APPENDIX A:

CRITERIA/QUESTIONS: EVALUATING FUNCTIONS AND SERVICES

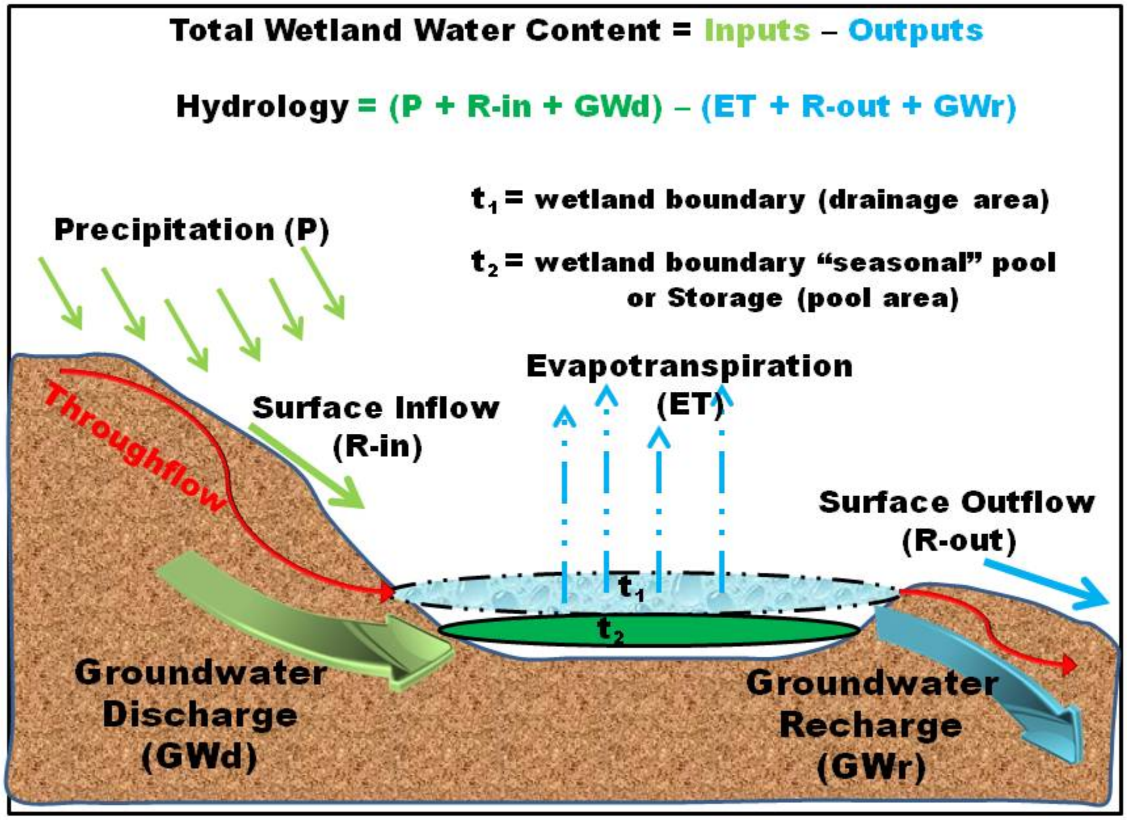
A list of criteria were developed by an interagency (COE, FWS, MSB, NRCS, EPA) group in the Matanuska Susitna Borough (MSB) utilizing the Highway Methodology workbook (USACE). The criteria can be applied to other areas of the State; are flexible, easily observed and utilizes best professional judgment. The criteria are used to assist the evaluator to identify the principle wetland functions and services for the wetland(s) in the assessment area. A series of questions and criteria are asked for each function group - hydrology, biogeochemical (water quality), and habitat for the wetland class or type (HGM) that occurs within the project boundary. An excellent reference for descriptions of wetland class and associated functions is http://www.cooklinletwetlands.info/Ecosystems. The following functions for each can help the evaluator when assessing wetland functions. The form can be found on the Alaska Share Point Site: (Appendix%20A_Criteria%20for%20Functions_Evaluation%20Form).

HYDROLOGY FUNCTIONS (water quantity related)

F1 – Contribution To Groundwater (Recharge) & Transmission Of Groundwater (Discharge) (Hydro)

Water flowing underground in aquifers discharges to the surface at discrete points where it meets surface waters and forms groundwater-dependent ecosystems, including springs, wetlands, rivers, and lakes. The geochemistry reflects the geology of the aquifer; for example groundwater may have high concentrations of specific minerals. The combination of geochemistry and hydrogeology creates ecosystem conditions that are often distinct from the surrounding aquatic ecosystem and can influence plant and animal species composition. Salmon often congregate around areas of cool groundwater discharge into streams and lakes in the summertime. In many areas, the importance of sustainable groundwater management can be important for species of conservation concern to promote biological diversity.

Understanding the water budget and hydrologic cycle is important when evaluating groundwater recharge and discharge. Precipitation is a common input of water to any site. Other possible inputs include surface runoff, springs, groundwater recharge and pumping (e.g., to or from). Water leaves wetland sites by evapotranspiration, infiltration, groundwater recharge, surface flow, and other means. The drainage area above a wetland will indicate how much surface runoff will supply water to the site. The water budget is usually expressed as Water Inflows = Water outflows + Storage. For the purpose of wetland delineation and management, storage is the total wetland water content at any one time under the prevailing management and current hydrologic conditions. Thus the water budget can be rearranged as *Total Wetland Water Content = Water In – Water Out.* The total wetland water content refers to the water held within the delineated boundary of the wetland at any one time, including water ponded on the ground surface and water within the soil. In many parts of Alaska and other places in the lower 48, the water content is higher and at the beginning and ending of the growing season rather than in mid-summer due to high evapotranspiration and/or less precipitation. The water content sufficient to maintain hydrophytic vegetation and hydric soils up to the wetland boundary could be considered the full wetland water content or wetland pool. Throughflow (e.g., interflow, storm seepage,) refers to the shallow subsurface flow of water through the upper soil profile. The graphic below represents a typical water budget showing inputs and outputs:



CRITERIA (general)

1. Public or private wells occur downstream of the wetland
2. Potential exists for public or private wells downstream of the wetland
3. Wetland is underlain by bedrock, permafrost, or impervious soils
4. Wetland is associated with a perennial or intermittent watercourse
5. Wetland is associated with a watercourse but lacks a defined outlet or contains a constricted outlet
6. Wetland contains only one outlet, no inlet
7. Quality of water associated with the wetland is high
8. Wetland shows signs of variable water levels
9. Piezometer data demonstrates discharge
10. Other

F1r - RECHARGE

This function assesses the ability of a wetland to infiltrate water into the underlying aquifer. Replenishment of groundwater is an important function for providing a drinking water source, its role in supporting wetland hydrologic regimes, and its contribution to the base flows of fish bearing streams. Groundwater, though not as readily observable as surface water, is closely linked to surface water. Many surface water bodies may represent areas where the water table is at or above the ground surface, such as those fed by recharge from the Talkeetna Mountains to the north (Jokela et al. 1991). The relationship of the groundwater table and the land surface dictates which function – *groundwater recharge where wetlands add water to the groundwater system*, or *groundwater discharge where wetlands take water from the groundwater system*. Some wetlands can act as both a recharge and a discharge system depending on weather. Both functions will be addressed for F1. If the wetland only functions or is a primary function for recharge, it can be noted as F1r. If the wetland only functions or is a primary function for discharge it can be noted as a F1d. Groundwater recharge is the primary mechanism for aquifer replenishment which ensures future sources of groundwater for commercial and residential use.

It is important to understand that the proportion of surface and groundwater inputs of a particular wetland, and the wetland's interaction with groundwater can vary considerably depending on soil type, precipitation (rates, types, timing, and amounts), and other factors including the extent of impervious surfaces (roofed and paved areas) and storm sewers (Grannemann et al. 2000). Although it can be difficult to directly measure the amount of groundwater interaction occurring within a wetland, it is important to estimate recharge rates to understand the effects of groundwater on other hydrologic processes and to assess how development activities may change recharge rates (Grannemann et al. 2000).

Although wetlands are important in maintaining water quality in wells, few wetlands play a significant role in recharging the deeper aquifers. It is important to note that wetlands typically recharge less to groundwater and base flows than do most undeveloped upland areas because of the more permeable soils typically found in uplands (National Wetland Technical Council (NWTC) 1978). Wetlands may, however play an important role during dry periods, where they may be the last places holding any water that could potentially recharge underlying aquifers. It is important to understand that recharge and discharge can reverse in the same spot in the same wetland. During wet times discharge to the wetland may dominate, fed by recharge up-gradient. During dry times, if that discharge slows or stops, the gradient beneath the wetland may reverse, and the wetland can feed underlying aquifers. The reverse also occurs: dry periods may cause wetlands to become dry, and therefore to be fed only by increasing rates of discharge, especially if a large lake or area of much greater storage lies up-gradient.

