrete habitat patches comprised of but not limited to individual forests, wetlands, shrub lands, and shorelines.
>
> **Hydrologic connectivity** — A measure of the ability of water to flow into or out of the wetland. See also *Hydrologic exchange.*

Consistence — The degree of cohesion and adhesion of soil material and its resistance to deformation when a stress is applied, expressed by a set of soil attributes. Individual field tests can be performed for specific aspects of consistence, including rupture resistance, penetration resistance, plasticity, toughness, stickiness, and manner of failure. The similar term "consistency" is used by engineers to describe similar concepts regarding the response of soils to applied force, but the tests prescribed are different.

Contiguous — Touching or joining at the edge or border; generally, a wetland that grades into a water body with which it is contiguous. Compare to *Abutting, Bisecting, Bordering.*

Conveyance — A feature that allows for conveying water from one location to another; it may be a natural and/or human-constructed feature. See also *Channel, Ditch*

Corridor — Linear habitats with the range of environmental functions necessary to permit the movement of animals between larger and more fully functioning habitats; areas that contain relatively undisturbed habitat and/or vegetation that maintain connections for wildlife throughout the landscape. See also *Habitat connectivity.*

Cover class — In ecological contexts, " cover class" refers to a system for classifying the percentage of an area covered by vegetation, such as in vegetation surveys or land use studies. This system is a way to quantify and categorize the amount of vegetation present, often using a set of predefined classes. See also *Areal cover.*

Cowardin classification — The first commonly used classification system for wetlands developed in 1979 by the U.S. Fish and Wildlife Service. The Cowardin system classifies wetlands based on water flow, substrate types, vegetation types, and dominant plant species. Compare to *Hydrogeomorphic classification.* See also C*lass* and *System*.

> **Dominant life form** — That life form of plants (e.g., tree, shrub, moss) that constitutes the uppermost layer of vegetation at a site and possesses at least 30 percent areal cover. The dominant life form determines the Class of vegetated wetlands in this classification.

Criteria — Measures, standards, or guidelines used to make assessments or decisions. See also *Descriptor, Indicator, Metric, Variable.*

Culvert — A structure that allows water to flow under a road, railroad, trail, or similar obstruction from one side to the other. Typically embedded so as to be surrounded by soil, a culvert may be made from a pipe, reinforced concrete or other material.

D

Dam — Obstruction across a watercourse or natural drainage area, which does or may impound or divert water to produce a lake, pond, wetland, or other widened aquatic feature. Dams are artificially constructed by humans or beavers. Compare to *Debris jam, Tide gate, Weir*. See also *Flow restriction*.

Debris jam — A stream-blocking feature of wood, boulders, gravel or complex mixtures of these features formed by various natural processes. An accumulation of material, organic or inorganic, floating or submerged, that has been lodged into place by the action of a flowing water. Debris jams partially or completely obstruct surface water flow and sediment causing a change in the course of flow. Compare to *Dam, Tide gate, Weir* See also *Flow restriction*.

Deepwater habitat — Any open water area that has a mean annual water depth >6.6 ft, lacks soil, and/or is either unvegetated or supports only floating or submersed macrophytes. Permanently flooded lands lying below the deepwater boundary of wetlands. Compare to *Wetland*. See also *Cowardin classification*.

Delineation — The process of precisely defining the boundaries of a specific natural resource, such as a wetland, stream, or aquifer, within a given area. This scientific, site-specific analysis identifies the exact location and extent of the resource by combining fieldwork, data collection, and mapping to create a clear, documented representation essential for regulatory compliance, land-use planning, and environmental protection efforts.

> **Wetland delineation** — The scientific process of identifying, mapping, and describing the boundaries of wetlands, streams, lakes, and other aquatic features within a specific area, primarily for regulatory purposes under the Clean Water Act. See also *Wetland indicators*.

Denitrification — The microbially mediated heterotrophic process of converting nitrate or nitrite to either nitrous oxide or dinitrogen gas. Compare to *Nitrification*. See also *Nitrate*.

Density — The number of individuals of a species per unit area.

Depletion — See *Redoximorphic features.*

Deposition — This term refers to the deposition or accumulation onto the bed, banks, or floodplain of materials that has been transported into a wetland or open-water system by moving water. See also *Sedimentation*.

Depression — Any relatively sunken part of the earth's surface; especially a low-lying area surrounded by higher ground. A closed depression has no natural outlet for surface drainage. An open depression has a natural outlet for surface drainage. Compare to *Flat, Floodplain, Fringe, Slope.*

> **Depression (HGM)** — See *Hydrogeomorphic classification.*
>
> **Groundwater Depression** — See *Landscape* position.
>
> **Surface Water Depression** — See *Landscape* position.

Descriptor — On the NEWFA data sheet, some metrics are in the form of a multiple-choice question that provides from one to several possible answers. The answer or answers selected by an assessor are referred to as "descriptors." See also *Criteria*, *Indicator*, *Metric, Variable*.

Detritus — Particulate organic matter from the breakdown of dead plants, animals, and waste products, such as fallen leaves, dead organisms, and fecal matter. See also *Humus*.

Developed — An area which has been altered from its natural state for human use, typically involving construction and the installation of infrastructure like roads, utilities, and buildings. This modification prepares the land for purposes such as residential, commercial, industrial, or recreational activities.

> **Developed, Open Space (LULC) —** See *LULC classification*.
>
> **Developed, Low Intensity (LULC) —** See *LULC classification*.
>
> **Developed, Medium Intensity (LULC) —** See *LULC classification*.
>
> **Developed, High Intensity (LULC) —** See *LULC classification*.

Dike —Artificial wall, embankment, ridge, or mound, usually of earth or rock fill, constructed to control or confine water. Compare to *Berm*, *Levee*.

Discharge — See *Groundwater.*

Discrete ecological unit — A distinct unit whose boundaries are based on changes in ecological features, such as soil type, vegetation communities, etc. Compare to *Wetland complex*.

Disturbance — An event that disrupts the processes or structure of ecological systems. Disturbances may occur naturally (e.g., wildfires, storms, floods) or be caused by human actions (e.g., clearing land, building roads, altering stream channels). The effects of disturbances on ecological systems are controlled in large part by their intensity, duration, frequency, timing, and size and shape of area affected. See also *Stressor*, *Impact*

Ditch — An open and usually unpaved (unlined), channel or trench excavated to convey water for drainage (removal) or irrigation (addition) to or from a landscape; smaller than a canal; some ditches are modified natural waterways. See also *Channel*, *Conveyance*.

Diurnal — In the biological sense, it refers to activity during daytime, often with a corresponding period of inactivity during the night.

Dominant — Species that are most numerous, or form the bulk of the biomass, and therefore have the greatest effect or influence on the ecological community, generally controlling the presence, abundance, or type of other species. Also biological, chemical, or physical feature that exerts a controlling influence on or defines the character of a community. See also *Codominant, Cowardin classification.*

Downstream — The direction that a river or stream flows, from higher to lower elevation. See also *Elevation*, *Flowing water, Streamflow, Watershed.*

Drainageway — A general term for a course or channel along which water moves in draining an area. See also *Spillway*, *Swale.*

Drift — A general term applied to all mineral material (clay, silt, sand, gravel, boulders) transported by a glacier and deposited directly by or from the ice, or by running water emanating from a glacier. Drift includes unstratified material (till) that forms moraines, and stratified deposits that form outwash plains, eskers, kames, varves, and glaciofluvial sediments. The term is generally applied to Pleistocene glacial deposits in areas that no longer contain glaciers. See also *Glaciated, Moraine, Surficial geology, Till.*

Dune — A low mound, ridge, bank, or hill of loose, windblown granular material (generally sand), either barren and capable of movement from place to place or covered and stabilized with vegetation but retaining its characteristic shape. Commonly found along low-lying seashores above high-tide level, more rarely on the border of large lakes or river valleys, as well as in various desert regions.

E

Effectiveness — The capability of a wetland to perform a function because of its physical, chemical, or biological characteristics; the intrinsic or potential functional capacity of a wetland. See also *Functional capacity, Opportunity*.

Elevation — The height of a point on the earth's surface relative to mean sea level.

Emergent vegetation — Rooted herbaceous (non-woody) plants that stand erect and grow in saturated soils or soils covered with water for large portions of the growing season. Compare to *Aquatic bed vegetation*, *Herbaceous vegetation*.

> **Nonpersistent emergent** — Emergent hydrophytes whose stems and leaves are evident above the surface of the water, or above the soil surface if surface water is absent, only during the growing season or shortly thereafter. Typically, plant leaves and stems break down soon after the growing season or drop beneath the water surface. Many nonpersistent emergents have fleshy or spongy tissues. During the dormant season, there is no obvious sign of emergent vegetation.

> **Persistent Emergent** — Emergent hydrophytes whose stems and leaves are evident throughout the year above the surface of the water, or above the soil surface if surface water is absent.

Emergent wetland — Wetland composed primarily of emergent vegetation: Term used in vegetation-based classification. Compare to *Aquatic bed wetland, Scrub-shrub wetland, Forested wetland.*

> **Emergent Herbaceous Wetlands (LULC) —** See *LULC classification.*

> **Emergent Microhabitat** — See *Microhabitat.*

> **Emergent Sub-Unit** — See *Vegetated wetland sub-unit.*

> **Emergent Wetland (Cowardin)** — See *Class (Cowardin).*

Eolian — Sand, silt or clay-sized material transported and deposited (eolian deposit) primarily by the wind. Commonly refers to sandy material in dunes or to loess in blankets on the surface. See also *Parent material.*

Erosion — The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep. The process in which a material is worn away by a stream of liquid (water) or air, often due to the presence of abrasive particles in the stream.

Esker —See *Glaciofluvial deposits.*

Estuary — A partially enclosed, coastal water body where freshwater from rivers and streams mixes with salt water from the ocean. A complex of saltwater and brackish wetlands and waterbodies subject to periodic inundation by tides; the mixing zone of marine saltwater and fresh water from rivers, streams, and/or upland runoff. See also *Brackish, Salinity, Saltwater.*

> **Estuarine (Cowardin) —** See S*ystem.*

> **Estuarine Fringe** — See *Landscape position*

Eutrophication — The undesirable overgrowth of vegetation caused by high concentrations of plant nutrients in bodies of water, especially nitrogen and phosphorous, often as a result of human activities.

Evaporation — The process of liquid water becoming water vapor, including vaporization from water surfaces, land surfaces, and snow fields, but not from leaf surfaces.

Evapotranspiration — The combination of surface evaporation and transpiration by plants through which water is released into the atmosphere as water vapor. Abbreviated as ET. See also *Evaporation, Transpiration*.

F

Fetch — The uninterrupted/unobstructed distance over which the wind blows across a body of water, influencing the size and characteristics of the waves generated.

Fibric — See *Organic soil material, Peat*.

Filtration — The blockage of sediment by standing vegetation.

Flat — An area characterized by a continuous surface or stretch of land that is smooth, even, or horizontal, or nearly so, and that lacks any significant curvature, slope, elevations, or depressions. Compare to *Depression, Floodplain, Fringe, Slope.* See also *Mud flat, Tidal flat.*

> **Groundwater Flat** — See *Landscape* position
>
> **Mineral soil flats (HGM)** — See *Hydrogeomorphic classification*.
>
> **Organic soil flats (HGM)** — See *Hydrogeomorphic classification.*
>
> **Surface Water Flat** — See *Landscape* position

Floating-leaved plants — See *Aquatic bed vegetation*

Flood — An overflow or inundation that comes from a river or other body of water and causes or threatens damage. Any relatively high streamflow overtopping the natural or artificial banks in any reach of a stream. A relatively high flow as measured by either gage height or discharge quantity. See also *Overbank flooding.*

Flooded — A condition in which the soil surface is temporarily covered with flowing water from any source, such as streams overflowing their banks, runoff from adjacent or surrounding slopes, inflow from high tides, or any combination of sources. Compare to *Ponding*. See also *Standing water*.

