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Yukon wetland classification standards

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Summary

The purpose of this document is to provide specific guidance for identifying and classifying wetlands of the Yukon using indicator criteria specific to the Yukon Territory. The aim is to describe the major wetland classes and their distinguishing characteristics in the Yukon. This technical document serves as a guide for practitioners adept at wetland field identification and mapping. It should be used to determine whether a site meets the criteria to be identified as a wetland and, if so, to assign one of the five appropriate wetland classes.

Note that non-technical users may wish to refer to the visual, plain-language Yukon Wetland Field Guide developed by Ducks Unlimited Canada (2024). It uses readily observable soil, water and vegetation characteristics to support wetland classification, and is aligned with these classification standards. While this document focuses on scientific technical information, the Yukon Wetland Field Guide offers cultural context and knowledge about wetlands, guidance on the Lands and Peoples Relationship Model for collaborative work, and a summary of wetland wildlife.

This technical document provides several classification tools:

1. First, a key is used to determine whether an area is a wetland.
2. Then, the two wetland groups, organic and mineral, are defined alongside a discussion of peat.
3. The wetland classification dichotomous key allows the user to work through observation to determine the type of wetland: bog, fen, marsh, swamp, or shallow water wetland.
   a. The key is supported by both a table and a narrative description of wetland types and forms, soils, vegetation, water and nutrient regimes, and the landscape setting.
   b. In addition, wetland types are overlain on an edatopic grid for visual reference and the appendices include a further description of gradients of the edatopic grid.
4. The appendices offer descriptions of the soil drainage classes, guidance regarding soil mottling characterization and the von Post scale of peat decomposition.
5. A Yukon-specific list of wetland indicator species including trees, shrubs, forbs, ferns and allies, mosses, liverworts and lichens is available. For the most up-to-date list, please contact the Fish and Wildlife Branch of the Government of Yukon at fish.wildlife@yukon.ca or 867-667-3645.

By offering clear criteria and tools, this document supports consistent and accurate identification and classification of wetlands in the Yukon and achieves implementation goal #2 of the Policy for the Stewardship of Yukon's Wetlands (2022).

Any classification represents one point in time. Wetlands are dynamic and change over time, as well as being affected by natural disturbances including flood, fire, drought and beaver activity. Human activities like development and resource extractions also affect wetlands. Climate change is a common

factor to many of these forces. For these reasons, and depending on the goals of the classification, reassessment of wetlands may be needed, as part of a flexible approach.

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1 Wetlands of the Yukon

Wetlands are an integral feature of First Nations' traditional territories and the Yukon's natural environment. Wetlands are landscape features that play an essential role in ecosystem function, support ecosystem 'services', benefit people and communities, are culturally important to Indigenous communities and provide high-value habitat for a diverse range of flora and fauna.

The Policy for the Stewardship of Yukon's Wetlands (Government of Yukon 2022) defines wetlands[1] as:

> *"… areas that typically have water at, or near, the ground surface during some or all of the year. These areas can be considered wetlands if the water is present long enough for poorly drained soils to form, and for water-loving plants to become the dominant type of plant in the area. There are five classes of wetlands: bogs, fens, marshes, swamps and shallow open water wetlands."*

Despite their ecological and social significance, the wetlands of the Yukon have not previously been classified or characterized at the territorial scale, especially in terms of distinguishing environmental and vegetation characteristics. This classification standard draws upon plot data stored in the Government of Yukon's Yukon Biophysical Inventory System and expert knowledge to offer specific guidance for wetland identification using Yukon-specific criteria. It provides in-depth descriptions of the five major wetland classes and their distinctive characteristics and establishes a robust framework for identifying, delineating and characterizing wetlands within the territory. This report is a technical document intended to set classification criteria and clarify wetland concepts in the Yukon. Please refer to the companion Yukon Wetland Field Guide (Ducks Unlimited Canada, 2024) for a plain-language guide to wetland classification, images of wetland indicator species and to learn about cultural and socio-economic contributions of wetlands to Indigenous peoples in the Yukon.

Wetlands occur in landscape positions where water accumulates or drains very slowly, and their size varies based on the surrounding terrain. In contrast, terrestrial ecosystems are characterized by lower soil moisture and a greater degree of soil aeration and are typically populated by plants adapted to drier conditions. Wetlands can exhibit various spatial patterns: they might be characterized by a predominant single wetland class or form a series of multiple wetland classes, occurring gradually or abruptly along a hydrological gradient. These latter wetlands are referred to as a wetland complex and can contain variations in vegetation and soil conditions. A wetland complex contains two or more functionally connected wetlands.

Wetlands are not restricted to depressional locations but exhibit a wide range of landscape patterns influenced by numerous biotic and abiotic factors. Biotic factors, such as beaver activity, impact hydrology and vegetation composition, while the presence of peat deposits fosters peat accumulation and influences paludification processes. Paludification, a biotic process, involves the transformation of vegetation and organic matter to peat in wetlands. Abiotic factors including topographic position, soil

[1] Definition modified from that in National Wetlands Working Group 1988, in Warner and Rubec (1997).

moisture, nutrient dynamics and precipitation patterns interact to shape wetland distribution and formation.