Some wetlands do contribute to groundwater recharge as a principal function. These wetlands are: 1) bogs; 2) the headwater fens; 3) some depressions; and 4) wetlands lying in the upper portions of their watersheds. Below is a list of these qualifiers that were used to select or exclude wetlands considered to perform contribution to groundwater as a principal function within the MSB but may be used in other areas of the State:

CRITERIA for RECHARGE

Fr1) Is the wetland classified as a bog? (NWI; Cook Inlet Keeper- LB3, LB63, LB36). ***Notes:*** *Bogs are by definition recharge mounds. They hold a lens of precipitation-derived water either directly above an underlying mineral substrate or above underlying fen peat. That precipitation-derived water is released both as* *evapotranspiration or surface water discharge, but can recharge shallow groundwater in the underlying fen peat or mineral substrate. Because underlying substrates lie in areas of groundwater discharge, the recharge originating in the bog mound will not contribute substantially to deeper groundwater recharge, it will only augment what is already being discharged to near the surface, except during extended periods of drought (Hill and Siegel 1981, Siegel and Glaser 1987, Siegel et al. 1995).*

Fr2) Is the wetland classified as a headwater fen?

Fr3) Is the wetland classified as a depression? **Notes:** Wetlands mapped with the geomorphic component 'Depression' are disconnected at the surface, and where they do not receive large amounts of discharging ground water, they can contribute to underlying aquifers, particularly during periods of drought.

Fr4) Is the wetland located in the upper 1/3 of its (sixth-order Hydrological Unit Code [HUC]) watershed? **Notes:** *Wetlands in the upper portions of their watershed probably recharge groundwater to the lower portions, at least during periods of drought.*

HUC codes are developed b USGS. The following link can provide general information: http://water.usgs.gov/GIS/huc.html . HUC codes are also in the Geodata file. Generally, the HUC is based on a 12-digit number as follows:

Hydrologic Unit Level	**Name**	**Digits**	**Size**	**Units**
1	Region	2	Average:177,560 square miles	21
2	Sub-region	4	Average: 16,800 square miles	222
3	Basin	6	Average: 10,596 square miles	352
4	Sub-basin	8	Average: 703 square miles	2,149
5	Watershed	10	63-391 square miles (40,000-250,000 acres)	22,000 (estimate)
6	Subwatershed	12	16-63 square miles (10,000-40,000 acres)	160,000 (estimate)

Naming the hydrologic units: hydrologic units are numbered sequentially beginning upstream and proceeding downstream within each HU. For example, the uppermost end of the HU is coded 9908020301, the next HU downstream is 9908020302.

A sample numbering of hydrologic units:	**Level**
First 2 fields are the Region----------------- 01	1
Next 2 fields are the Subregion---------- 0108	2
Next 2 fields are the Basin ------------ 010802	3
Next 2 fields are the Subbasin ----- 01080204	4
Next 2 fields are the Watershed 0108020401	5
Next 2 fields are the Subwatershed 010802040101	6

Fr5) Other: record number and criteria.

F1d - DISCHARGE

This function assesses whether or not a wetland is situated in a landscape position that primarily receives groundwater discharge. The transmission of groundwater can serve as a hydrologic source for wetlands, streams, and water bodies. Water exchange between groundwater aquifers and surface water also provides a major pathway for the transfer of essential nutrients to plants (i.e., calcium, potassium, and phosphate). Nutrients are released into the groundwater by weathering along subsurface flow paths and are made available for uptake when discharged to the surface. This transmission is known to have a strong ecological effect in plant species health and diversity (Eriksson 1984). Groundwater discharge helps maintain a wetland's water balance and water chemistry. This function is also critical to the formation of hydric soils and the maintenance of ecosystem habitats in different wetland types.

Groundwater and peat development play a major role in the region's extensive peatland systems, creating widespread fens and bogs. Fens are generally rich in dissolved minerals because of the profusion of discharged groundwater feeding into them. Groundwater often flows across fens as surface water through channels, pools, and other open water bodies which may form characteristic surficial drainage patterns (Winter et al. 1998). Peatlands have the ability to hold precipitation and feed underlying aquifers that eventually discharge into surface water or valley bottoms.

Precipitation is the primary water source of bogs. Bogs are a strong indicator that groundwater discharge does not reach the surface; although it may be strong beneath and adjacent to the bog. Precipitation does not contain elevated levels of dissolved minerals and is mildly acidic. The surface water of bogs is consequently low in minerals concentrations and is acidic. Bogs have low pH (<4.2) due to production of specific organic acids by specialized sphagna, and low specific conductance (<50 uS/s- primarily due to [Ca] < 2 mg/l) because meteoric water is the only source.

Bogs are generally poorly developed, often either forested with black spruce (*Picea mariana*) with an understory dominated by Labrador tea (*Ledum palustre*) and leatherleaf (*Chamadaphne calyculata*); or are in an earlier stage of development with sparse cover of sundew (*Drosera rotundifolia*), bog cranberry (*Vaccinium oxycoccus*), Labrador tea, round sedge (*Carex rotundata*) and crowberry (*Empetrum nigrim*). They are usually dominated with acid loving, sphagnum. Fens generally lack sphagnum, are less acidic or even alkaline or mineral rich and support, more varied vegetation composed of grasses or sedges. Below is a list of qualifiers that can be used to select or exclude wetlands considered to perform transmission of groundwater as a principal function.

CRITERIA for DISCHARGE

Fd1) For South Central Alaska where there is Cook Inlet Keeper (CIK) wetland mapping:

a. Does the wetland polygon have a hydrologic code that may indicate a water table at or near the surface?

b. Does the wetland polygon have an S, DW, R, RT, or SF geomorphic component?

Notes:

"S" polygons are Discharge Slope Ecosystems. These ecosystem wetlands occur over a mineral soil at the wetland to upland transition. They are found at the edges of all wetland ecosystems, and at slope breaks on terraces. They commonly occupy foot- and toe-slope landscape positions at the edge of peatlands or stream valleys where groundwater discharges or where dense till perches a water table close to the surface. Discharge slope wetlands are fed either by upslope groundwater storage capacity, or a perched water table atop dense till. Many are forested. All wetlands that border uplands contain a Discharge Slope component, though sometimes this component is narrowly restricted (Gracz 2011).

“DW” polygons are Relict Glacial Drainageway Ecosystems. These ecosystems contain significant groundwater flow where transmission of groundwater is common (Gracz 2011).

“R” polygons are riparian ecosystem wetlands including rivers and streams and their adjacent valley bottoms. The hyporheic zone, the region of interface between groundwater and streams, is found within this ecosystem type.

“RT” polygons are Ripple Trough Ecosystem wetlands. Ripple Trough Ecosystem wetlands are peatlands. They often support a bisecting stream. Because the adjacent glacial sediments are coarse-grained cobbles and gravels which allow rapid groundwater transmission, Ripple Trough wetlands are often fens that receive ample shallow groundwater discharge near the surface. Accordingly, they usually show somewhat higher pH and relatively small seasonal water table fluctuations (Gracz 2011).

“SF” polygons are spring fen wetlands. **Spring fen** wetlands are small peatlands surrounded by uplands, thus there is no surface connection to the stream network, and they do not perform streamflow moderation as a principal function. In addition, these wetlands are driven by groundwater discharge, and are connected to other wetlands and to streams through shallow, unconfined groundwater movement through underlying permeable sediments. They are underlain with thick, well-sorted and coarse-grained glacial fluvial sediments, allowing ample groundwater transmission (Spence et. al. 2011) where surface topography intersects the relatively shallow water table (Jokela et al. 1991). Because of the steady supply of shallow groundwater, water table elevations in spring fens vary the least of any wetland type further limiting their ability to perform streamflow moderation as a principal function (Gracz 2011).

Fd2) Other: list number and criteria

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F2 - Streamflow Moderation & Floodflow Alteration (Hydro)

In some areas a wetland (s) may provide both of these functions. In more urban areas, the Flood flow Alteration may be the main function of wetlands as a result of impervious surface. This function considers the effectiveness of the wetland in reducing flood damage by water retention for prolonged periods following precipitation events and the gradual release of floodwaters. It adds to the stability of the wetland ecological system or its buffering characteristics.

CRITERIA (general)

1. Area of wetland is large relative to its watershed (basin)
2. Effective flood storage is small or non-existent upslope or above the wetland
3. Wetland watershed contains a high percent of impervious surfaces
4. Wetland contains hydric soils which are able to absorb and detain water
5. Wetland has an intermittent outlet, ponded water, or signs are present of variable water level
6. Watershed has a history of economic loss due to flooding
7. Wetland is associated with a sinuous or diffuse river/stream
8. Wetland contains a high density of vegetation
9. Wetland outlet is constricted
10. Wetland exists in a relatively flat area that has flood storage potential
11. Other: record number and write in notes description

F2s - STREAMFLOW MODERATION

By holding water within its soils or on its surface, a wetland may delay the release of water downslope and downstream during and after precipitation events. This delayed release may reduce the magnitude of peak stream flows, associated flood stages, and reduce bank erosion and channel bed scour. Slow release of water from wetlands may sustain stream flows during dry seasons and may help provide a continuous source of outflow into downslope waters (Adamus Resource Assessment 1987). The evaluator should understand that while it is possible for an individual wetland to be singularly effective in maintaining stream flows, more often moderation of stream flow is the result of the interrelated functioning of a series of wetlands and water bodies within a watershed (NWTC 1978).