Floodplain — The nearly level plain that borders a stream and is subject to inundation under flood-stage conditions unless protected artificially. It is usually a constructional landform built of sediment deposited during overflow and lateral migration of the streams. Compare to *Depression, Flat, Fringe, Slope*. See also *Inundation. Overbank flooding, Sediment*.

> **Active floodplain** — The land beside a river that receives overbank flow when discharge exceeds channel capacity.
>
> **River/Stream Floodplain** — See *Landscape* position
>
> **Riverine (HGM)** — See *Hydrogeomorphic classification*.

Flow restriction — Features or structures which might affect or impede the movement of surface water through or out of an aquatic system. See also *Dam*, *Debris jam, Flowing water, Streamflow, Tide gate, Weir.*

Flowing water — Water that is moving, typically in continuous motion, such as rivers, streams, tides, and currents. See also *Lotic, Fluvial, Alluvial, Flow restrictions, Hydrologic connections*.

> **Bidirectional flow** — Water both enters and exits the wetland or waterbody at the same location in response to the ebb and flow of the tides (does not include flooding by abnormally high storm tides).
>
> **Inflow** — Water flows into the wetland or waterbody via a river, stream, ditch, or is pumped in from a wetland or waterbody at a higher elevation, with no significant discharge of surface water to a stream, wetland or waterbody at a lower elevation.

Outflow — Water flows out of the wetland or waterbody via a river, stream, seepage, or ditch to a wetland or waterbody at a lower elevation, with little or no observable inflowing surface water source.

Throughflow — Wetland or waterbody receives surface or ground water from a wetland or waterbody at a higher elevation which passes through the wetland and is discharged to a stream, wetland or other waterbody at a lower elevation.

Unidirectional flow — Water flows into and/or out of the wetland or waterbody in one direction, from higher to lower elevations due to gravity, forming rivers, streams, and other water bodies

Flowing Water Microhabitat — See *Microhabitat*.

Flowing Water Sub-Unit — See *Non-Wetland Sub-Unit.*

Fluvial — Of or pertaining to rivers or streams; produced by stream or river action. See also *Lotic, Flowing water*.

Forb — A plant with a soft, rather than permanent, woody stem that is not a grass or grass-like

Forested vegetation— An area with a predominance of woody plants 6m high or taller. Shrubs often form a second layer beneath the forest canopy, with a layer of herbaceous plants growing beneath the shrubs. Compare to *Scrub-shrub vegetation*. See also *Tree, Woody plant.*

Deciduous Forest (LULC) — See *LULC classification*.

Evergreen Forest (LULC) — See *LULC classification*.

Mixed Forest (LULC) — See *LULC classification*.

Forested wetland — Wetland composed primarily of trees and woody vines: Term used in vegetation-based classification. Compare to *Aquatic bed wetland, Emergent wetland, Scrub-shrub wetland.*

Forested Microhabitat — See *Microhabitat.*

Forested Sub-Unit — See *Vegetated wetland sub-unit.*

Forested Wetland (Cowardin) — See *Class (Cowardin).*

Woody Wetlands (LULC) — See *LULC classification.*

Free-floating plants — See *Aquatic bed vegetation*

Freshwater — Waters containing less than 0.5 parts per thousand of ocean-derived salts. Compare to *Brackish*, *Saltwater*. See also *Salinity*.

Friable — Easily crumbled or reduced to powder; crumbly and loose; describes materials like soil and rock that break apart readily under gentle pressure.

Fringe — The edge or periphery of a water body, like a lake or river. The water level and flow of the wetland are directly influenced by the water body due to a continuous or very frequent hydrologic connection between them. Compare to *Depression, Flat, Floodplain, Slope.*

Estuarine Fringe — See *Landscape position.*

Fresh Water Tidal Fringe — See *Landscape position.*

Lacustrine fringe (HGM) — See *Hydrogeomorphic classification.*

Lake/Pond Fringe — See *Landscape position.*

Marine Fringe — See *Landscape position.*

River/Stream Fringe — See *Landscape position.*

Tidal fringe (HGM) — See *Hydrogeomorphic classification.*

Function — The normal activities or actions that occur in wetland ecosystems, or simply, the things that wetlands do. Wetland functions result directly from the characteristics of a wetland ecosystem and the surrounding landscape, and their interaction. Compare to *Condition, Services.*

Functional assessment — The method by which the capacity of a wetland to perform individual functions is measured or characterized. This approach measures capacity using combinations of variables in numeric models to determine a functional capacity grade. See also *Indicator, Metric, Variable*, *Model*.

Functional capacity — The rate or magnitude at which a wetland ecosystem can perform a specific function. Functional capacity is dictated by characteristics of the wetland ecosystem and the surrounding landscape, and interaction between the two. See also *Effectiveness, Opportunity*.

Functional capacity grade (FCG) — A measure of the capacity of a wetland to perform an individual function.

G

Geomorphic setting — The topographic location of a site within the surrounding landscape and the geology that underlies it. See also *Landscape position*.

Geomorphology — The geologic composition and structure of a landscape, i.e. its topography, landforms, soils, and geology. The science that treats the general configuration of the earth's surface; specifically, the study of the classification, description, nature, origin, and development of landforms and their relationships to underlying structures, and of the history of geologic changes as recorded by these surface features.

Geospatial — Refers to the geographic location and characteristics of natural or constructed features and boundaries on the Earth. See also *GIS*.

GIS (Geographic Information System) — A system of spatially referenced information, including computer programs that acquire, store, manipulate, analyze, and display spatial data. See also *Geospatial*.

Glaciated — Describes an area which has been subject to glaciation and the resulting effects of glacial activity on the earth's surface. See also *Glaciation, Quaternary, Surficial geology.*

Glaciation — The formation, movement and recession of glaciers or ice sheets. A collective term for the geologic processes of glacial activity, including erosion and deposition. See also *Glaciated, Quaternary, Surficial geology.*

Glaciofluvial deposits — Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur in the form of outwash plains, valley trains, deltas, kames, eskers, and kame terraces. See also *Outwash*, *Surficial geology*.

Esker — A long, narrow, sinuous and steep-sided ridge composed of irregularly stratified sand and gravel deposited as the bed of a stream flowing in an ice tunnel within or below the ice (subglacial) or between ice walls on top of the ice of a wasting glacier and left behind as high ground when the ice melted. Eskers range in length from less than a kilometer to more than 160 kilometers, and in height from 3 to 30 meters.

Kame — A low mound, knob, hummock, or short irregular ridge, composed of stratified sand and gravel deposited by a subglacial stream as a fan or delta at the margin of a melting glacier; by a supraglacial stream in a low place or hole on the surface of the glacier; or as a ponded deposit on the surface or at the margin of stagnant ice.

Kame terrace — A terrace-like ridge or bench consisting of stratified sand and gravel deposited by a meltwater stream flowing between a melting glacier and a higher valley wall or lateral moraine and left standing after the disappearance of the ice. It is commonly pitted with "kettles" and has an irregular ice-contact slope.

Outwash plain — An extensive lowland area of coarse textured glaciofluvial material. An outwash plain is commonly smooth; where pitted, due to melt-out of incorporated ice masses, it generally is low in relief.

Glaciolacustrine deposits — Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes by water originating mainly from the melting of glacial ice. Many deposits are bedded or laminated with varves or rhythmites. See also *Surficial geology*.

Varve — A sedimentary layer or a lamina or sequence of laminae deposited in a body of still water within a year. Specifically, a thin pair of graded glaciolacustrine layers seasonally deposited, usually by meltwater streams, in a glacial lake or other body of still water in front of a glacier.

Glaciomarine deposits — Glacially eroded, terrestrially derived sediments (clay, silt, sand, and gravel) that accumulated on the ocean floor. Sediments may be accumulated as an ice-contact deposit, by fluvial transport, ice-rafting, or eolian transport. See also *Surficial geology*.

Groundwater — Water occurring beneath the ground surface under saturated conditions. That portion of the water below the ground surface which fills all the unblocked pores of the material below the water table and is under greater pressure than atmospheric pressure. Includes (1) water that flows or seeps downward and saturates soil or rock, supplying springs and wells. (2) Water stored underground in rock crevices and in the pores of geologic materials that make up the Earth's crust. Compare to *Surface water*. See also *Aquifer, Saturation, Subsurface flow, Water table*.

Groundwater discharge— Water which flows to the surface and is received by a wetland or some other area as a result of lateral seepage or upward movement of groundwater.

Groundwater recharge— Infiltration of precipitation which flows to the water table. The movement of water into the storage component of an aquifer or a recharge area.

Groundwater Depression — See *Landscape* p*osition*

Groundwater Flat — See *Landscape* p*osition*

Groundwater Slope — See *Landscape* p*osition*

Growing season — That part of the year that begins with green-up and bud-break of native plants in the spring and ends with plant dieback and leaf-drop in the fall due to the onset of cold weather.

H

Habitat — The environment occupied by individuals of a particular species, population, or community; the natural home or environment where a plant, animal, or other organism lives and grows, providing the necessary conditions, resources, and space for survival. See also *Integrity, Plant community, Resilience, Wildlife.*

Hemic — See *Organic soil material, Mucky peat*.

Herb — A non-woody vascular plant without perennial aboveground woody stems, with perennating buds borne at or below the ground surface; stems that are not secondarily thickened and that die down annually.

Herb strata — See *Strata.*

Herbaceous vegetation — Composed of plants with the characteristics of an herb; plants with no persistent woody stem above ground; includes forbs (both flowering forbs and spore-bearing ferns), graminoids, and herbaceous vines. Not limited to hydrophytes. Compare to *Emergent vegetation*. See also *Herb, Layer, Strata.*

Herbaceous layer — See *Layer.*

Heterogeneity —Variation in environmental conditions, resource composition, and structural complexity within an area, providing diverse niches and resources that generally support higher species richness and biodiversity. Compare to *Homogeneity*.

HGM — See *Hydrogeomorphic classification.*

High Tide Line — The line of intersection of the land with the water's surface at the maximum height reached by a rising tide. The high tide line may be determined, in the absence of actual data, by a line of oil or scum along shore objects, a more or less continuous deposit of fine shell or debris on the foreshore or berm, other physical markings or characteristics, vegetation lines, tidal gages, or other suitable means that delineate the general height reached by a rising tide. The line encompasses spring high tides and other high tides that occur with periodic frequency but does not include storm surges in which there is a departure from the normal or predicted reach of the tide due to the piling up of water against a coast by strong winds such as those accompanying a hurricane or other intense storm. Compare to *Ordinary High-Water Mark*.

Hillslope (slope)— The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Histic epipedon — A thick (20- to 60-cm, or 8- to 24-inch) organic soil horizon that is saturated with water at some period of the year (unless the soil is artificially drained) and that is at or near the surface of a mineral soil. See also *Histosols, Organic soil material, Wetland indicator*.

Histosols — Soils that have organic soil materials in more than half of the upper 80 cm (32 inches) or that have organic materials of any thickness if they overlie rock or fragmental materials that have interstices filled with organic soil materials. See also *Histic epipedon, Organic soil material, Wetland indicator*.

Homogeneity — Refers to an environment with little variation, meaning a large area of uniform characteristics and few different habitat types or resources. Compare to *Heterogeneity*.

Horizon — See *Soil profile*.

Human-altered material — Mineral or organic soil material that has been mixed or otherwise purposefully altered on site by human activity. Included within the concept are deep tillage, onsite excavation and replacement, and the development of anthric saturation by subsoil compaction and flood irrigation. Human-altered material is recognized as a kind of parent material. Compare to *Human-transported material*. See also *Anthropogenic*.