The capacity of a wetland to temporarily store (retain) surface and shallow subsurface water that can support stream flow depends on existing hydrology (including the position of the water table), presence of restrictive soil layers, characteristics of the soil profile (including the amount of pore space available for water storage), and micro- and macro-topographic relief (ADEC & USACE 1999). Precipitation-driven wetlands underlain by impermeable soil layers have the capacity to store surface and near-surface water within surface relief features, organic soil horizons, and silty or loamy mineral horizons (ADEC & USACE 1999). Organic soil horizons typically have greater storage capacity than mineral soils, particularly in the winter when surface organic horizons are dry. These dry horizons can be a sink for snowmelt. Generally, the soil directly above the seasonal frost layer is saturated. The seasonal frost layer deepens as the growing season progresses, so does the water table. This allows the top layers that were previously saturated to receive and store water from precipitation events, allowing for greater water storage capacity in the summer months (ADEC & USACE 1999).

Wetlands with a surface outlet and wetlands along streams are presumed to moderate surface flows to varying degrees. Wetlands without continually saturated soils are presumed to perform this function more effectively, as their capacity to store water during storm events is higher. Wetlands with dense vegetation and those situated across flatter slopes can slow water more than other wetland types (Sather et al. 1984, Thompson 1998). The National Wetland Inventory (NWI), NRCS Soil and Ecological Site mapping, Rosgen Stream Classification, and other wetland mapping (Gracz, 2011) can assist in analyzing this function. The following criteria are:

CRITERIA (specific/localized)

1) Does the NWI wetland polygon map unit (or other classification) begin with "R" (Riverine) or is the polygon immediately adjacent to an "R"?

   Notes: "R" polygons are riparian ecosystem wetlands including rivers and streams and their adjacent valley bottoms. Gracz (2011) utilizes Rosgen's Stream Classification System (Rosgen 1996) with some modification in mapping these wetland types in Mat-Su.

2) Is the wetland complex large compared to its watershed?

   Notes: "Large" is defined as a "6^{th} order Hydrological Unit Code" (HUC) polygon as classified by the U.S. Geologic Service. This definition of "large" was used in the Anchorage Wetland Assessment Method calculation (Municipality of Anchorage 1996).

3) Is the wetland polygon located in the upper 1/3 of its watershed?

4) For Southcentral Alaska with Cook Inlet Keeper (CIK) wetland mapping: Is the wetland polygon hydrologic code greater than or equal to 3 (not LB3, LB36, LB63, not D, not SF) and adjacent to a polygon adjacent to an "R"?

   Notes:

   Hydrologic code >=3 is defined as where the water table varies enough to support shrub dominated plant community (Gracz 2011).

   "R" polygons are riparian ecosystem wetlands including rivers and streams and their adjacent valley bottoms. (See notes under #1 above.)

   LB3 polygons are characterized by having well developed *Sphagnum* peat cover, though not necessarily fibric or undecomposed. See http://www.kenaiwetlands.net/MapUnitDescriptions/LB3.htm for more information.)

   LB36 polygons are sphagnum lawn on a relict glacial lakebed with forested areas.

   LB63 polygons are forested relict glacial lakebed with sphagnum lawn areas.

   LB36 and LB63 are infrequent wetland complexes that contain *Sphagnum* moss-dominated wetlands (LB3 component) and the woodland-to-forested wetlands (LB6 component). If *Sphagnum* is more abundant, the wetland is named LB36, if the woodland to forest dominates, the wetland it is named LB63. The components typically segregate into a *Sphagnum*-dominated area fringed by a forest or woodland. The forest usually abuts a Discharge Slope Ecosystem, or upland. Black spruce (*Picea mariana*) is the dominant forest type; Lutz spruce (*P.* X *lutzii*) is uncommon adjacent to sphagnum-dominated components (Gracz 2008). (See http://www.kenaiwetlands.net/MapUnitDescriptions/LB36.htm for more information.)

D polygons are depression wetlands formed by the deposition at the margins of ablating glaciers. These wetlands are surrounded by uplands, and there is no wetland connection to a navigable waterbody. Most depression ecosystem wetlands are occupied by only one or two plant communities and lack the full range from open water to forest. The most common are depressions occupied by either bluejoint grass or shrubby peatlands with or without black spruce forest. Many contain some area of sedge-dominated peatland (Gracz 2008). (http://www.kenaiwetlands.net/EcosystemDescriptions/Depression.htm for more information.)

SF polygons are spring fen ecosystems. **Spring fen ecosystem** wetlands are small peatlands surrounded by uplands. These wetlands are driven by groundwater discharge, and are connected to other wetlands and to streams through shallow, unconfined groundwater movement through underlying permeable sediments. They have thick well-sorted and coarse-grained glacial sediments, allowing ample groundwater discharge where surface topography intersects the relatively shallow water table. Because of the steady supply of shallow groundwater, water table elevations in spring fens vary the least of any wetland ecosystem (Gracz 2011). (See http://www.cookinletwetlands.info/Ecosystems/SpringFen.html for more information.)

5) Other: list number and record criteria

F2f - FLOODFLOW ALTERATION (Storage and desynchronization)

Wetlands play an important role in regulating the flow of water in a watershed. Similar to the stream flow moderation function, many wetlands have the capacity to regulate downstream flows by storing water from precipitation events. This is particularly important during large storm events and during spring break up. Flood flows can be lessened when peak flows from runoff, surface flow, and precipitation are retained in wetlands, reducing the danger of downstream flooding. This function is often performed to varying degrees by almost all wetlands. Floodwater storage is very important in developed areas such as Anchorage, Fairbanks, and the MSB because impervious surfaces resultant from development have the potential to increase the rate and volume of runoff delivered to surface water systems. Development also has the potential to decrease the number and area of wetlands, which further increases the risk of flood and property damage (Tilton et al. 1997).

Water velocity can be reduced by spreading water over a larger area, by surface roughness, and by obstructions. Wetlands with dense woody vegetation are generally better at slowing floodwaters than wetlands dominated by open water or low-growing or herbaceous vegetation, which offers little resistance to such flows. Wetlands with no outlet or with restricted outlets can attenuate and capture floodwaters more effectively than wetlands with unrestricted outlets. Examples of wetlands with a restricted outlet include oxbows or kettle depressions that are drained by a stream channel. The presence of floodplain wetlands abutting streams may also serve as temporary storage areas for overbank flows. The temporary storage of surface water, combined with the reduction of floodwater velocities by floodplain vegetation, serves to reduce flood peaks and increase duration of flow (Novitzki 1978). Below is a list of qualifiers that were used to select or exclude wetlands considered to perform floodflow alteration as a principal function:

CRITERIA (specific/localized)

1) Does the wetland polygon map unit begin with "R" or is the polygon immediately adjacent to an "R"? **Notes:** "R" polygons are riparian ecosystem wetlands including rivers and streams and their adjacent valley bottoms. Gracz (2011) utilizes Rosgen's Stream Classification System (Rosgen 1996) with some modification in mapping these wetland types in Mat-Su.
2) Is the wetland polygon located in the upper third (1/3) of its sixth-order HUC watershed? **Notes:** A "6th order Hydrological Unit Code" (HUC) polygon is a classification of the U.S. Geological Survey.
3) Are there many impermeable surfaces in the area?
4) Other: list number and criteria

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F3 - SEDIMENT/SHORELINE STABILIZATION (HYDRO)

Wetland vegetation can often stabilize stream banks and pond or lake fringes. Vegetation can bind and stabilize substrates and dissipate wave or current action, trap sediments during periods of inundation. The effectiveness of shoreline vegetation in controlling erosion depends on the plants present, width of the vegetated bank, efficiency of the vegetation in trapping sediments, soil composition of the bank or shore, height and slope of the bank or shore, and the elevation of the toe of the bank relative to mean high water (Sather et al. 1984). In some streams, erosion and collapse of stream banks can reduce the availability of cover, degrade water quality, and reduce the suitability of coarse sediment important for salmon spawning, at least temporarily (Adamus Resource Assessment 1987).

Generally, plant species with deep, binding root masses are more effective at stabilizing soils on streambanks and shorelines than are species with less dense root systems. Trees and shrubs often have deep, soil-binding root masses. Annual herbaceous plants are considered to lack such root masses. Perennial herbaceous species vary with respect to their root masses and should be considered individually. Perennial sedges, rushes, and grasses, for example, provide rhizomes, stolons or dense fibrous root systems for good soil stabilization. Annual grasses or forbs may not (ADOT & PF2010).

Wetlands that are adjacent to surface waters for a longer duration generally provide this function more frequently than do wetlands that are adjacent to surface waters for a shorter duration. Where plant cover exists along shorelines, the principal factors determining the degree of shoreline protection are the ability of the plants to survive prolonged flooding and their resistance to undermining (NWTC 1978). There may be other overriding factors affecting bank stability, such as soil texture (sand and gravel are highly erodible whereas soil with cohesive aggregates is not) and soil layering (e.g., a layer of cobbles or gravel will be stable in low velocity water but less so in higher velocity water). Where such factors apply, best professional judgment should be used by the evaluator when assessing this function (ADOT & PF 2010). Below is a list of considerations that the evaluator can use to assess whether a wetland has the potential to perform the sediment/shoreline stabilization function. This function is not assessed for Slope or Depression HGM classes. *Note: If the evaluator finds a wetland in either of these two classes in which the principle or secondary function is Sediment/Shoreline Stabilization, they can assess the wetland for this function.* The following criteria are:

CRITERIA

1. Is the wetland adjacent to a stream, pond, or lake? ***Notes:*** *Wetlands with surface water or wetlands immediately adjacent to water bodies, flowing or not, have the opportunity to perform shoreline functions. CIK (Cook Inlet Keeper wetland mapping) Polygons with a hydrologic component of "1", or classified as a "R", or polygons immediately adjacent to a mapped "LAKE", "R", or intersected by a stream were selected. A hydrologic component greater than 1 indicates a wetland that has surface water all year over at least 10% of the wetland (an indication of ponding). "R" polygons are riparian ecosystem wetlands including rivers and streams and their adjacent valley bottoms.*
2. Is the bank vulnerable to disturbance? **Notes**: refer to score sheet for indicators.
3. Are the soils along the bank primarily unstable such as silty? Ice-wedge polygons? Hummocky terrain? Is there evidence of instability?
4. Is the wetland vegetation comprised of large trees and shrubs that withstand major flood events or erosive incidents and stabilize the shoreline on a large scale (feet)?

5. Is the wetland vegetation comprised of a dense resilient herbaceous layer that stabilizes sediments and the shoreline on a small scale (inches) during minor flood events or potentially erosive events?
6. Indications of erosion or siltation are present
7. Topographical gradient is present in wetland
8. Potential sediment sources are present up-slope
9. Potential sediment sources are present upstream
10. No distinct shoreline or bank is evident between the waterbody and the wetland or upland
11. High flow velocities in the wetland
12. Dense vegetation is bordering watercourse, lake or pond
13. Other: record number and criteria

References

Adamus Resource Assessment, Inc. 1987. Juneau Wetlands Functions and Services. Prepared for the City and Borough of Juneau, Department of Community Development.

Alaska Department of Transportation and Public Facilities (ADOT&PF). 2010. Alaska Wetland Assessment Method (Version 1.0). Research and Technology Transfer Division and Statewide Environmental Office, Fairbanks and Juneau, Alaska.

Sather, J.H. and R.D. Smith. 1984. An overview of major wetland functions and services. U.S. Fish and Wildlife Service, Office of Biological Services. FWS/OBS-84/18. 68 pp.

National Wetlands Technical Council (NWTC). 1978. Scientists' Report: National Symposium on Wetlands. Washington D.C.

BIOGEOCHEMICAL FUNCTIONS (water quality and biomass)

F4 - SEDIMENT/TOXICANT/PATHOGEN RETENTION (BIOGEOCHEM)

The slow movement of sediment-laden water through wetland vegetation and across uneven ground surfaces results in retention of the sediments and other pollutants. This process can provide water quality functions to downstream and down gradient aquatic systems. Wetlands with flatter gradients have a higher potential for sediment retention than wetlands with steep gradients because flows are slower and retention time is longer (Magee and Hollands 1998). Some wetlands, especially in urban areas such as Anchorage, Fairbanks or the MSB may also receive pollutants such as sand, metals, and petroleum products in runoff from roadways and developed areas. Wetlands may perform contaminant removal functions by receiving and storing pollutants and toxins and immobilizing them by accumulation in fine grained mineral or organic soil layers. Where nutrient concentrations are high in aquatic systems, the nutrient uptake function can remove a pollutant from the system. While retention of pollutants may degrade the wetland itself, that retention would enhance the quality of downstream waterways for organisms such as salmon.

Long term retention by wetlands can also result in the chemical transformation of the retained sediments, nutrients, and toxins. Heavy metals and hydrocarbons are often deposited along with sediment when runoff enters a wetland. Once deposited, pollutants may be altered biologically; they can be broken down by bacteria or taken up by plants and deposited in wetland sediments when the plant dies. Toxins can also be immobilized or converted chemically to a less toxic form. This biological or physical entrapment of sediments and toxins is beneficial to aquatic life and downstream water quality. Where no wetlands occur, these toxins and sediments continue downstream to a surface water system where they can impair both public health and ecosystem health (Tilton, et al. 1997).

Possible indicators of this function in wetlands include features that slow water movement, such as permeable moss surfaces, *Sphagnum* moss, hummocks, tussocks, low inundated areas, and visible sediment deposits on the soil surface (Post 1996). Although it could be argued that nearly all wetlands have the capacity to perform this function, the evaluator should look for indicators that could increase the likelihood that sediment or other pollutants are introduced to a particular wetland. This includes conditions such as proximity to roads, building pads, natural erosion features, mountainsides, industrial areas, and many other conditions where the opportunity for conveyance of sediments or pollutants is greatest. Below is a list of qualifiers that were used to select or exclude wetlands considered to perform sediment/toxicant/pathogen retention as a principal function:

CRITERIA

1) Is the wetland on the State of Alaska's Impaired Water Bodies List or immediately adjacent to a location on the list (ADEC 2010)?

   Notes: Alaska Department of Environmental Conservation reports on the condition of Alaska's waters to the U.S. Environmental Protection Agency in the *Integrated Water Quality Monitoring and Assessment Report* (Integrated Report). The Integrated Report contains the Impaired Water Bodies List and helps the State prioritize waters for future data gathering, watershed protection, and restoration.

2) Is the wetland adjacent to a road?

Notes: All wetland polygons that intersect a road or are within 50 feet of a road were selected for this effort.

3) Does the wetland (or map unit if NWI or CIC) begin with "R" (Riparian) or is the polygon immediately adjacent to an "R"?

Notes: "R" polygons are riparian ecosystem wetlands including rivers and streams and their adjacent valley bottoms. Gracz (2011) utilizes Rosgen's Stream Classification System (Rosgen 1996) with some modification in mapping these wetland types in Mat-Su.

4) Is the wetland a peatland (if mapped, it is every polygon but an "S" polygon)?
5) Is the wetland disturbed (or if mapped does the map unit end with "d")?

Notes: A wetland is classified as disturbed when its character cannot be discerned from the present landscape or the landscape recorded on 1996 aerial photography. Wetland units mapped as disturbed indicate that they are disturbed beyond recognition of their pre-human disturbance character. Disturbed units can be created by a variety of human activities; the most common activities in the MSB are road building, logging, and gravel extraction. In other communities it might be trails, commercial development, ATV use.

6) Potential sources of excess sediment are in the watershed above the wetland
7) Potential or known sources of toxicants are in the watershed above the wetland
8) Public or private water sources occur downstream
9) Fine grained mineral or organic soils are present
10) Opportunity for sediment trapping by slow moving water or deepwater habitat are present in this wetland
11) Is the wetland adjacent to agricultural lands that may have the potential to increase sediment or chemicals into the wetland? (i.e., fallow fields, use of herbicides/pesticides, overuse of fertilizers).
11) Other: record number and criteria

References

Gracz, M. 2011. Wetland Mapping and Classification of the Cook Inlet Lowlands, Alaska (http://www.cookinletwetlands.info/) Accessed on April 10, 2011.

Magee, D.W., G. Hollands. 1998. A Rapid Procedure for Assessing Wetland Functional Capacity – Based on HGM Classification. Normandeau Associates. Bedford, New Hampshire.

Post, R.A. 1996. Functional Profile of Black Spruce Wetlands in Alaska. Alaska Department of Fish and Game, Fairbanks, Alaska. Report EPA910/R-96-006 prepared for U.S. Environmental Protection Agency, Region 10.

Rosgen, D. 1996. *Applied River Morphology*. Wildlife Hydrology, Pagosa Springs, CO.

Tilton, D., B. Fahey, and D.H. Merkey. 1997. Rouge River national wet weather demonstration project: A wetland protection plan for the headwaters of Johnson Creek and the Middle Rouge River. RPO-NPS-TM25.00. Rouge Program Office and Wayne County Department of Environment, Wayne County, MI.

F5 - NUTRIENT REMOVAL/TRANSFORMATION (BIOGEOCHEM)

Wetlands may retain nutrients from water entering a site, incorporating them into plant tissue and sometimes into the soil. Nutrients can enter wetlands in one form and leave in another. Wetland productivity depends heavily on inputs of organic matter and nutrients; wetland systems in turn export organic matter and nutrients to the downstream environments (NWTC 1978). Most wetlands seem to act as nutrient traps, at least during the growing season. Periodic inundation or overbank flooding into wetlands can allow decaying plant material to be washed downstream to other aquatic ecosystems, where it would support the food web with energy and nutrients.