Human-transported material — Mineral or organic soil material that has been moved horizontally onto a pedon from a source area outside of that pedon by directed human activity, usually with the aid of machinery. Human-transported materials are most commonly associated with building sites, mining or dredging operations, sanitary landfills, or other similar activities that result in the formation of a constructional anthropogenic landform. Human-transported material is recognized as a kind of parent material. It almost always has a lower boundary that can be easily recognized as a lithologic discontinuity or contact with a buried soil. Compare to *Human-altered material*. See also *Anthropogenic*.

Hummock — A low mound, ridge, or microtopographic high. Often composed of organic materials (typically less than 1m high) along the banks and floodplains of fluvial systems created by the collection of sediment and biotic material around wetland plants such as sedges. In wet areas, plants growing on hummocks may avoid some of the deleterious effects of inundation or shallow water tables. See also *Microfeature, Pit and mound*, *Roughness.*

Humus — A brown or black complex variable material resulting from partial decomposition of plant or animal matter and forming the organic layer/matter of soil. See also *Detritus*, *Organic matter*, *Soil surface.*

Hydraulic conductivity — A measure of how easily water can flow through a porous material, such as soil or rock. It quantifies the material's ability to transmit fluids under pressure, with higher values indicating less resistance to flow and easier water movement. This property is influenced by factors like pore size, pore connectivity, and the fluid's viscosity, and it is a key component in Darcy's Law which describes fluid flow in porous media. Compare to *Permeability*.

> **Saturated hydraulic conductivity (Ksat)**— Measures the ease with which water flows through a soil when it is completely full of water, or saturated. It is expressed as a velocity, such as meters per day or centimeters per hour, representing the volume of water that moves through a unit area of soil in a unit of time under a specific water pressure gradient. Factors like soil texture, structure, and pore size significantly influence Ksat, with coarser-textured soils like sand generally having higher Ksat values than fine-textured soils like clay.

Hydraulic head — A position of higher water table relative to a lower one. Water flows toward decreasing hydrostatic heads, and not necessarily to lower elevations. See also *Water table*.

> **Hydraulic gradient** — The change in total head with a change in distance in a given direction. The direction is that which yields a maximum rate of decrease in head.

Hydric soil — See *Wetland indicator*.

Hydrodynamics — Refers to the movement of water and its capacity to do work. There are three qualitative categories of hydrodynamics: (1) vertical fluctuations of the water levels or water table, (2) unidirectional surface or near-surface flows that range from strong currents contained in channels to slow sheet flow down a slope, and (3) bidirectional flows resulting from tides or wind-driven currents in lakes. See also *Flowing water, Hydrologic exchange.*

Hydrogeomorphic (HGM) classification— A system used to classify wetlands based on the position of the wetland in the landscape (geomorphic setting), the water source for the wetland, and the flow and fluctuation of the water once in the wetland. Compare to *Cowardin classification, Landscape position*.

> **Depression (HGM) —** Depression wetlands occur in topographic depressions that allow the accumulation of surface water. They are distinguished from Lacustrine Fringe wetlands by the lack of deep-water areas found in lakes, reservoirs, and other large bodies of water. Depressions may have any combination of inlets and outlets or lack them completely. Potential water sources are precipitation, overland flow, streams, or groundwater flow from adjacent uplands. The predominant direction of flow is from the margins of the topographic depression to the lowest point in the depression. Hydrodynamically, depressions exhibit vertical fluctuations with temporal scales ranging from a few days to many months. Depressions lose water through intermittent or perennial outlets, infiltration and percolation to subsurface layers, and evapotranspiration. Small or “micro” depression areas that occur in association with other wetland classes, such as riverine

or flat wetlands, are generally not considered to belong to the depression class, but rather are considered to be characteristic components of the wetland class in which they occur. Prairie potholes, playa lakes, vernal pools, Carolina Bays, and cypress domes are common examples of depression wetlands.

Lacustrine fringe (HGM) — Lacustrine fringe wetlands are adjacent to lakes, reservoirs, or other large bodies of water. Sources of water are the adjacent body of water, precipitation and groundwater discharge where lacustrine fringe wetlands intergrade with uplands or slope wetlands. Surface water flow is bidirectional. Lacustrine fringe wetlands lose water by flow returning to the adjacent body of water after flooding, and evapotranspiration. Organic matter may accumulate in areas sufficiently protected from shoreline wave erosion. Unimpounded marshes of the Great Lakes are an example of lacustrine fringe wetlands.

Mineral soil flats (HGM) — Mineral soil flats are most common on relatively flat land surfaces such as interfluves, extensive relic lake bottoms, or large alluvial terraces. The primary source of water is precipitation. They receive virtually no groundwater discharge, which distinguishes them from the depression and slope wetland classes. Dominant hydrodynamics are vertical fluctuations. Mineral soil flats lose water by overland flow, infiltration, and percolation to subsurface layers, and evapotranspiration. They are distinguished from non-wetland flats land surfaces by their poor vertical drainage due to low permeability soils or impermeable layers (e.g., hardpans), slow lateral drainage, and low hydraulic gradients. Pine flatwoods on hydric soils are an example of mineral soil flat wetlands.

Organic soil flats (HGM) — Organic soil flats, or extensive peatlands, differ from mineral soil flats in part because their elevation and topography are controlled by vertical accretion of organic matter. They commonly occur on flat interfluves but may also be located where depressions have become filled with peat to form a relatively large flat surface. Precipitation is the dominant water source, while water loss is via overland flow and infiltration and percolation to subsurface layers. Portions of the Everglades and northern Minnesota peatlands are examples of organic soil flat wetlands.

Riverine (HGM) — Riverine wetlands occur in floodplains and riparian corridors associated with stream channels. The dominant sources of water are overbank or backwater flow from the stream channel. Additional sources may be groundwater or overland flow from adjacent uplands, tributary inflow, and precipitation. During overbank events, the hydrodynamics of riverine wetlands are unidirectionally downstream. Headwater riverine wetlands often intergrade with slope, depression, or flat wetlands as the stream channel diminishes. Riverine wetlands lose water via the return of surface water to the stream channel, infiltration and percolation to subsurface layers and the stream channel, and evapotranspiration. Bottomland hardwood forests on floodplains are an example of riverine wetlands.

Slope (HGM) — Slope wetlands are found on slightly sloping to steeply sloping land surfaces where groundwater discharge or saturated overland flow occurs without channel formation. Slope wetlands are distinguished from depression wetlands by the lack of a closed topographic depression and the predominance of the groundwater water source. Precipitation is also a potential source of water. Hydrodynamics are dominated by downslope, unidirectional flow of water. Slope wetlands lose water primarily by saturated subsurface flows, surface flows, and by evapotranspiration. Fens are a common example of slope wetlands.

Tidal fringe (HGM) — Tidal fringe wetlands occur along coasts and estuaries under the influence of sea level and tides. They intergrade landward with riverine wetlands where tidal influence diminishes, and channel flow becomes the dominant water source. Additional water sources may be groundwater and precipitation. Because tidal fringe wetlands are frequently flooded and water table elevations are controlled mainly by sea surface elevation, tidal fringe wetlands seldom dry for significant periods. Tidal fringe wetlands lose water by tidal exchange, by overland flow to tidal creek channels, and by evapotranspiration. Organic matter normally accumulates in higher elevation marsh areas where flooding is less frequent, and the wetlands are isolated from shoreline wave erosion by intervening areas of low marsh or dunes. Spartina alterniflora salt marshes are a common example of tidal fringe wetlands.

Hydrologic exchange — Movement of water and water-mediated transfer of materials (such as nutrients and sediments), energy, and organisms within or between aquatic resources. See also *Flowing water.*

Closed system — A system where water accumulates, but the absence of an outlet results in minimal or no surface or groundwater outflow or exchange with other aquatic resources.

Open exchange — Unimpeded movement of water and materials between two aquatic resources.

Non-tidal exchange — The movement of water and materials between AU and an adjacent waterbody driven by factors such as currents or regular streamflow.

Tidal exchange — The regular influx and outflow of water between the AU and an adjacent tidal water body due to regular rising and falling of tides.

Hydrologic regime — The distribution and circulation of water in an area, on average, during a given period including normal fluctuations and periodicity. See also *Hydroperiod*, *Water regime*.

Hydrology — The science dealing with the properties, distribution, and circulation of water.

Wetland hydrology— See *Wetland indicator*.

Hydroperiod — The characteristic pattern of water level fluctuations in a wetland during a typical year. Includes the depth, frequency, duration, and timing of inundation, flooding or saturation of soils. Patterns can be daily, monthly, seasonal, annual, or longer term. See also *Hydrologic regime*, *Water regime*

Hydrophyte — Plant that grows in water or on a substrate that is saturated at a frequency and duration during the growing period sufficient to affect plant occurrence.

Hydrophytic vegetation — See *Wetland indicator*.

Hyporheic — Saturated zone under a river or stream, comprising substrate with the interstices filled with water. See also *Saturation*, *Subsurface flow*.

I

Impact — Changes to the environment that are caused by human disturbances. The effect to the ecosystem, environmental process, or species can be beneficial, detrimental or neither. See also *Disturbance*, *Stressor*.

Impervious surface — A hard surface area which either prevents or retards the entry of water into the soil; and/or a hard surface area which causes water to run off the surface in greater quantities or at an increased rate of flow from the flow present under natural conditions.

Indicator — Observable characteristics that are correlated with environmental variable conditions in a wetland or the surrounding landscape. Indicators determine or aid in determining whether or not certain stated circumstances exist. See also *Criteria*, *Descriptor, Metric, Variable*.

Inclusion — See *Soil map unit*.

Infiltration — The downward entry of water into the immediate surface of soil or other material. Compare to *Percolation*. See also *Permeability*.

Infiltration capacity — The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate — The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Inflow — See *Flowing water.*

Inlet — A point where water flows into the wetland. The inlet can be a natural area (stream channel or groundwater discharge point) or constructed (pipe, culvert, stormwater ditch). Compare to *Outlet*. See also *Flowing water*.

Integrity — The degree to which a natural habitat's composition, structure, and ecological processes remain intact and functional, free from human-induced alterations. Compare to *Resilience*.

Interflow — See *Subsurface flow.*

Interspersion — The degree of intermixing of different cover types, regardless of the number of types or their relative proportions.

Inundation — Rising and spreading of water over land not usually submerged. A condition in which water from any source temporarily or permanently covers a land surface. This term is inclusive of flooding and ponding. See also *Flooded, Ponding*.

Invasive species — Defined by the National Invasive Species Council (NISC) as (1) a non-native (alien) to the ecosystem under consideration and (2) a species whose introduction is likely to cause economic or environmental harm, or harm to human health. Species introduced from other that exhibit a tendency to significantly displace native species, hybridize with native species, alter biological communities, or alter ecosystem processes. For the purposes of this method, invasive species refers to plant species only.

K

Kame — See *Glaciofluvial deposits.*

Kame terrace — See *Glaciofluvial deposits.*

Ksat — See *Hydraulic conductivity.*

L

Lacustrine — Refers to lake environments, characterized by still, deep water and sedimentation. See also *Lentic*.

Lacustrine fringe (HGM) — See *Hydrogeomorphic classification.*

Lacustrine (Cowardin) — See S*ystem.*

Lake — An inland body of permanently standing water, occupying a depression on the earth's surface, generally of appreciable size (larger than a pond) and too deep to permit vegetation (excluding subaqueous vegetation) to take root completely across the expanse of water. Compare to *Pond.*

Lake/Pond Fringe — See *Landscape position.*

Land use/land cover (LULC) classification— Classification using categories of land cover types (i.e. open water, forest, etc.) or land use types (i.e. pasture high-intensity development, etc.). Roads may also be classified as a separate land use. See also *National Land Cover Database*.