Wetlands can attenuate surface runoff, reducing downstream erosion and allowing the sediments, pollutants, and nutrients carried in runoff to sink and be deposited in the wetland. Urban storm water runoff and runoff from cultivated areas are often rich in nutrients and sediments. Nitrogen and phosphorous assimilated by wetland vegetation prevents eutrophication in downstream lakes and rivers. Nutrients can also be trapped in sediments, thereby preventing them from degrading downstream water quality. In addition, the filtering capacity of wetlands protects groundwater by removing contaminants before they seep into the aquifer (Rouge River FA 1997).

Another factor affecting nutrient cycling is the differing biomass turnover rates between vegetation strata. Deciduous shrubs turn over 34 to 43% of their biomass annually, adding a substantial amount of litter to the soil surface (ADEC & USACE 1999). Shrubs recycle nutrients effectively because tissue nutrient pools are high in proportion to biomass. The herbaceous stratum produces new growth and senesces annually, decomposing more rapidly than woody vegetation and thus cycling nutrients fairly rapidly. Mosses generally prohibit nutrient cycling by acting as nutrient sinks; they rapidly intake nutrients and have slow rates of decomposition.

Wetland plant material may be consumed directly by vertebrates and invertebrates, or chemically and physically altered through decomposition before use by other consumers. Decomposition and the rate at which nutrients are transformed to usable forms by plants influence plant productivity and ultimately food chain dynamics. The rate of decomposition and the degree to which nutrients and organic carbon are transported out of the wetland affect the wetland's role in the aquatic food chain. This is of particular importance to productive fish streams and downslope marine habitats. Below is a list of considerations that the evaluator can use to assess whether a wetland has the potential to perform the nutrient removal/retention/transformation function.

CRITERIA

1. Is the wetland large relative to the size of its watershed?
2. Does water pond in the wetland?
3. Are there potential sources of excess nutrients present in the watershed above the wetland?
4. Does the NRCS Soil Survey indicate the wetland is underlain by poorly drained fine grained mineral or organic soils? Do the soils have a low saturated hydraulic conductivity?
5. Does the wetland have a dense herb stratum?
6. Does water slowly flow down into the wetland?
7. Is the water retention/detention time in this wetland increased by constricted outlet or

thick vegetation?

8. Does water flow through the wetland diffusely and have contact with vegetation, hummocks, tussocks, or large woody debris?
9. Does a deep peat layer exist in the wetland?
10. Is the wetland associated with an intermittent or perennial stream?
11. Does the wetland have uneven topography (i.e. hummocks, micro-highs/lows)?
12. Does the wetland have a dense shrub or tree canopy?
13. Other: record number and criteria.

F6 - FOODCHAIN SUPPORT (BIOGEOCHEM)

This function assesses the ability of a wetland to produce and export food/nutrients for both terrestrial and aquatic organisms. Food and nutrients include plant forage species, invertebrates, wildlife prey species, and particulate and dissolved organic matter (carbon). Generally, wetlands with higher density of vegetation have potential for more forage plant production and particulate and dissolved organic material production than do wetlands containing less vegetative cover. Due to their proximity and interconnectedness to wetlands, the vegetated upland areas adjacent to wetlands (i.e., vegetated buffers) can also contribute to this function (ADOT&PF 2010).

On-site food sources available to wildlife can depend on the plant volume and species composition, presence of open water and streams, and time of year. More vertical vegetation canopy layers (e.g., the on-site or nearby presence of some trees) may increase the amount or variety of food resources available on site. Wetlands with high plant species diversity are often indicative of a large gene pool for wetland plant species, and therefore may support numerous stages of the food chain. Wetlands with a high proportion of edible plant species are presumed to support food webs to a higher degree. Wetland systems that have lower levels of nutrients, lower pH, peat soils, and evergreen vegetation are presumed to have lower plant productivity that is less able to support food webs.

Shrub dominated wetlands can provide food for moose, beaver, and small birds. Emergent and aquatic vegetation can provide food for moose, beaver, muskrat, and water birds. Common berry-producing plants available to wildlife include crowberry, high-bush cranberry, low-bush cranberry, cloudberry, and bog blueberry. Additionally, in the wetter portions of these wetlands, insects may reproduce and flourish, providing a viable food source for both birds and fish. In areas adjacent to anadromous fish streams, many different mammals and raptors feed on fish carcasses and leave parts of the decomposing fish on the ground which in turn supplies nutrients to the plant community.

The level of wetland functionality as it relates to organic carbon and other nutrient export depends on the potential of a wetland to produce organic carbon and make it available, as well as the potential of the surrounding wetlands to support surface and shallow subsurface flow to riparian corridors. Wetlands with surface flow outlets, wetlands that flood, and wetlands used by highly mobile fish and wildlife species have mechanisms for exporting organic matter and nutrients. Wetlands generally export organic carbon if they are located on toe slopes or in valley bottom positions, are proximal to streams and have hydraulic gradients that direct surface and subsurface flow to these streams, or have groundwater at or very close to the ground surface during much of the growing season (ADEC & USACE 1999). A wetland's water regime is the most important feature in consideration of its ability to export food, since the water regime controls the dominant vegetation types as well as influences both nutrient and animal mobility and access. Numerous studies have shown that watersheds with a larger proportion of wetlands tend to export more carbon that is important to downstream food webs, compared with watersheds that have fewer wetlands. Service to food webs can depend partly on the quality and timing of the exported carbon (Adamus 2010).

Wetlands with surface or subsurface outlets can more readily export organic material to downstream habitats than can wetlands without outlets. Note that the outlet need not be a channel, but could also be overland flow where it is conceivable that water moves across the wetland surface. In general, wetlands that have seasonal variability in soil saturation are more productive than wetlands that are permanently inundated (Mitsch and Gosselink 2000); however, this does not address the importance of permanent water to wildlife, fish, and other aquatic species, and their contribution to production export. For this reason, perennial surface water is considered superior to seasonal/intermittent or temporary/ephemeral hydrologic regimes. In addition, opportunities for breakdown and export of organic materials to downstream aquatic habitats via surface water are generally greater at wetlands containing water for longer, rather than shorter, durations (ADOT&PF 2010). This function is likely not performed during late spring and early summer, when discharge from adjacent landscapes and rainfall is low and hummocky depressions are typically free of water. Below is a list of qualifiers for lands considered to perform foodchain support as a principal function:

CRITERIA

1. Is the wetland unit a stream, lake, or pond or immediately adjacent to a stream, lake, or pond? **Notes:** This question addresses the opportunity for wetlands to export nutrients to downstream wetlands; therefore supporting a wider range of organisms
2. Are wildlife food sources, both plants and animals, available within this wetland?
3. How many strata or layers of vegetation exist? The greater number of strata the higher the function for food support
4. What is the vegetation cover? The higher the cover, the higher the function.
5. Fish or shellfish develop or occur in this wetland
6. Economically or commercially used products found in this wetland
7. Evidence of wildlife use found within this wetland
8. High aquatic vegetative diversity/abundance is present
9. Wetland contains flowering plants that are used by nectar-gathering insects
10. What is the pH of the soil porewater? (for example):
    a. pH 4.2 – 7.0: high (the higher the pH, the greater the biomass)
    b. pH less than 4.2: moderate
    c. pH greater than 8.5: low
11. Other: record

References

Adamus Resource Assessment, Inc. 1987. Juneau Wetlands Functions and Services. Prepared for the City and Borough of Juneau, Department of Community Development.

Alaska Department of Environmental Conservation/U.S. Army Corps of Engineers Waterways Experiment Station (ADEC & USACE). 1999. *Operational Draft Guidebook for Reference Based Assessment of the Functions of Precipitation-Driven Wetlands on Discontinuous Permafrost in Interior Alaska.* Technical Report Number: WRP-DE-1999. Anchorage, Alaska.

Alaska Department of Transportation and Public Facilities (ADOT&PF). 2010. Alaska Wetland Assessment Method (Version 1.0). Research and Technology Transfer Division and Statewide Environmental Office, Fairbanks and Juneau, Alaska.

Mitsch, W.J. and J.G. Gosselink. 2000.Wetlands, 3rd Ed. John Wiley & Sons, New York.

HABITAT FUNCTIONS

F7- RESIDENT AND ANADROMOUS FISH HABITAT (HABITAT)

This function evaluates a wetlands capacity to support anadromous fish. It is important to note that this assessment will not predict habitat suitability or occurrence accurately for every species. Fish species can be dependent on wetland habitats for early development and rearing due to their relative cover, low water velocity, and abundance of food sources. Wetlands with open water and ponds that are adjacent to anadromous fish (fish that are born in fresh water, migrate into salt water for most of their lives, and then return to fresh water to breed and die) streams can provide important spawning and rearing habitat for fish species. Wetlands with surface water present, a defined and consistent inlet and outlet, and moderate vegetation interspersion are likely to provide fish habitat (Adamus Resource Assessment 1987).