Barren Land (Rock/Sand/Clay) — Areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.

Cultivated Crops — Areas used to produce annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20% of total vegetation. This class also includes all land being actively tilled.

Developed, Open Space — Areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20% of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.

Developed, Low Intensity — Areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20% to 49% percent of total cover. These areas most commonly include single-family housing units.

Developed, Medium Intensity — Areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50% to 79% of the total cover. These areas most commonly include single-family housing units.

Developed, High Intensity — Highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80% to 100% of the total cover.

Forest, Deciduous — Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species shed foliage simultaneously in response to seasonal change.

Forest, Evergreen — Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species maintain their leaves all year. Canopy is never without green foliage.

Forest, Mixed — Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75% of total tree cover.

Grassland/Herbaceous — Areas dominated by graminoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling but can be utilized for grazing.

Open Water — Areas of open water, generally with less than 25% cover of vegetation or soil.

Pasture/Hay — Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20% of total vegetation.

Perennial Ice/Snow — Areas characterized by a perennial cover of ice and/or snow, generally greater than 25% of total cover.

Shrub/Scrub — Areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.

Wetlands, Emergent Herbaceous — Areas where perennial herbaceous vegetation accounts for greater than 80% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

Wetlands, Woody — Areas where forest or shrubland vegetation accounts for greater than 20% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

Landscape — A broad or unique land area comprised of an assemblage or collection of landforms that define a general geomorphic form or setting (e.g., mountain range, lake plain, lava plateau, or loess hill). Landforms within a landscape are spatially associated but may vary in formation processes and age. See also *Landscape position.*

Landscape position — Defined by NEWFA as the geomorphic setting or location of a wetland in the landscape. Landscape position may be defined by topographic location, hydrologic inputs and/or relationship to a water body. Also used to refer to the location of a wetland in the watershed. NEWFA uses the following terms and definitions. Compare to *Hydrogeomorphic classification.* See also *Geomorphic setting.*

Depression, Groundwater — Wetlands that occur in topographic depressions, where the dominant source of water is groundwater discharge.

Depression, Surface Water — Wetlands that occur in topographic depressions, where the dominant sources of water are precipitation and overland flow.

Flat, Groundwater — Wetlands located on land lacking in topographic relief, where the dominant source of water is groundwater discharge.

Flat, Surface Water — Wetlands located on land lacking in topographic relief, where the dominant sources of water are precipitation and overland flow.

Floodplain, River/Stream — Wetlands that occur in riparian corridors in association with stream channels, where the dominant water sources are overbank flooding and subsurface hydraulic connections between the stream channel and the wetland.

Fringe Estuarine — Wetlands that are contiguous with estuarine waters; that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land.

Fringe, Lake/Pond — Wetlands that are adjacent to lakes or ponds where the water elevation of the lake maintains the water table in the wetland and may include wetlands comprised of floating vegetation attached to land.

Fringe, Marine — Wetlands that are contiguous with marine waters, where water regime is determined by the ebb and flow of oceanic tides.

Fringe, River/Stream — Wetlands that are contained within the channel of a flowing waterbody; may include wetlands comprised of floating vegetation attached to land.

Tidal Fringe, Fresh Water — Wetlands that occur in the upper reaches of tidal systems where the main source of hydrology is from freshwater river flow, but still are subject to diurnal tidal cycles.

Slope, Groundwater — Wetlands located on sloping land, where the dominant source of water is groundwater discharge.

Slope, Surface Water — Wetlands located on sloping land, where the dominant sources of water are precipitation and overland flow.

Layer — Term to describe the vertical arrangement of vegetation in a habitat, classified primarily by height. Often used interchangeably with the term strata, however NEWFA uses the terms to represent separate metrics. Layer is a measure of areal cover, whereas strata is a measure of vertical complexity. Compare to *Strata*.

Tree Layer — All woody plants (including vines) at least 6m tall.

Shrubaceous Layer — All woody plants (including vines) less than 6m tall.

Herbaceous Layer — All non-woody plants (including mosses and aquatic bed plants).

Understory Layer — All woody plants (including vines) less than 6m tall AND all non-woody plants. Represents the combination of the shrubaceous and herbaceous layers.

Leaching — The removal of soluble material from soil or other material by percolating water.

Lentic — Having slow moving or still water, such as a pond or lake. Compare to *Lotic***.** See also *Lacustrine*, *Standing water*.

Levee — A natural or man-made feature that restricts movement of water into or through an area. An embankment of sediment, bordering one or both sides of natural or artificial channels. Compare to *Berm*, *Dike*.

Liana — See *Woody vine*.

Loam — See *Mineral soil material.*

Lodgment till — See *Till*, *Surficial geology.*

Loess — Material transported and deposited by wind and consisting dominantly of silt-sized particles.

Lotic — Having running water, such as a river or stream. Compare to *Lentic*. See also *Fluvial, Riverine.*

M

Macrophyte — Any plant species that can be readily observed without the aid of optical magnification. This includes all vascular plant species and mosses (e.g., *Sphagnum* spp.), as well as large algae (e.g. *Chara* spp.)

Marine — Large-scale saltwater environments found in oceans, seas, and estuaries, characterized by a high salt concentration. See also *Ocean, Saline.*

Marine Fringe — See *Landscape position.*

Marine (Cowardin) — See S*ystem.*

Marsh — Wetlands frequently or continually inundated with water, characterized by emergent soft-stemmed vegetation adapted to saturated soil conditions. Compare to *Swamp*. See also *Emergent vegetation, Tidal marsh.*

Matrix — See *Soil profile.*

Melt-out till — See *Till*, *Surficial geology*.

Method — A particular procedure or set of procedures to be followed.

Metric — An environmental variable used as a surrogate indicator in the process of determining the level of function a wetland is currently performing. Field metric ratings may involve direct measurement or best professional judgment. See also *Criteria, Descriptor, Indicator, Variable*.

Microfeatures — Defined by NEWFA as objects or features that add structure and roughness to the ground surface. Microfeatures include coarse woody material, boulders, and microtopographic changes. See also *Roughness*.

Microhabitat — Defined by NEWFA as an area contained within a Sub-Unit which is at least $4m^2$ but not large enough to be readily identified on aerial photography as a separate Sub-Unit. Compare to *Sub-Unit*.

Aquatic Bed Microhabitat — An area (at least $4m^2$ but not large enough to be readily identified on aerial photography) comprised of aquatic bed plants, contained within a Vegetated Wetland Sub-Unit of any type.

Emergent Microhabitat — An area (at least $4m^2$ but not large enough to be readily identified on aerial photography) comprised of emergent vegetation (all non-woody plants, including mosses) contained within a Vegetated Wetland Sub-Unit which is NOT itself classified as an Emergent Sub-Unit. Emergent microhabitats do not include aquatic bed plants.

Flowing Water Microhabitat — An area of flowing water (at least $4m^2$) contained within a Vegetated Wetland Sub-Unit which is not large enough to be readily identified on aerial photography as a separate Non-Wetland Sub-Unit.

Forested Microhabitat — An area (at least $4m^2$ but not large enough to be readily identified on aerial photography) comprised of trees (woody plants at least 6m tall) contained within a Vegetated Wetland Sub-Unit which is NOT itself classified as a Forested Sub-Unit.

Scrub-Shrub Microhabitat — An area (at least $4m^2$ but not large enough to be readily identified on aerial photography) comprised of shrubs (woody plants less than 6m tall) contained within a Vegetated Wetland Sub-Unit which is NOT itself classified as a Scrub-Shrub Sub-Unit.

Standing Water Microhabitat — An area of standing water (at least $4m^2$) contained within a Vegetated Wetland Sub-Unit which is not large enough to be readily identified on aerial photography as a separate Non-Wetland Sub-Unit.

Unvegetated Microhabitat — An area with less than 5% vegetative cover (at least $4m^2$) contained within a Vegetated Wetland Sub-Unit which is not large enough to be readily identified on aerial photography as a separate Non-Wetland Sub-Unit.

Mineral soil — Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil. Mineral soils may contain organic soil horizons (see *Histic epipedon*) but do not have enough organic soil material to be classified as an organic soil. Compare to *Organic soil*. See also *Mineral soil material, Soil separates*.

Mineral soil flats (HGM) — See *Hydrogeomorphic classification*.

Mineral soil material — Soil material with properties that are dominated by the mineral component of the soil rather than the organic part. Mineral soil material contains roughly less than about 35 percent organic matter (or less than about 20 percent organic carbon). Compare to *Organic soil material*. See also *Soil separate, Soil textural class*.

Clay — Mineral soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Loam — Mineral soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Mucky modified mineral soil material — A USDA soil texture modifier, e.g., mucky sand. Mucky modified mineral soil material has between 5 and 12 percent organic carbon. Where the organic component is peat (fibric material) or mucky peat (hemic material), mucky mineral soil material does not occur.

Sand — Mineral soil material that is 85 percent or more sand and not more than 10 percent clay.

Silt — Mineral soil material that is 80 percent or more silt and less than 12 percent clay.

Minor component — See *Soil map unit.*

Model —A simplified representation of a complex system, phenomenon, or process designed to help understand, explain, and predict real phenomenon that are difficult to observe directly. Models can be physical, mathematical, conceptual, or computational. See also *Indicator, Metric, Variable.*

Moraine — In terms of glacial geology, a mound, ridge, or other topographically distinct accumulation of unsorted, unstratified drift, predominantly till, deposited primarily by the direct action of glacial ice in a variety of landforms. Also, a general term for a landform composed mainly of till (except for kame moraines, which are composed mainly of stratified outwash) that has been deposited by a glacier. Some types of moraines are disintegration, end, ground, kame, lateral, recessional, and terminal. See also *Drift, Till*.

Mottles — Spots or blotches of different color or shades of color interspersed within the dominant color in a soil layer, usually resulting from the presence of periodic reducing soil conditions. Outdated term. See *Redoximorphic features*.

Muck — See *Organic soil material.*

Mucky modified — See *Mineral soil material.*

Mucky peat — See *Organic soil material.*

Mud flat — A relatively level area of fine-grained material (e.g., silt) along a shore (as in a sheltered estuary) or around an island, alternately covered and uncovered by the tide or covered by shallow water, and barren of vegetation. See also *Flat*, *Tidal flat*.

Munsell color notation — See *Soil profile.*

N

National Land Cover Database (NLCD) —Database developed by the interagency Multi-Resolution Land Characteristics Consortium using remote sensing to classify land use and land cover into defined categories. See also *Land use/land cover*.

Nitrate — The most oxidized form of nitrogen that can be used as an alternate electron acceptor in anaerobic respiration. The microbial transformation from ammonium to nitrite and from nitrite to nitrate is known as vitrification, which is an energy-yielding aerobic process. See also *Denitrification, Nitrification*.

Nitrification — The process of converting ammonia into nitrites or nitrates, inorganic forms of nitrogen that can be assimilated by plants. Compare to *Denitrification.* See also *Nitrate.*

Non-tidal — Water levels do not typically change in response to the gravitational pull of the sun and the moon; may experience tidal inundation during extreme weather events. Compare to *Tidal*.

Non-tidal exchange — See *Hydrologic exchange.*

Non-Wetland Sub-Unit — Defined by NEWFA as a sub-division of an assessment unit which does not meet the definition of a wetland, including include all non-wetland aquatic resources (areas with less than 5% vegetative cover) as well as areas of upland which are fully enclosed by the assessment unit, large enough to be identified on aerial photography. Compare to *Vegetated Wetland Sub-Unit*.

Flowing Water Sub-Unit — Defined by NEWFA as a body of water within an assessment unit, large enough to be identified on aerial photography, with a detectable current (at least periodically), confined within a bed and banks and with an average width of 3m or less.

Standing Water Sub-Unit — Defined by NEWFA as an enclosed area of standing water within an assessment unit, large enough to be identified on aerial photography, but no larger than 4 ha.

Other Sub-Unit — Defined by NEWFA as any non-wetland area within an assessment unit, which is not open or flowing water, large enough to be identified on aerial photography (e.g. mud flats, beach/dune, bedrock, cobble, upland, etc.).

O

Ocean — The continuous body of saltwater that surrounds the continents, covers approximately 71% of the surface of the Earth, and contains 97% of Earth's water. See also *Marine, Saline.*

Open exchange — See *Hydrologic exchange.*

Open water body (Shoreline Stabilization) — See *Resource Specific Function (RSF).*

Opportunity — The capability of a wetland to perform a function in response to current circumstances; current function. See also *Effectiveness*, *Functional capacity.*

Ordinary High-Water Mark (OHWM) — Defined by federal regulations as the line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas. Compare to *High Tide Line.*

Organic — Pertaining to, or derived from, living organisms, or to compounds containing carbon as an essential component.

Organic matter — Plant and animal residue in the soil in various stages of decomposition. See also *Humus.*

Inland Organic Material — See *Surficial geology*.

Tidally-Flooded Organic Material — See *Surficial geology.*

Organic soil — A soil is classified as an organic soil when it is: (1) saturated for prolonged periods (unless artificially drained) and has more than 30 percent organic matter if the mineral fraction is more than 50 percent clay, or more than 20 percent organic matter if the mineral fraction has no clay; or (2) never saturated with water for more than a few days and having more than 34 percent organic matter. Compare to *Mineral soil*. See also *Histosols, Organic soil material.*

Organic soil flats (HGM) — See *Hydrogeomorphic classification.*

Organic soil material — Soil material that is saturated with water for long periods or artificially drained and, excluding live roots, has an organic carbon content (by weight) of 18% or more with 60% or more clay, or 12% or more organic carbon with 0% clay. Soils with an intermediate amount of clay have an intermediate amount of organic carbon. If the soil is never saturated for more than a few days, it contains 20 percent or more organic carbon. Organic soil material includes muck, mucky peat, and peat. Compare to *Mineral soil material.*

Muck (or Sapric) — The most highly decomposed of all organic soil material. Unconsolidated soil material consisting primarily of highly decomposed organic material in which identification of plant forms is not possible. Sapric soil material has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material. Use only with organic horizons (of any thickness) of mineral and organic soils that are saturated for 30 or more cumulative days in normal years or are artificially drained.

Mucky peat (or Hemic) — Organic soil material, which is characterized by decomposition in between fibric material (peat) and sapric material (muck). Consists primarily of organic matter that is in an intermediate stage of decomposition such that a significant part of the original material can be recognized, and a significant part of the material cannot be recognized. Use only with organic horizons (of any thickness) of mineral and organic soils that are saturated for 30 or more cumulative days in normal years or are artificially drained.

Peat (or Fibric) — The least decomposed of all organic soil material. Consists largely of undecomposed, or slightly decomposed, organic matter accumulated under conditions of excessive moisture. Contains a significant fraction of decomposed plant material in which individual plant fibers can still be detected. Fibric soil material has three-fourths or more fibers after rubbing, the lowest bulk density, and the highest water content at saturation of all organic soil material. Use only with organic horizons (of any thickness) of mineral and organic soils that are saturated for 30 or more cumulative days in normal years or are artificially drained.

Outflow — See *Flowing water.*

Outlet — A point where water flows out of the wetland. The outlet can be a natural flow path or a structure such as a pipe or weir. Compare to *Inlet*. See also *Flowing water*.

Outwash — Stratified and sorted sediments (chiefly sand and gravel) removed or "washed out" from a glacier by meltwater streams and deposited in front of or beyond the end moraine or the margin of a glacier. The coarser material is deposited nearer to the ice. See *Glaciofluvial deposits*, *Surficial geology*.

Outwash plain — See *Glaciofluvial deposits.*

Overbank flooding — Overbank flooding is inundation from rising water levels in rivers and streams when water overflows the banks of the channel and covers the active floodplain. Indicators of overbank flow include sedimentation, drainage patterns, debris lines, reclining vegetation, and gauge data. See also *Floodplain.*

Overland flow — Water that flows over the land surface, typically after rainfall or snowmelt, when the soils cannot absorb water, such as when rain or meltwater flows over already saturated soils, or as a result of high intensity precipitation. See also *Runoff, Sheetflow, Stormwater.*

Oxic — A situation when molecular oxygen is present. Compare to *Anoxic*. See also *Aerobic.*

Oxidation-reduction — A complex of biochemical reactions in soil that influences the valence state of component elements and their ions. Prolonged soil saturation during the growing season elicits anaerobic conditions that shift the overall process from an oxidizing condition to a reducing condition. See also *Redox*, *Redoximorphic features*.

P

Pan — a compact, dense layer in a soil that impedes the movement of water and the growth of roots

Palustrine (Cowardin) — See S*ystem.*

Parent material — The unconsolidated, more or less weathered, mineral or organic matter from which a soil profile develops. The parent material may have been essentially the same as the unaltered soil material currently lying below the solum, or the material from which the soil formed may have all been subject to pedogenic processes and can no longer be observed at the site. Compare to *Surficial geology*. See also *Soil survey.*

Patch — a spatially distinct structural element of a wetland system large enough to serve as habitat for wildlife, or to serve as an indicator of spatial variations in hydrological or edaphic (soil) conditions within a wetland

Peat — See *Organic soil material.*

Pedon — See *Soil map unit*.

Percolation — The movement of water through soil layers or material. Compare to *Infiltration*. See also *Permeability.*

Permeability — The ability of a material to allow the passage of a liquid, such as water through rocks. Permeable materials, such as gravel and sand, allow water to move quickly through them, whereas impermeable material, such as clay and asphalt, don't allow water to flow freely.

> **Soil permeability** — The ease with which gases, liquids, or plant roots penetrate or pass through a layer of soil. The rate at which water moves through the least permeable layer governs soil permeability.

Phreatic zone — See *Water table.*

Pit and Mound — Pit and mound topography refers to micro-scale, undulating features in forests, created by trees being uprooted, typically by windthrow. The pit forms where the root ball was, and the mound is formed from the pulled-up soil and root system. See also *Hummock, Microfeature, Roughness*.

Plant community — A group of plant species living together and linked together by their effects on one another and their responses to the environment they share. Typically, the plant species that co-occur in a plant community show a definite association or affinity with each other. All of the plant populations occurring in a shared habitat or environment. See also *Aquatic bed, Emergent, Forested, Habitat, Scrub-shrub.*

Polypedon — See *Soil map unit*.

Pond — A body of standing fresh water occupying a small surface depression, formed naturally or by hollowing or embanking, usually smaller than a lake. Compare to *Lake*.

Ponded — A condition in which water stands in a closed depression. Water may be removed only by percolation, evaporation, and/or transpiration. Compare to *Flooded*.

Precipitation — The total measurable supply of water of all forms of falling moisture, including dew, rain, mist, snow, hail, and sleet; usually expressed as a depth of liquid water on a horizontal surface in a day, month, or year, and designated as daily, monthly, or annual precipitation. See also *Rainfall*.

Primary production — The conversion of solar energy into organic matter by photosynthesis.

Q

Qualifying water body (Storm Surge Reduction) — See *Resource Specific Function (RSF).*

Quaternary — The period of the Cenozoic Era of geologic time, extending from the end of the Tertiary Period (about 1.6 million years ago) to the present and comprising two epochs, the Pleistocene (Ice Age) and Holocene (Recent); also, the corresponding (time-stratigraphic) "series" of earth materials. See also *Surficial geology*.

R

Railroad bed — The trace or track of a railroad route, commonly constructed slightly above the adjacent land, and composed mostly of earthy materials (gravel, rock fragments, etc.). Abandoned or reclaimed beds may no longer be topographically or visually distinct, but the materials used to construct them may still be a significant portion of the soil zone.

Rainfall —Precipitation in the form of liquid water. The amount of rain, usually expressed in inches depth of water on an area, that reaches the surface of the Earth. See also *Precipitation*.

Recharge — See *Groundwater.*

Redox — See *Redoximorphic features*.

Redox potential — Reduction-oxidation potential, or a measure of the potential movement of electrons in a system. Reduction refers to the chemical process whereby molecules of a substance gain an electron. Oxidation refers to loss of electrons. Measuring the redox potential of a wetland soil provides information about the types of chemical reactions that are occurring in the soil, and thus whether the soil is more aerobic (contains oxygen) or anaerobic (lacks oxygen). See also *Oxidation-reduction, Redoximorphic features.*

Redoximorphic features — Features in the soil that are a morphological expression of saturation with water, development of anaerobic conditions, and alternating periods of oxidation-reduction reactions. Redoximorphic features are associated with wetness are formed by the processes of reduction, translocation, or oxidation of iron and manganese oxides. Reduction occurs during saturation with water, and oxidation occurs when the soil is not saturated. The characteristic color patterns created by these processes were formerly called mottles and low chroma colors. See also *Oxidation-reduction, Soil profile.*

> **Concentration** — A localized area within a ped or a horizon where iron-manganese compounds have accumulated as a result of reduction-oxidation processes. The concentrations have enhanced pigmentation compared to the surrounding matrix (commonly redder). Redox concentrations can be further characterized as a) Nodules and concretions, which are cemented bodies that can be removed from the soil intact. Concretions are distinguished from nodules on the basis of internal organization. A concretion typically has concentric layers that are visible to the naked eye. Nodules do not have visible organized internal structure; and b) Masses, which are non-cemented concentrations of substances within the soil matrix; and c) Pore linings, i.e., zones of accumulation along pores that may be either coatings on pore surfaces or impregnations from the matrix adjacent to the pores.
>
> **Depletion** — A localized area within a ped or a horizon where iron-manganese compounds have been depleted as a result of reduction-oxidation processes which cause the ions to migrate away toward areas of lower concentration. The depleted area, due to its loss of pigment, reveals the underlying mineral color, which is generally grayer, lighter, or less red than the surrounding matrix. Redox depletions can be further characterized as a) Iron depletions, i.e., zones that contain

low amounts of iron and manganese oxides but have a clay content similar to that of the adjacent matrix; and b) Clay depletions, i.e., zones that contain low amounts of iron, manganese, and clay (often referred to as silt coatings or skeletans).

Reference —Benchmark used for comparison.

Reference condition — A benchmark, or standard, against which the current health or status of an ecosystem is evaluated, typically representing the expected ecological state of a region with minimal human disturbance. See also *Condition*.

Reference domain — The geographic area (such as an ecoregion or physiographic province) from which reference wetlands are selected. A reference domain may or may not include the entire geographic area in which a wetland type occurs. Also, all wetlands within a defined geographic area that belong to a single regional wetland subclass.

Reference site — A wetland (or other aquatic resource) within a region that represents typical, representative, or common examples of a particular hydrogeomorphic wetland type, or examples of altered states. Reference wetlands, in the context of methods for assessing wetland functions, mean the sites chosen to represent the full range of functioning in a region or hydrogeomorphic class. Data collected at these sites is used for the development and calibration of a method.

Reference standard —Set of characteristics which correspond to the highest potential capacity for an individual wetland function or conditions which correspond to the least degraded reference sites of a regional wetland subclass.

Resilience — An ecosystem's ability to withstand disturbances, recover its vital functions and structure, and continue providing essential services. Compare to *Integrity*.