Many Alaska streams and their tributaries are anadromous fish streams. In Southcentral Alaska, anadromous species of interest include Chinook salmon (*Oncorhynchus tshawytscha),* chum salmon (*O. keta)*, coho salmon (*O. kisutch)*, pink salmon (*O. gorbuscha*), and sockeye salmon (*O. nerka),* as well as Dolly Varden (*Salvelinus malma*) (ADF&G 2009). For the purpose of this method, "anadromous streams" are defined as streams important to the spawning, rearing, or migration of anadromous fish species. The importance of anadromous fish species in Alaska is hard to overemphasize, as they are some of the most important commercial, subsistence, recreational, and tourism resources in the state. However, resident fish such as Arctic char (Salvelinus alpnus), Dolly varden (S. malma), Arctic grayling (Thymalus arcticus), and Whitefish (Coregonus sp.) are important in local areas within the state. Streams and the abutting wetlands provide vital freshwater habitat and resources, affecting all life stages, for large populations of resident and anadromous fish.

Owing to their importance to Alaska's economy, subsistence needs, and recreational fishing; anadromous streams are protected under Alaska Statute 41.14.870, also known as the Alaska Fish Act. Federal protection of fish habitat through the Magnuson-Stevens Fishery and Conservation and Management Reauthorization Act of 2006 directs federally-funded projects consult with the National Marine Fisheries Service when any of their activities may have an adverse effect on essential fish habitat (EFH). This legislation protects against adverse effects that may include direct (e.g., contamination or physical disruption), indirect (e.g., loss of prey, or reduction in species' fecundity), site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.

Probably the most important consideration in assessing a particular wetland capacity to support or improve downstream fish habitat is the wetlands proximity to streams or waterbodies. Several GIS stream layers in the geodata folder include U.S. Geological Survey (USGS) digital line graphics datasets, USGS National Hydrography Dataset (NHD), U.S. Fish and Wildlife Service National Wetland Inventory (NWI) mapping, ecological site descriptions, and the ADF&G anadromous stream mapping. Data creation methods, age of data, and accuracy varies greatly among each dataset. Over the past several years, The Bureau of Land Management (BLM) has actively been revising and increasing the accuracy of the NHD for some areas within the State. There are also wetland mapping layers available within the Kenai and MatSu Boroughs (Gracz 2011In some regions, stream data may be accurate enough for analysis, though field verification is necessary for streams not readily viewable in aerial photos such as small streams and streams under forest canopy, as these may be very inaccurate in location.

Below is a list of qualifiers that were used to select or exclude wetlands considered to perform fish habitat for resident and anadromous as a principal function:

CRITERIA (general and localized)

1) Is the wetland associated/ mapped as an anadromous fish stream by ADF&G? Is the stream within the wetland known to support native populations of resident fish?

> **Notes:** ADF&G is responsible for maintaining anadromous waters data and the publication of the Catalog of Waters Important for the Spawning, Rearing or Migration of Anadromous Fishes and its associated Atlas. The Catalog and Atlas are updated as more current surveys document the presence or absence of anadromous fish in waterbodies and nomination forms are submitted to ADF&G. It is important to note that the ADF&G information on the extent of anadromous fish habitat captures most large streams but does not capture most small streams. The ADF&G anadromous stream data is delineated at a coarser scale and often doesn't match streams visible on aerial photography, but can contain more detailed small stream data than the NHD information.

2) Does the wetland polygon map unit begin with "R" (Riparian) or is the polygon immediately adjacent to an "R"?

> **Notes:** "R" polygons are riparian ecosystem wetlands including rivers and streams and their adjacent valley bottoms. Gracz (2011) utilizes Rosgen's Stream Classification System (Rosgen 1996) with some modification in mapping these wetland types in the MSB.

3) Is the wetland polygon adjacent to a NHD mapped stream that flows into an anadromous fish stream?

> **Notes:** NHD is the US Geological Service's National Hydrography Dataset. The NHD offers the most accurate and comprehensive GIS data available for streams, ponds, and lakes. Accuracy problems do arise when trying to use the NHD stream mapping in conjunction with the ADF&G anadromous stream data, which this analysis has considered. The NHD dataset is more recent and more closely matches the actual stream corridors visible on available aerial photography; however the GIS lines lack anadromous fish information.

4) In Southcentral Alaska, where CIK wetland mapping exists, does the wetland polygon have a hydrologic code of "1" and adjacent to a wetland polygon that is adjacent to an "R"?

> **Notes:** Wetlands with a hydrologic code greater than 1 indicates a wetland that has surface water all year over at least 10% of the wetland. It is reasoned that these wetlands have the highest probability of supporting pipe systems or other flow pathways through which juvenile fish can pass. "R" polygons are river and stream reaches and their immediately adjacent valley bottoms.

<u>Fish Habitat – Standing Water:</u>

5) What is the vegetation cover near standing water? Shade?
6) What is the substrate? Sandy is preferred. Silty is not.
7) Habitat is preferred if the wetland is connected to permanent water but is low if isolated

<u>Fish Habiat for running or moving water</u>:

8) The presence of pools-riffles are generally preferred habitat as opposed to none present
9) Habitat is preferred if the substrate is sandy and rocky rather than muddy or shifting material
10) Habitat is preferred if there is plenty of cover which includes boulders, cutbanks: 25-30%; adequate 10-25% and lower if less than 10% or more than 50% are present.

General

11) Evidence of fish present
12) Man-made streams are absent
13) Water velocities are conducive for fish use
14) Defined stream channel is present
15) Wetland is part of a larger, contiguous watercourse
16) Wetland has sufficient size and depth in open water areas so as not to freeze solid and retain some open water during winter
17) Spawning areas are present (submerged vegetation or gravel beds)
18) Barriers to anadromous fish are absent from the stream reach associated with the wetland
19) Other: record number and criteria

Note: this function may also be used for non-anadromous fish. Specify the fish present and record criteria that may be specific to the type of fish.

References

Adamus Resource Assessment, Inc. 1987. Juneau Wetlands Functions and Services. Prepared for the City and Borough of Juneau, Department of Community Development.

Gracz, M. 2011. Wetland Mapping and Classification of the Cook Inlet Lowlands, Alaska (http://www.cookinletwetlands.info/) Accessed on April 10, 2011.

Rosgen, D. 1996. *Applied River Morphology*. Wildlife Hydrology, Pagosa Springs, CO.

F8- HABITAT AND MAINTENANCE OF BIODIVERSITY (HABITAT)

This function evaluates the capacity of a wetland to support an abundance and diversity of plants, birds, raptors, amphibians, and mammals, especially species that are most dependent on wetlands or water. Densities of fauna and flora can be exceptionally high in some wetlands, partly due to high productivity of vegetation and invertebrates, and partly because wetland vegetation often provides nest sites in close proximity to preferred foods (Adamus 2010). Organisms are likely dependent on wetland habitat factors such as the availability of cover, freedom from disturbance, availability of food, availability of specialized habitat features, water regime (especially fluctuations in water level), and interspersion of different vegetation forms and water. This function considers the effectiveness of the wetland in providing habitat for various types of resident and migratory species typically associated with wetlands and the wetland edge (USACE 1995).

Relatively few mammals are truly wetland-dependent. However, some mammal species are highly wetland-dependent in some areas at certain times of the year. Many birds depend on wetland habitats during all or parts of their life histories. Wetlands can also provide important spawning and rearing habitat for fish. Functions directly related to wildlife use could include fish passage, fish rearing habitat, avian nesting and resting, wildlife breeding habitat, and movement corridors. Variables influencing habitat suitability include vegetation structure, macro and micro-topography, and hydrologic conditions (ADEC & USACE 1999). Life history requirements for vertebrate and invertebrate species include predator escape, food, resting, and reproduction. Habitats may also serve as potential movement zones for migratory animals and animals with large home ranges, corridors for gene flow between separated populations, and avenues for progeny to exploit new areas. The ability of a wetland to support these larger spatial functions depends on landscape level position and regional patterns, such as migration routes.

The level of interspersion of different vegetation types in a wetland can influence the quality of wildlife habitat. When vegetation types are highly interspersed, more edge between communities exists. Edge communities are important to many wildlife species, and generally the more edge within a wetland, the greater diversity of wildlife (Thompson 1998). Interspersion of vegetation types indicates a more diverse canopy structure, and typically the greater structure in canopy results in a greater diversity of wildlife. Similar to the level of interspersion among vegetation, interspersion of open water habitat and vegetation communities can directly influence the quality of wildlife habitat. Typically, the greater interspersion of open water and plant communities, the greater the diversity of wildlife. Seasonally flooded wetlands interspersed with surface water are often important to pre-breeding waterfowl, which depend on the rich invertebrate resources found there.

Open water often provides habitat for waterfowl, possible spawning and/or rearing habitat for fish, and habitat for wetland-dependent mammals (beaver, otter, and muskrat) and amphibians (wood frog). Proximity of a habitat type to water can also influence wildlife use. Streams and their adjacent riparian communities can support a variety of wildlife. Many different food sources including fish, aquatic insects, and plants are available within the streams themselves. Stream banks often provide protected sites for dens and nests, easy access to drinking water, and are often used as travel corridors by larger mammals (Thompson 1998).