Resource Specific Function (RSF) — Defined by NEWFA as a function which is only applicable to certain wetlands systems and should not be assessed in all cases. Each RSF has criteria which determine when the function is applicable based on the presence and characteristics of the relevant resource. NEWFA uses the following terms in the RSF context:

Bank (Bank Stabilization) — Defined by NEWFA as a vertical feature (minimum height 10 cm) at the interface of flowing water system and a terrestrial system; wetlands may be present at one or both sides of the bank. Compare to *Streambank*.

Open water body (Shoreline Stabilization) — Any area that under normal patterns of precipitation has water flowing or standing above ground. Aquatic vegetation within the area of flowing or standing water is either non-emergent, sparse, or absent. This term includes rivers, streams, natural or man-made lakes or ponds, estuaries, and the ocean.

Qualifying water body (Storm Surge Reduction) — All tidally-influenced waters (including tidal creeks) and any non-tidal water body large enough to produce storm surge under the right conditions. Lake Champlain is considered a qualifying non-tidal water body. See also *Storm surge*.

Shoreline (Shoreline Stabilization) — Linear feature at the interface of an open water body and the adjacent terrestrial system.

Shore zone (Storm Surge Reduction) — Terrestrial area adjacent to the edge of an open water body; zone of influence where the water body directly affects the land.

Retentionability — Defined by NEWFA as the capacity of a wetland to restrict and slow the flow of surface water long enough for one or more water quality related biogeochemical processes to occur.

Rhizosphere — The zone of soil in which interactions between living plant roots and microorganisms occur.

Riparian areas — Vegetated ecosystems along a water body through which energy, materials, and water pass; strip of land adjacent to a body of water that is transitional between the aquatic system and the upland. Riparian areas characteristically have a high water table and are subject to periodic flooding and influence from the adjacent water body. These systems encompass wetlands, uplands, or some combination of these two landforms. They will not in all cases have all the characteristics necessary for them to be also classified as wetlands.

River — A natural, flowing, freshwater system of considerable volume and generally with a permanent base flow, moving in a defined channel toward a larger river, lake, or sea. Compare to *Stream*.

> **River/Stream Floodplain** — See *Landscape position*

> **River/Stream Fringe** — See *Landscape position*

Riverine — The interconnected natural components of rivers, including the river channel, riparian zones, and wetlands. See also *Lotic*.

> **Riverine (Cowardin)** — See S*ystem***.**

> **Riverine (HGM)** — See *Hydrogeomorphic classification*.

Road-bed — The trace or track of a wheeled vehicle route that may or may not be raised slightly above the adjacent land, and composed of earthy fill material (gravel, rock fragments, etc.) or local soil material. Traffic can alter various soil properties primarily by compaction. Abandoned or reclaimed beds may no longer be topographically or visually distinct. However, materials used to construct beds or changes in soil properties may continue to have a significant impact on soil management or plant growth.

Root zone — The portion of a soil profile in which plant roots occur.

Roughness — The quality or state of having an uneven or irregular surface; the amount of friction or resistance a surface provides against water flow. See also *Microfeatures*.

Runoff — That part of the precipitation, snow melt, or irrigation water that runs off the surface of a drainage area into stream channels. See also *Overland flow, Sheetflow, Stormwater*.

> **Groundwater runoff** — The part of the runoff that enters the soil and becomes ground water before being discharged into a stream channel as spring or seepage water.

> **Surface runoff** — The part of the runoff that that flows across the surface of the land, without sinking into the soil, before it joins a stream or river, is called surface runoff.

S

Salinity — Total amount of solid material in grams contained in 1 kg of water when all the carbonate has been converted to oxide, the bromine and iodine replaced by chlorine, and all the organic matter completely oxidized. See also *Brackish, Freshwater, Saltwater*.

Saltwater — Waters in which ocean-derived salts measure 0.5 parts per thousand or greater. Includes brackish and estuarine waters. Compare to *Freshwater*. See also *Brackish*, *Salinity*.

Sand — See *Mineral soil material.*

Sapric — See *Organic soil material, Muck.*

Sapling — A young tree termed a “sapling” based on size measurements such as height and diameter breast height; the sizes that constitute “sapling” vary with different locations and plant communities.

Saturation — Wetness characterized by zero or positive pressure of the soil water. See also *Aquifer*, *Groundwater, Water table*.

Saturated soil conditions — A condition in which all easily drained voids (pores) between soil particles in the root zone are temporarily or permanently filled with water to the soil surface at pressures greater than atmospheric. This definition includes part of the capillary fringe above the water table (i.e., the tension saturated zone) in which soil water content is approximately equal to that below the water table. See also *Hydric soils.*

Saturated zone - See *Water table*.

Unsaturated zone - See *Water table*.

Scrub-shrub vegetation — An area with a predominance of woody plants less than 6m tall. Scrub-shrub vegetation includes true shrubs, young specimens of tree species that have not yet reached 6 m in height, and woody plants (including tree species) that are stunted because of adverse environmental conditions. Compare to *Forested vegetation*. See also *Shrub*, *Woody plant*.

Shrub/Scrub (LULC) — See *LULC classification.*

Scrub-shrub wetland — Wetland composed primarily of scrub-shrub vegetation: Term used for vegetation-based classification. Compare to *Aquatic bed wetland, Emergent wetland, Forested wetland.*

Scrub-shrub Microhabitat — See *Microhabitat.*

Scrub-Shrub Sub-Unit — See *Vegetated wetland sub-unit.*

Scrub-Shrub Wetland (Cowardin) — See *Class (Cowardin).*

Sediment — Organic or inorganic material transported and/or deposited by wind or water action. Sediment can be coarse (i.e., gravel or larger) or fine (i.e. clay, silt, sand). Material in suspension in flowing water or recently deposited from suspension after the water loses velocity. See also *Deposition, Sedimentation, Suspended sediment, Suspended solids*.

Particle size — The diameter, in millimeters, of suspended sediment or bed material. Particle size classifications are not the same as soil texture classes. Particle-size classifications are: (1) Clay—0.00024-0.004 millimeters (mm); (2) Silt—0.004-0.062 mm; (3) Sand—0.062-2.0 mm; and (4) Gravel—2.0-64.0 mm. Compare to *Soil separates, Soil texture.*

Sedimentation — This term refers to the settling out of materials that have been transported into a wetland or open-water system by moving water. See also *Deposition, Sediment*.

Seep — An area semi-permanently to permanently saturated by groundwater discharging to the surface, often at the toe of a slope. See also *Groundwater*.

Services — The benefits that human populations receive from functions that occur in ecosystems. Refers to society's perception of ecosystem functions (functions occur in ecosystems regardless of whether or not there is a benefit to society). Compare to *Condition, Function.*

Sheetflow — The movement of water over the land surface as a sheet, rather than through clearly defined channels. See also *Overland flow, Runoff, Stormwater*.

Shore zone (Storm Surge Reduction) — See *Resource Specific Function (RSF).*

Shoreline (Shoreline Stabilization) — See *Resource Specific Function (RSF).*

Shrub — Defined by NEWFA as any woody plant less than 6m tall. A shrub generally exhibits several erect, spreading, or prostrate stems and has a bushy appearance. Compare to *Tree*. See also *Scrub-shrub vegetation, Woody plant.*

Shrub Strata — See *Strata.*

Shrubaceous Layer — See *Layer*.

Understory Layer — See *Layer*.

Similarity index — A similarity index is a measure that quantifies the resemblance between two or more entities, in our contexts, typically wetland sites or data sets. It is often expressed as a percentage, with higher percentages indicating greater similarity. See also *Reference*.

Silt — See *Mineral soil material.*

Slope — The part of a hill (an elevated area of the land surface) between the summit and the drainage line, valley flat, or depression floor at the base of the hill. Compare to *Depression, Flat, Floodplain, Fringe.* See also *Hillslope.*

Groundwater Slope — See *Landscape position*

Slope (HGM) — See *Hydrogeomorphic classification.*

Surface Water Slope — See *Landscape position*

Snag — A standing dead tree or part of a dead tree from which at least the leaves and smaller branches have fallen; often called stumps if less than 20 feet tall. Snags are typically vertical. Dead trees that have fallen over but are not lying on the ground are not considered snags.

Soil Examination Area (SEA)— Defined by NEWFA as a sub-division of an assessment unit for data collection purposes; based on changes in soil type, surficial geology and/or landscape position. Compare to *Assessment sub-unit*.

Soil map unit — A collection of areas with soil components or miscellaneous areas that are both defined and named the same. Each map unit differs in some respect from all others in a survey area and is uniquely identified by a symbol on a soil map. Each individual area (polygon) on the map is a "delineation." See also *Soil profile, Soil survey.*

Component — Within the context of a map unit, a component is an entity that can be delineated at some scale. It is commonly a soil, but it may be a miscellaneous area. Components consisting of soil are named for a soil series or a higher taxonomic class. Those that are miscellaneous areas have an appropriate name, such as Rock outcrop or Urban land. In either case, each component that makes up a map unit can be identified on the ground as well as delineated separately at a sufficiently large scale.

Inclusion — See *Minor component*.

Minor component — One or more polypedons or parts of polypedons within a delineation of a map unit, not identified by the map unit name (not one of the named component soils or named miscellaneous area components). Such soils or areas are either too small to be delineated separately without creating excessive map or legend detail, or occur too erratically to be considered a component, or are not identified by practical mapping methods. Formerly referred to as an inclusion.

Pedon — The smallest unit or volume of soil that contains all the soil horizons of a particular soil type. It usually has a surface area of approximately 1 sq m (10.76 sq ft) and extends from the ground surface down to bedrock.

Polypedon — Two or more contiguous pedons, which are all within the defined limits of a single soil series. a group of contiguous, similar pedons that constitute a complete soil individual, which is the basic unit classified into a soil series.

Soil profile — A more or less two-dimensional vertical section of the soil cut on a plane at right angles to the soil surface extending through all its horizons and into the parent material. Used for describing the kinds and arrangement of horizons making up the soil. See also *Soil map unit.*

> **Layer** — A soil horizon, subhorizon, or combination of contiguous horizons or subhorizons sharing at least one property referred to in the hydric soil indicators.
>
> **Horizon** — A layer, approximately parallel to the surface of the soil, distinguishable from adjacent layers by a distinctive set of physical, chemical, and biological properties or characteristics (e.g., color, structure, texture, etc.) produced by soil-forming processes.
>
> **Matrix** — The portion of a given soil having the dominant color. In most cases, the matrix will be the portion of the soil having more than 50 percent of the same color. When three colors occur, such as when a matrix, depletions, and concentrations are present, the matrix may represent less than 50 percent of the total soil volume.
>
> **Munsell color notation** — A widely accepted color designation system using notations for hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with hue of 10YR, value of 6, and chroma of 4. The National Cooperative Soil Survey adopted the Munsell system to describe soil color in 1949.
>
> **Redox** — See *Redoximorphic features*.
>
> **Texture** — See *Soil texture*.

Soil separates — The grouping, by size, of mineral soil particles that are less than 2.0 mm in equivalent diameter into discreet classes, which range from clay to very coarse sand. In soil survey the most commonly used set of classes is the USDA system. Other systems, such as the Unified and AASHO, are also recognized for specific uses. See also *Mineral soil material, Soil texture, Particle size*.

> **Clay** — Mineral soil particles less than 0.002 millimeter in diameter composed of naturally occurring aluminum silicate.
>
> **Sand** — Individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz.
>
> **Silt** — Individual mineral particles larger than coarse clay (0.002 mm) and smaller than a very fine sand grain (0.05 mm).

Soil surface — The upper limits of the soil profile. For mineral soils, this is the upper limit of the highest mineral horizon. For organic soils, it is the upper limit of undecomposed, dead organic matter. Fresh leaf or needle fall that has not undergone observable decomposition is excluded from soil and may be described separately. See *Humus*.

Soil survey — Describes the characteristics of the soils in a given area, classifies the soils according to a standard system of taxonomy, plots the boundaries of the soils on a map, stores soil property information in an organized database, and makes predictions about the suitability and limitations of each soil for multiple uses as well as their likely response to management systems. See also *Soil map unit, Web Soil Survey.*

> **Soil series** — A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement. Soil series are commonly used to name dominant or codominant polypedons represented on detailed soil maps.

Soil texture — The proportions (by weight) of various size classes of soil separates (sand, silt, and clay) making up a soil sample. In the field, soil texture is estimated by tactile tests, such as feeling a moist sample and ribboning. Laboratory measurements of the various soil separates making up a sample use a combination of differential settling in a water column (e.g., pipette method) and dry sieving. NEWFA uses 12 basic textural descriptors, in order from greatest proportion of coarse particles to greatest proportion of fine particles: sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The descriptors can be further amended based on dominant sand size (very fine sand, fine sand, sand, coarse sand, etc.). See also *Soil separates.*

Texture class — Generalized classes of soil texture. NEWFA uses 7 soil texture classes for mineral soils, in order from greatest proportion of coarse particles to greatest proportion of fine particles: Sandy, Sandy Loams, Coarse Loamy, Medium Loamy, Fine Loamy and Clayey.

Sphagnum — A type of moss contributing to the formation of some organic soil materials. Sphagnum fibers are generally lighter in color than other moss fibers and are noted for their low bulk density. Due to their cellular structure, they have a very high water-holding capacity in both living and dead fibers, more than other organic materials.

Spillway — An open or closed channel, conduit, or drop structure used to convey water from a reservoir. It may contain gates, either manually or automatically controlled, to regulate the discharge of water. See also *Drainageway*.

Standing water — Water above the soil surface; not flowing. See also *Surface water, Inundation, Flooded, Ponding.*

Standing Water Microhabitat — See *Microhabitat.*

Standing Water Sub-Unit — See *Non-Wetland Sub-Unit.*

Stormwater — The water coming from rain or snow that runs off surfaces such as rooftops, paved streets, highways, and parking lots. It can also come from hard grassy surfaces like lawns, play fields, and from graveled roads and parking lots. See also *Overland flow, Runoff, Sheetflow*.

Strata — Term to describe the vertical arrangement of vegetation in a habitat, classified primarily by height. Often used interchangeably with the term layer, however NEWFA uses strata to represent separate metrics. Strata is a measure of vertical complexity, whereas layer is a measure of areal cover. Compare to *Layer*.

Canopy — All woody plants (including vines) which are more than 12 meters tall, highest vegetation stratum in an assemblage.

Sub-Canopy — All woody plants (including vines) which are 6 to 12 meters tall, saplings usually occur in this stratum.

Shrub Strata — All woody plants (including vines) which are less than 6 meters tall.

Herb Strata — All non-woody plants (including mosses and aquatic bed plants).

Stratified — Formed, arranged, or laid down in layers. The term refers to geologic deposits. Layers in soils that result from the processes of soil formation are called horizons; those inherited from the parent material are called strata. See also *Surficial geology.*

Stream — A body of flowing water that moves under gravity to progressively lower levels, in a relatively narrow but clearly defined channel on the ground surface, in a subterranean cavern, or beneath or in a glacier. It is a mixture of water and dissolved, suspended, or entrained matter. Compare to *River*. See also *Resource specific functions.*

River/Stream Floodplain — See *Landscape position.*

River/Stream Fringe — See *Landscape position.*

Stream channel — With respect to streams, a channel is a natural depression of perceptible extent that periodically or continuously contains moving water. It has a definite bed and banks that serve to confine the stream's water.

Streambank — The streambank is the sloping to vertical terrain alongside the bed of a river, creek, or stream, forming the sides of the channel where the water flow is contained.

Streamflow

Stress — The condition of diverting potentially useful energy from an ecosystem or an organism. See also *Disturbance, Impact, Stressor*.

Stressor — An agent that inflicts stress on a wetland. The response of a wetland to a stressor depends on wetland type, size, and severity of the stressor. Key stressors are anthropogenic actions that tend to modify the quantity and/or quality of physical or biological habitat, sediment supplies, and/or water supplies upon which the desired functions of the wetland depend. See also *Disturbance, Impact, Stress*.

Storm surge — An abnormal, sudden rise of sea level along an open coast during a storm, caused primarily by onshore-wind stresses, or less frequently by atmospheric pressure reduction, resulting in water piled up against the coast. It is most severe when accompanied by a high tide.

Sub-Canopy — See *Strata.*

Subglacial — Formed or accumulated in or by the bottom parts of a glacier or ice sheet; said of meltwater streams, till, moraine, etc.

Subsurface flow — The movement of water below the Earth's surface through porous media and fractured rock. See also *Baseflow*, *Groundwater*.

Interflow —The precipitation that infiltrates into the soil and moves laterally under the surface until intercepted by a stream channel or until it resurfaces downslope of its point of infiltration. The water moving as interflow discharges directly into a stream or lake. See also *Groundwater discharge.*

Shallow subsurface flow — The movement of water through the unsaturated zone of the soil. This rapid lateral movement of water occurs in soil pore spaces and fractures, typically above the permanent groundwater table, and is a significant mechanism for water and solute transport to streams and rivers. It is faster than deep groundwater flow but slower than surface runoff.

Sub-Unit — See *Assessment Sub-Unit.*, *Non-Wetland Sub-Unit, Vegetated Wetland Sub-Unit.*

Surface water — Water on the surface of the earth; occurring above the ground as in flooded or ponded conditions. Water present above the substrate or soil surface. Compare to *Groundwater*. See also *Standing water*.

Surface Water Depression — See *Landscape position*

Surface Water Flat — See *Landscape position*

Surface Water Slope — See *Landscape position*

Surficial geology — The unconsolidated deposits found closest to the earth's surface, sometimes referred to as Quaternary geology. These materials, located above the underlying bedrock, were formed and deposited during or since the last glaciation. Surficial geology units may be classified by the method of deposition and/or the size, type, composition and sorting of materials in each layer. NEWFA uses the following terms and definitions. See also *Quaternary*. Compare to *Parent material*.

Alluvium, Coarse-Grained — Unconsolidated, clastic material subaerially deposited by running water (channel flow), including gravel, sand, silt, clay, and various mixtures of these.

Alluvium, **Fine-Grained** — Unconsolidated, clastic material subaerially deposited by running water (channel flow), including gravel, sand, silt, clay, and various mixtures of these.

Anthropogenic, **Dense** — Organic or mineral soil material, typically loamy-textured, that has been moved from a source area outside of that area by directed human activity, usually with the aid of machinery. The method of deposition and material physical properties often result in firm layers that reduce or restrict soil water movement.

Anthropogenic, **Loose** — Organic or mineral soil material, typically coarse-textured, that has been moved from a source area outside of that area by directed human activity, usually with the aid of machinery. The coarse-textured material generally lacks firm, water-restricting layers.

Coastal Sands — Sand-sized, clastic material transported and deposited primarily by wind, commonly in the form of a dune or a sand sheet, and/or well sorted, sand-sized, clastic material transported and deposited primarily by wave action and deposited in a shore environment.

Colluvium — Unconsolidated, unsorted earth material being transported or deposited on side slopes, at the base of slopes, or both by mass movement (e.g., direct gravitational action) and by local, unconcentrated runoff.

Mixed Glacial Materials — Glacial drift (primarily till) materials containing a variety of layers both firm and friable in consistence, or layers of an intermediate consistence that may slow soil water movement but not to the effect of restrictive layers in lodgment till.

Organic Materials, **Inland** — Unconsolidated sediments or deposits in which carbon is an essential, substantial component, formed in the inland environment where soil water is fresh.

Organic Materials, **Tidally-Flooded** — Unconsolidated organic and mineral materials formed in areas subject to periodic or occasional overflow by salt water, containing water that is brackish to strongly saline.

Shallow Bedrock — Glacial drift (primarily till) materials with a bedrock contact typically within observable depths (i.e., within 2 meters of depth).

Stratified Coarse Materials — Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice; the deposits are stratified and may occur in the form of outwash plains, valley trains, deltas, kames, eskers, and kame terraces.

Stratified Fine Materials — Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes by water originating mainly from the melting of glacial ice. Many are bedded or laminated with varves or rhythmites. Also, glacially eroded, terrestrially derived sediments (clay, silt, sand, and gravel) that accumulated on the ocean floor as marine deposits.

Till, Lodgment — Subglacial till deposited by an active glacier (flowing ice) commonly characterized by dense, fissile (“platy”) structure and containing rock fragments with their long axes oriented generally parallel to the direction of ice flow.

Till, Melt-Out — Till formed by slow melting of debris-rich stagnant ice, but without secondary flow processes; the fabric and clast orientations, imparted by ice processes, remain mostly intact and the materials are primarily friable in consistence.

Suspended sediment — Very fine soil particles that remain in suspension in water for a considerable period of time without contact with the bottom. Such material remains in suspension due to the upward components of turbulence and currents.

Suspended solids — Solids that are not in true solution and that can be removed by filtration. Such suspended solids usually contribute directly to turbidity. Defined in waste management, these are small particles of solid pollutants that resist separation by conventional methods. See also *Filtration*.

Swale — A shallow, open depression in unconsolidated materials that lacks a defined channel but can funnel overland or subsurface flow into a drainageway. Soils in swales tend to be moister and thicker compared to surrounding soils. See also *Drainageway*.

Swamp — Wetlands often partially or intermittently covered with water and dominated by woody vegetation. Compare to *Marsh*. See also *Forested vegetation.*

System (Cowardin) — The highest level in the Cowardin classification, which refers to a complex of wetlands and deepwater habitats that share the influence of similar hydrologic, geomorphologic, chemical, or biological factors. See also *Cowardin classification*.

Estuarine (Cowardin) — Consists of deepwater tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land. The salinity may be periodically increased above that of the open ocean by evaporation. The Estuarine System extends (1) upstream and landward to where ocean-derived salts measure less than 0.5 ppt during the period of average annual low flow; (2) seaward to an imaginary line closing the mouth of a river, bay, or sound; and (3) to the seaward limit of wetland emergents, shrubs, or trees where they are not included in (2). The Estuarine System also includes offshore areas of continuously diluted sea water.

Lacustrine (Cowardin) — Consists of wetlands and deepwater habitats with all of the following characteristics: (1) situated in a topographic depression or a dammed river channel; (2) lacking trees, shrubs, persistent emergents, emergent mosses or lichens with 30 percent or greater areal coverage; and (3) total area of at least 8 ha. Similar wetlands and deepwater habitats totaling less than 8 ha are also included in the Lacustrine System if an active wave-formed or bedrock shoreline feature makes up all or part of the boundary, or if the water depth in the deepest part of the basin equals or exceeds 2.5 m at low water. Lacustrine waters may be tidal or nontidal, but ocean-derived salinity is always less than 0.5 ppt.

Marine (Cowardin) — Consists of the open ocean overlying the continental shelf and its associated high-energy coastline. Marine habitats are exposed to the waves and currents of the open ocean and the Water Regimes are determined primarily by the ebb and flow of oceanic tides. Salinities exceed 30 parts per thousand (ppt), with little or no dilution except outside the mouths of estuaries. Shallow coastal indentations or bays without appreciable freshwater inflow, and coasts with exposed rocky islands that provide the mainland with little or no shelter from wind and waves, are also considered part of the Marine System because they generally support typical marine biota.

Palustrine (Cowardin) — Consists of all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5 ppt. It also includes wetlands lacking such vegetation, but with all of the following four characteristics: (1) area less than 8 ha; (2) active wave-formed or bedrock shoreline features lacking; (3) water depth in the deepest part of basin less than 2.5 m at low water; and (4) salinity due to ocean-derived salts less than 0.5 ppt.