The availability of appropriate food sources plays an important role in assessing habitat suitability for wildlife. The habitat function should be evaluated to cover a wide range of species (i.e., from large to small, generalists to specialists, etc.). A diverse vegetation community may rank higher than other types by providing forage for a wider variety of species. Generally, willows, sedges, and aquatic vegetation provide preferred browse for wildlife. Potential of the habitat type to support insects and other invertebrates should also be considered, as these may be important food sources for small mammals, as well as birds and fish.

Presence of a thick organic layer may also be important, as this may provide winter and nesting habitat for rodents. The ability of a habitat to provide adequate cover for predator avoidance and escape is determined in part by structure of the vegetation (ADEC 1999). Habitat types with closed and open shrub canopies are often more important than habitat types dominated by shorter herbs or dwarf shrubs.

Habitats may serve as potential movement corridors for animals with large home ranges, as well as for migratory animals. The ability of a habitat to support these larger spatial functions depends on landscape level position and regional patterns, such as migration routes (ADEC 1999). Riverine wetlands and their adjacent streams should be evaluated in terms of suitability for fish passage, while palustrine wetlands should be evaluated in terms of their ability to support migratory seabirds, shorebirds, and waterfowl. It is important to note that many of these components, although can be evaluated separately, are interrelated and contribute to the ecosystem service of each habitat type. For example, a ponds' suitability as stopover habitat for migratory birds is related to its ability to support a healthy community of aquatic invertebrates and edible foliage, thus serving as a feeding and resting station on the migration route. Furthermore, habitat types do not stand alone and may be most important as part of the greater landscape. For instance, the entire project area may provide suitable moose habitat due to abundant browse foods. Below is a list of considerations that the evaluator can use to help identify the habitat features within a particular wetland and determine whether those features working together contribute to the biodiversity of an area.

CRITERIA

1. Does the wetland contain a stream or is the wetland situated within a riparian corridor?
2. Is the wetland undisturbed? Not degraded or not fragmented by human activity.
3. Are the uplands surrounding this wetland undeveloped?
4. Is the wetland contiguous with other wetland systems or connected by a stream or lake? Is there open water?
5. Does the wetland exhibit a high degree of interspersion of vegetation classes and/or open water?
6. Does the wetland indicate the occurrence of preferred habitat forage? edible plant species?
7. Are there more species of plants within the wetland compared to other nearby wetlands?
8. Is the wetland free of non-native plants?
9. Are there regionally uncommon plants growing the wetland?
10. Is there animal sign in the wetland?
11. Are there multiple vegetation stratums with more than 10% cover in each?
12. Does the seasonal uses of the wetland vary for wildlife?
13. Does the wetland appear to support varied population diversity/abundance of wildlife during different seasons?
14. Does the wetland contain or has potential to contain a high population of insects?
15. Are there areas of open water space within the wetland that could be favored by aerial foragers (bats, birds, insects)?

16. Does the wetland vegetation have edge habitat?
17. Are there snags within the wetland that could be used for perching birds or provide nesting habitat for cavity nesters?
18. Is there an abundance of dead woody material within the wetland?
19. Does the wetland contain surface water during all or most of the migration period?
20. Other: record number and criteria

SERVICES

F9-HABITAT FOR SPECIES OF INTEREST (SERVICE)

While all species within a wetland contribute to the functioning of that particular wetland, some species play particularly important roles. These species are often considered indicators of the overall health of an ecosystem as they are most sensitive to ecological changes, disturbances, and other impacts to wetlands. Some species can be so closely associated with a particular wetland habitat that, should that habitat be reduced in size or otherwise disturbed severely enough, that organism can be measured and can serve as a metric of the degree of disturbance of that system (Batser and Sharitz 2006). An official list of indicator species specific to wetlands in Alaska or of particular importance does not exist. Information provided here includes habitat features related to certain species that fall on a variety of "species of interest" list or are otherwise being tracked by certain groups. The evaluator should consult with regional wildlife experts to determine if additional species and qualifiers should be added to the assessment based on the project location and time of year.

In certain wetland types, available habitat features are of particular importance to species that are considered endangered, threatened, sensitive, or are indicator species. Wildlife species are typically dependent on habitat factors such as the availability of cover, freedom from disturbance, availability of food, availability of specialized habitat features, water regime (especially fluctuations in water level), and interspersion of different vegetation forms and water. In some areas of the State, wildlife habitat has been largely affected by transportation corridors (roads and railroads), residential and commercial development, past resource management practices, and recreation. These impacts often influence wildlife distribution by changing dispersal movement patterns and causing the degradation or loss of available habitat. Disruption of dispersal movements can isolate populations and increase the probability of localized extinctions.

Certain birds have long been an important indicator of disturbances to wetland systems. Accordingly, a review of available "species of interest" lists published by conservation groups and state and federal agencies only report birds. These species are listed on Table 1. The species included on this list were those that are expected to use wetland habitats during a portion of the breeding season. Numerous seasonal migrants that may use portions of an area or region as brief resting and staging events during migration were omitted from the list. Refer to the Wildlife Conservation: Alaska's Statewide Strategy: www.sf.adfg.state.ak.us/statewide/ngplan

Table 1. Bird "Species of Interest"

Species	ESA Alaska Region (2010)	USFWS Bird of Conservation Concern (2008)	USGS Priority Bird Species for Conservation	State of Alaska Species of Special Concern	Audubon 2010 WatchList	Alaska Natural Heritage Program State Rank*
Red-throated Loon	No	No	No	No	Yes	S4B, S4N (14Nov2008)
Horned Grebe	No	Yes	No	No	No	S4S5B, S4N
Lesser Yellowlegs	No	Yes	No	No	Yes	S5B
Solitary Sandpiper	No	Yes	No	No	Yes	S4B (13Oct2008)
Hudsonian Godwit	No	Yes	No	No	Yes	S2S3B
Short-billed Dowitcher	No	Yes	No	No	Yes	S4S5B
Great Gray Owl	No	No	Yes	No	No	S4
Olive-sided Flycatcher	No	Yes	Yes	Yes	Yes	S4S5B (13Oct2008)
Northern Shrike	No	No	Yes	No	No	S4B,S4N
American Dipper	No	No	Yes	No	No	S5
Gray-cheeked Thrush	No	No	Yes	Yes	No	S4S5B
Bohemian Waxwing	No	No	Yes	No	No	S5B
Rusty Blackbird	No	Yes	Yes	No	Yes	S4B,S3N (13Oct2008)

**Notes*
S1 - Critically imperiled in state. (Usually 5 or fewer occurrences); S2 - Imperiled in state. (6-20 occurrences); S3 - Rare or uncommon in state. (21-100 occurrences); S4 - Apparently secure in state, but with cause for long-term concern (usually more than 100 occurrences; S5 - Demonstrably secure in state; S#S# - State rank of species uncertain, best described as a range between the two ranks.
Qualifiers: B - Breeding status ; N - Non-breeding status; Breeding and non-breeding designations are attached to the rank when a species has distinct breeding and non-breeding populations in Alaska, and birds in those distinct populations face different threats or have different population trends.

Similar to the bird species listed above, certain plant species are also used and tracked as indicators of healthy ecosystems. The Alaska Natural Heritage Program (AKNHP) maintains a list of sensitive: http://aknhp.uaa.alaska.edu/botany/rare-plants-species-lists/. It is possible that any of these species could occur in evaluated wetlands. Table 2 lists those species found in the South Central area, their state status, and briefly describes the typical habitat that they occupy. Every species on this list is apparently secure on a global basis, but the species range from critically imperiled in Alaska to rare or uncommon.

Table 2. Rare Plant Species

Species	State Status	Known Local Distribution	Habitat
Blysmopsis rufa	Critically imperiled	Matanuska Valley	Coastal and inland salt or brackish marshes or freshwater peatlands
Carex atratiformis	Imperiled	Knik Arm	Forest margins, open woodlands, calcareous ledges, stream banks, lakeshores, wet cliffs, high elevation seeps. Elevation: 10-1500 m
Carex bebbii	Critically imperiled	Cook Inlet	Wetlands and lake margins, uncommon in wet areas among meadows. Wet places with calcareous or neutral soils, gravelly lakeshores, stream banks, meadows, forest seeps. Elevation: 0-2100 m
Carex interior	Critically imperiled	Palmer Hay Flats	Wet meadows, seeps, and bogs sphagnum peat; usually in more or less calcareous sites
Cicuta bulbifera	Imperiled	Knik Arm, 3 Mile Lake	Marshes, bogs, and lakeshores; lakes on floodplains along rivers. Most specimens recorded at 0-300 m. Often associated with *Menyanthes trifoliata*, *Carex utriculata*, *Pedicularis macrodonta*, and *Potentilla palustris*; surrounded in upland by birch
Eriophorum viridicarinatum	Imperiled	Anchorage, Kenai peninsula	Marshes, meadows, bogs, fens, wet woods
Geum aleppicum var. strictum	Critically imperiled to imperiled	Kenai Peninsula	Thickets, meadows. Very few collections in Alaska – it is therefore difficult to characterize its distribution and habitat requirements
Lycopus uniflorus	Rare or Uncommon	Anchorage Bowl	Wetlands
Maianthemum stellatum	Imperiled	Palmer hillside, Matanuska Valley, Bluffs along the Glenn Highway	Moist woods, meadows, coastal thickets, sand dunes, marginal woodlands
Malaxis paludosa	Rare or uncommon	Anchorage Bowl	Muskeg or other wetlands, open sphagnum bogs, swampy woods
Potamogeton obtusifolius	Imperiled to rare or uncommon	Matanuska-Susitna Valley (Mud Lake and small unnamed pond near Palmer)	Shallow lakes. Growing with *Potamogeton gramineus* and *P. richardsonii* at 0.25 m depth.

Below is a list of considerations that the evaluator can use to help identify the wetland types or habitat features that are conducive to supporting populations of the species described above.

CRITERIA

1. Does the wetland provide habitat for the bird species listed in Table 1?
2. Does the wetland support habitat for plant or animal species determined to be a species of

interest (or concern or significance) by the U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration Fisheries, or ADF&G, as determined by agency consultation?

3. Does the wetland support habitat for a rare plant species listed in Table 2 (ranked and tracked by the Alaska Natural Heritage Program)?
4. Is the wetland adjacent to a mapped anadromous stream?
5. Does the wetland contain surface water during all or most of the migration period?
6. Other: record number and criteria

V10 - RECREATION (SERVICE)

This service considers the suitability of the wetland and associated watercourses to provide recreational opportunities including, but not limited to hiking, skiing, boating, canoeing, and bird watching. Other recreational activities could also occur.

Alaska residents value open space, including wetland areas, for recreational opportunities. Many of the recreational services in wetlands are associated with trail use. Many traditional trails provide for a wide range of functional and recreational activities, including dog mushing, snow machining, skiing, hiking, biking, and wood hauling. Important to this methodology, winter trails are often routed through open wetlands, where low-growing vegetation is covered in snow.

Another set of recreational services of wetlands are associated with lakes, rivers, and other watercourses using motorized and non-motorized forms of recreation. People skate on frozen lakes and use frozen rivers and creeks as snow machine and dog sled thoroughfares during the winter.

Wetlands are valuable for bird and other wildlife viewing. According to the USFWS (2003), 36% of all Alaskans participate in bird watching. Birding is also important to the State's economy; more than 40 percent of the total birders in Alaska come from elsewhere.

Below is a list of considerations that the evaluator can use to assess whether a wetland has the potential to have recreational services.

CRITERIA

1. Are there designated or undesignated trails in the wetland?
2. Is the wetland within or near an area managed by a lake management plan?
3. Does hiking, skiing, or snow shoeing occur within the wetland?
4. Does dog mushing or snow machining occur in the wetland?
5. Is there a boat launch ramp at or near this wetland area?
6. Is the wetland a short drive or walk from a populated area?
7. Is the wetland a known wildlife (including bird) viewing area?
8. Is the wetland part of a designated recreational area or state park?
9. Is off-road public parking available near this wetland?
10. Are there other recreational uses not listed above that occur in this wetland?
11. Is there trash, debris, and/or signs of disturbance due to recreational activities in or near the wetland?
12. Is the watercourse associated with this wetland wide and deep enough to accommodate boats and/or canoes?
13. Other: record number and criteria

★ V11 - UNIQUENESS/HERITAGE/CULTURE (SERVICE)

This service considers whether a wetland or its associated watercourse is culturally or historically important. Throughout their Alaska, native tribes have placed a great deal of service on their family ties and their ties to the land and water where their traditional resources originate. To this day, the physical and natural environment, including wetland areas, remain highly serviced to tribes. Wetlands are also important berry picking places for tribal members. Uniqueness considers the effectiveness of the wetland or its associated watercourse as a unique area. Uniqueness is defined as being "worthy of being considered in a class by itself, extraordinary." In the case of this methodology, a wetland is unique if it is different from other wetlands in the area. It can be different by providing biological, geological, or other features that are locally rare. It can be unique because it is performing a function that other nearby wetlands to do not perform.

Below is a list of considerations that the evaluator can use to assess whether a wetland has the potential to have a unique service.

CRITERIA

1. Does the wetland contain critical habitat for a state- or federally-listed threatened or endangered species?
2. Does the wetland have biological, geological, or other features that are locally rare or unique?
3. Is the wetland surrounded by uplands that are primarily developed?
4. Is the wetland surrounded by uplands that are developing rapidly?
5. Do resource agencies (USFWS, ADF&G, Corps, ect.) consider this wetland a unique area?
6. Do local area planning documents label the wetland area as unique?
7. Are rare plants or animals found in the wetland?
8. Are rare geologic or soil conditions found in the wetland?
9. Does this wetland perform a function(s) that is not occurring in other nearby wetlands?
10. Do tribal members have any special concern or interest in the wetland area?
11. Do the local tribes conduct personal use or subsistence- type activities in the wetland area?
12. Does the NRCS, Local Government Cultural Resources Coordinator have any special concern or interest in the wetland area?
13. Is there a historic trail in this wetland?
14. Is there evidence of previous development in the wetland?
15. Are there historic appearing buildings or sites in this wetland?
16. Other: record number and criteria

V12- VISUAL QUALITY/AESTHETICS (SERVICE)

This service considers the visual and aesthetic quality or usefulness of a wetland which can provide many valuable amenities such as scenic landscape, community identity, and open space, natural and the ability to retain the natural beauty of the land, minimizing light pollution, and noise pollution is a public priority

The beauty of natural areas, including wetlands, attracts visitors to the State.
Below is a list of considerations that the evaluator can use to assess whether a wetland has the potential to have visual quality or aesthetic services.

CRITERIA

1. Does the wetland fall within a community comprehensive plan jurisdiction where natural areas are serviced or protected for their visual qualities?
2. Is the wetland located near a scenic outlook or other roadside or trail pull-off where people may stop and view the area?
3. Is the wetland a popular place for people to stop and enjoy the view?
4. Is there trash, debris, and/or signs of disturbance due to people stopping to look at or beyond the wetland?
5. Is there a relatively unobstructed sight line through the wetland?
6. Is there a diversity of vegetative species visible from primary viewing locations near or at the wetland?
7. Is the wetland dominated by flowering plants or plants that turn vibrant colors in different seasons?
8. Is the land use surrounding the wetland undeveloped as seen from primary viewing locations?
9. Does the visible surrounding land use form a contrast with the wetland?
10. Does the wetland provide habitat for viewable wildlife?
11. Other: record number and criteria

***AFWA** Wetland Function-Service Evaluation form*

Wetland ID: | Location(gps/lat_long): | Evaluator: | Tract & Farm #:

Proposed Wetland Impact (type/acres): Circle if applies: AEW Other:

Adjacent land use: Distance to nearest roadway or other development (show on map):

Dominant Wetland Class (HGM): Cowardin Class: Viereck AK Class (if known):

Is the wetland a separate hydraulic system? If not, where does the wetland lie in the drainage basin?

How many tributaries contribute to the wetland? Wildlife Sign: (attach list for wildlife, plants, etc.)

FUNCTION & SERVICES	SYMBOL	Function		Rationale	Scores	
HYDROLOGICAL Total Score: 20		**Principle**	**Other**	**(criteria #)**	**Exisiting**	**Planned**
Groundwater Recharge/Discharge						
Streamflow Mod/Floodflow Alteration						
Sediment/Shoreline Stabilization						
BIOGEOCHEMICAL Total Score: 20						
Sediment/Toxicant Retention						
Nutrient Removal/Retention						
Nutrient/Foodchain Support						
HABITAT Total Score: 24						
Fish/Aquatic						
Wildlife Habitat						
SERVICES Total Score: 8						
Recreation						
Sensitive Species/Habitat						
Uniqueness/Heritage						
Visual Quality						
Other:						

Notes:

Note: Field forms will be available as individual files on the Alaska Share Point Site.

AFWA Summary of Scores Field form

	Existing	Planned
HYDROLOGICAL Max 20 Points		
Total Score from Principle Function (16)		
**Total Score from Other Function(s)(4)		
TOTAL		
BIOGEOCHEMICAL Max 20 Points		
Total Score from Principle Function (16)		
**Total Score from Other Function(s)(4)		
TOTAL		
HABITAT Max 24 Points		
Total Score from Principle Function (22)		
**Total Score from Other Function(s)(2)		
TOTAL		
***SERVICES Max 8 Points**		
*Give 2 points for each service **TOTAL**		

	Existing	Planned	MED CONSIDERED Yes or No
TOTAL FUNCTION & SERVICE SCORE			

**Give 2 points for each additional function

*Give 2 points for each service the wetland provides

	Total Points		
	Existing	**Planned**	**THRESHOLDS**
Cat I	58-72	< 58	NOT CONSIDERED A MED
Cat II	36 - 57	< 36	NOT CONSIDERED A MED BUT MITIGATION ALLOWED
Cat III	15 - 35	< 15	CONSIDERED A MED
Cat IV	<15	<15	CONSIDERED A MED

NOTES:

Note: The functional assessment is also used for creating, enhancing, and restoring wetlands.