Riverine (Cowardin) — Includes all wetlands and deepwater habitats contained within a channel, with two exceptions: (1) wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens, and (2) habitats with water containing ocean-derived salts of 0.5 ppt or greater. The Riverine System is bounded on the landward side by upland, by the channel bank (including natural and man-made levees), or by wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens. In braided streams, the System is bounded by the banks forming the outer limits of the depression within which the braiding occurs. The Riverine System terminates at the downstream end where the concentration of ocean-derived salts in the water equals or exceeds 0.5 ppt during the period of annual average low flow, or where the channel enters a lake. It terminates at the upstream end where tributary streams originate, or where the channel leaves a lake. Springs discharging into a channel are considered part of the Riverine System.

T

Texture — See *Soil texture*.

Throughflow — See *Flowing water.*

Tidal — Water levels which rise and fall in response to the action of lunar and solar forces upon the rotating earth; tidal waters end where the rise and fall of the water surface can no longer be practically measured in a predictable rhythm due to masking by other waters, wind, or other effects. Compare to *Non-tidal*. See also *Flowing water.*

Tidal creek — A narrow inlet or estuary that is directly influenced by ebb and flow of ocean tides, and thus it has variable salinity and electrical conductivity over the tidal cycle, and flushes salts from inland soils.

Tidal flat — An extensive, nearly horizontal, barren or sparsely vegetated tract of land that is alternately covered and uncovered by the tide, and consists of unconsolidated sediment (mostly clays, silts, sands and organic materials, or some combination of these). See also *Mudflat*. Compare to *Tidal marsh*.

Tidal marsh — An extensive, nearly level marsh bordering a coast (as in a shallow lagoon, sheltered bay or estuary) and regularly inundated by high tides; formed mostly of unconsolidated sediments (e.g., clays, silts, sands and organic materials, or some combination of these), and the resistant root mat of salt tolerant plants. Compare to *Tidal flat*. See also *Marsh*.

Fresh Water Tidal Fringe — See *Landscape position*

Tidal exchange — See *Hydrologic exchange*.

Tidal fringe (HGM) — See *Hydrogeomorphic classification.*

Tidally-Flooded Organic Material — See *Surficial geology*.

Tidally-influenced — An area where water levels rise and fall in response to the daily ebb and flow of the tides. Includes areas where tides affect water levels and currents, but the water remains fresh due to the influence of upstream freshwater flow.

Tide gate — A structure typically placed at a narrow point in a tidal flowage that is designed to control movement of tidal waters in one or both directions. Typically consists of a hinged door that opens to allow water to flow out during low tide and closes automatically when the tide rises, preventing saltwater from flooding upstream. Compare to *Dam, Weir*. See also *Flow restriction*.

Till — An unsorted and unstratified accumulation of glacial sediment, deposited directly by glacier ice; a heterogeneous mixture of different sized material deposited by moving ice (lodgment or basal till) or by the melting in-place of stagnant ice (ablation or melt-out till). See also *Drift, Moraine, Surficial geology.*

Topographic — A term referring to the slope and elevation of land.

Topographic relief — The differences in height from place to place on the land's surface, greatly affected by the underlying geology.

Topography — The relative position and elevations of the natural or manmade features of an area that describe the configuration of its surface.

Transect —A straight line that cuts through a natural landscape so that standardized observations and measurements can be made.

Meander transect — For the purposes of this method a meander transect is performed by walking through sub-unit being assessed and making general observations without being limited to a single straight line.

Transpiration — The process in plants by which water absorbed by plants, usually through the roots, is released as part of their metabolic process from their leaves into the atmosphere as water vapor, primarily through stomata.

Tree — Defined by NEWFA as any woody plant at least 6m tall. A tree generally has a single trunk, unbranched for 1 m or more above the ground, and a more or less definite crown. Compare to *Shrub*. See also *Woody plant*.

Canopy — See *Strata.*

Sub-Canopy — See *Strata.*

Tree Layer — See *Layer*.

Turbidity — Low water clarity principally because of suspended sediments; the amount of solid particles that are suspended in water and that cause light rays shining through the water to scatter. Turbidity is measured in nephelometric turbidity units (NTU).

Tussock — A plant growth form, generally in grasses or sedges, in which plants grow in tufts or clumps bound together by roots and elevated above the substrate.

Typical — That which normally, usually, or commonly occurs.

U

Upland — The land upslope from a wetland that lacks wetland characteristics. Also, any area that does not qualify as a wetland because the associated hydrologic regime is not sufficiently wet to elicit development of vegetation, soils, and/or hydrologic characteristics associated with wetlands. Such areas occurring within floodplains are more appropriately termed non-wetlands. Compare to *Wetland*.

Non-wetland — Any area that has sufficiently dry conditions that indicators of hydrophytic vegetation, hydric soils, and/or wetland hydrology are lacking. Any area that is neither a wetland, a deepwater aquatic habitat, nor other special aquatic site.

Understory Layer — See *Layer*.

Unidirectional flow — See *Flowing water.*

V

Vadose zone — See *Water table.*

Values — Outdated term. See *Services*.

Variable — An attribute or characteristic of a wetland ecosystem or the surrounding landscape that influences the capacity of the wetland to perform a function; measurable components of functions that are used to build the models for each function. See also *Criteria, Descriptor, Indicator, Metric, Model*.

Varve —See *Glaciolacustrine deposits*

Vegetated Wetland Sub-Unit — Defined by NEWFA as a sub-division of an assessment unit, large enough to be identified on aerial photography, which meets the definition of a wetland and has at least 5% vegetative cover during the peak vegetated period. Compare to *Non-Wetland Sub-Unit*.

> **Emergent Sub-Unit** — Defined by NEWFA as an area within an assessment unit large enough to be identified on aerial photography with at least 30% cover by emergent and/or aquatic bed vegetation (defined as all non-woody plants, regardless of height). Emergent sub-units include all aquatic bed vegetation, even when submerged.
>
> **Forested Sub-Unit** — Defined by NEWFA as an area within an assessment unit large enough to be identified on aerial photography with at least 30% cover by trees (defined as all woody plants 6m or taller).
>
> **Scrub-Shrub Sub-Unit** — Defined by NEWFA as an area within an assessment unit large enough to be identified on aerial photography with at least 30% cover by scrub-shrub vegetation (defined as all woody plants less than 6m tall).

W

Wake — The movement of water caused by a boat displacing water as it moves through it. The size and shape of the wake depend on factors like the boat's speed, size, and shape, as well as the type of propulsion system.

Water quality—Descriptive or quantitative measure of how suitable water is for a particular use, defined by its physical, chemical, and biological characteristics. Typically assessed against scientifically determined standards to ensure water can support human health, ecological conditions, and other specific purposes, like providing drinking water or sustaining aquatic life.

Water regime— Describes the long-term, seasonal pattern of water movement, timing, and quantity in a specific geological or hydrological system, such as a river, watershed, or wetland. Characteristics include natural variations in flow magnitude, timing, duration, frequency, and rates of change. See also *Hydrologic regime, Hydroperiod*.

Water table — The upper level of the saturated zone, where all the pore spaces in soil and rock are filled with groundwater. It represents the boundary between the unsaturated zone (with air and some moisture) and the saturated zone. See also *Aquifer, Groundwater, Hydraulic head*.

> **Capillary fringe** — The nearly saturated zone of soil located directly above the water table. This zone is kept moist by capillary rise, where water is pulled upwards by the adhesive forces between water and soil particles, and the cohesive forces between water molecules themselves.
>
> **Phreatic zone** — The area below the groundwater table, also known as the saturated zone.
>
> **Saturated zone** — The area below the water table; the portion of the soil profile where available water storage is completely filled. Also referred to as the phreatic zone.
>
> **Unsaturated zone** — The zone immediately below the land surface where the pores contain both water and air but are not totally saturated with water; the area above the water table. Also referred to as the vadose zone.

Vadose zone — The aerated region of soil above the permanent water table. Also identified as the portion of the soil profile above the saturation zone.

Watershed — The geographic area that contributes surface runoff to a common point, known as the watershed outlet; the boundary of an area from which water drains to a single point; in a natural basin, the area contributing flow to a given point on a stream

WebSoil Survey —Website which provides soil data and information produced by the National Cooperative Soil Survey. The website is operated by the USDA Natural Resources Conservation Service (NRCS). See also *Soil survey.*

Wetland complex — Collection of two or more wetlands that are close to each other and often hydrologically or ecologically connected, meaning they share water or influence each other's functions. Also, a single compound wetland with different ecological forms adjacent to each other and intermixed.

Wetland indicator — Specific observable characteristics that, when present in combination, identify an area as a wetland. Indicators fall into three main categories: wetland hydrology (water present for a sufficient duration), hydric soils (soils showing oxygen-depleted conditions), and hydrophytic vegetation (plants adapted to saturated conditions). See also *Delineation*, *Wetlands*.

Hydric soil — A soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (USDA Soil Conservation Service 1994). Most hydric soils exhibit characteristic morphologies that result from repeated periods of saturation or inundation for more than a few days. Saturation or inundation, when combined with microbial activity in the soil, causes the depletion of oxygen. Hydric soil includes soils developed under sufficiently wet conditions to support the growth and regeneration of hydrophytic vegetation. Hydric soils that occur in areas having positive indicators of hydrophytic vegetation and wetland hydrology are wetland soils.

Hydrophytic vegetation — The community (or sum total) of macrophytes that occurs in areas where inundation or soil saturation is either permanent or of sufficient frequency and duration to influence plant occurrence. When hydrophytic vegetation comprises a community where indicators of hydric soils and wetland hydrology also occur, the area has wetland vegetation.

Wetland hydrology— Refers to the presence of surface water or waterlogged soils for a sufficient period of time in most years to influence the kinds of plants and soils that occur in an area.

Wetlands — Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. Compare to *Deepwater habitat, Upland*. See also *Hydrophytic vegetation, Hydric soils, Hydrology.*

Freshwater wetland — a wetland whose driving source of hydrology is freshwater; usually water with less than 1,000 ppm (parts per million) of dissolved salt.

Saltwater wetland — a wetland whose driving source of hydrology is saltwater; seawater is around 35,000 ppm of dissolved salt.

Wetland hydrology — The sum total of wetness characteristics in areas that are inundated or have saturated soils for a sufficient duration to support hydrophytic vegetation.

Wetland soil — A soil that has characteristics developed in a reducing environment, which exists when periods of prolonged soil saturation result in anaerobic conditions. Hydric soils that are sufficiently wet to support hydrophytic vegetation are wetland soils.

Wetland vegetation — The sum total of macrophytic plant life that occurs in areas where the frequency and duration of inundation or soil saturation produce permanently or periodically saturated soils of sufficient duration to exert a controlling influence on the plant species present.

Wier — A small overflow barrier used to alter the flow characteristics of a river or stream. Weirs are commonly used to prevent flooding, measure discharge, and to help render a river navigable. Compare to *Tide gate, Dam*. See also *Flow restriction*.

Wildlife — All non-domesticated organisms, including animals and plants, that live and grow in their natural habitats without human intervention,

Woody plant — Seed plants (gymnosperm or angiosperm) that develop persistent, hard, fibrous tissues, basically xylem. See also *Forested vegetation, Scrub-shrub vegetation, Shrub, Tree.*

Woody vine (or liana) — A woody, climbing plant that begins life as terrestrial seedlings but relies on external structural support for height growth during some part of its life, typically exceeding 5 m in height or length at maturity.

Wrack or wrackline — An accumulation of natural floating debris (kelp, plastic debris, wood, and similar material) left along the shore of a river, lake, tidal marsh, or other water body by high water levels.

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