Permafrost is widespread in the Yukon, and is an additional influence on the distribution, form and appearance of wetlands. Permafrost also contributes to the formation of specific wetland features, including perched water tables, alpine wetlands in passes and plateaus, and wetlands on sloping surfaces. Additionally, permafrost plays a role in the initiation of paludification, where previously drier mineral soil habitats experience peat development due to a rise in the local water table.

Frozen soils with low ice content are not considered wetlands. However, areas with high-ice-content-permafrost close to the surface, where the excess ice volume exceeds the soil pore volume, often exhibit hydrologic conditions that support high moisture levels in the vegetation and soils and thus are generally classified as wetlands. The classification of an area as a wetland is not solely determined by the presence of high-ice-content-permafrost; it hinges on whether the surface conditions still satisfy wetland criteria.

Wet environments tend to be cooler than dry ones as more energy is required to warm water-saturated soil and to convert ice in frozen soil to water. The slow decomposition of plants in these cool, wet environments leads to peat accumulation and insulation of the underlying soil. Sphagnum moss further enhances this process by increasing soil acidity, reducing decomposition and promoting peat accumulation. This positive feedback mechanism contributes to the persistence of frozen soil in these environments.

Combined, biotic and abiotic factors create the diverse and dynamic wetland ecosystems found in the territory. Following an overview of the two wetland groups and the five classes, Section 2 provides keys and a summary table of featured characteristics and Section 3 provides detailed criteria for recognizing and classifying the five wetland classes within the Yukon using vegetation, soil and hydrological indicators.

1.1 Wetland groups

Wetlands can be subdivided into **two broad categories: organic wetlands (peatlands) and mineral wetlands**. Organic wetlands generally include bogs and fens, and mineral wetlands include swamps, marshes and shallow-water wetlands. Infrequently, a swamp or marsh may also be classified as an organic wetland. Before characterizing these two groups, a discussion of peat is warranted (see, for example, Rydin and Jeglum 2006).

Peat refers to organic material made up of dead, decomposing plant matter that has accumulated due to slow decomposition, which is a result of excessive moisture in the wetland environment. The texture of peat can vary, ranging from very fibrous and minimally decomposed to weakly fibrous, mushy and highly decomposed. Peat may also contain other substances such as mineral grains, and its definition can vary by jurisdiction based on the required organic component, typically ranging from 30% to 80% organic carbon.

The Canadian Soil Classification System (National Research Council of Canada 1998) uses the terms "O horizons" and "organic horizons" to describe peat. This includes the Of, Om, and Oh horizons, which are layers with a high (> 30%) organic matter content derived from various plant materials such as mosses, sedges, grasses, rushes, herbs and woody materials. These organic layers form in wetland environments. On the other hand, the L, F, and H organic horizons describe the organic component of upland soils. To assess the degree of decomposition in peat, the von Post scale is used, ranging from class 1 (undecomposed) to 10 (highly decomposed) (see Appendix 4). It is worth noting that a von Post value of 1 corresponds to living moss, which is not considered peat as it is not in a decomposed state.

1.1.1 Organic wetlands group (peatlands)

Organic wetlands are characterized by poorly to moderately decomposed peat, mostly composed of peat mosses, brown mosses or sedges, but can also include woody remains of shrubs or other plants. They form by two processes: terrestrialization and paludification. Terrestrialization involves the filling of a pond or lake with sediment and peat over an extended period. Paludification involves peat initialization on previously drier, inorganic soils.

In the Canadian Wetland Classification System (Warner and Rubec 1997), peatlands are defined as organic soil wetlands distinguished by an accumulation of over 40 centimetres of organic matter (peat) on the surface. This depth of peat accumulation is also a characteristic of organic wetland soils (excluding Folisols) or organic Cryosols, as defined in The Canadian System of Soil Classification developed by the National Research Council of Canada (1998).

Some Yukon wetlands display characteristics typical of bogs and fens (organic wetlands), even if their peat depths do not meet the 40-centimetre criterion of the Canadian Wetland Classification System. Formal recognition of the Yukon's shallow peat fens and bogs is required to prevent these wetlands from being misclassified as swamps. While wetland peat depth varies regionally, a minimum depth is needed for the sake of classification. Therefore, this Yukon wetland classification system specifies a **30-centimetre peat depth as the lower threshold** of peat accumulation for fens and bogs. In some other regions of the world, the minimum peat accumulation required is also 30 centimetres (Rydin and Jeglum 2006). In field measurements, it is important to recognize that peat depth can vary considerably even within short distances. For example, the peat depth beneath a sedge tussock on a hummock might exceed the depth in the hollows between tussocks by 20 centimetres or more.

1.1.2 Mineral wetlands

Mineral wetlands occur in areas with a significant accumulation of water on the surface or within the rooting zone of plants for a substantial part of the growing season. Influenced by factors such as geomorphology, hydrology, biotic interactions, soil properties (edaphic factors) and climate, these wetlands contain minimal organic matter or peat accumulation: less than 30 centimetres. The typical soils associated with mineral wetlands are Gleysols or Gleysolic Cryosols, or their peaty phases (Warner and Rubec 1997). The water regime in these wetlands is dynamic, often with fluctuating water tables and some can have water depths of up to 2 metres.

1.2 Introduction to wetland classes

Wetlands are divided into **five** distinct classes based on their properties, which reflect their formative origin and the characteristics of the wetland environment (Warner and Rubec 1997). These wetland classes provide a useful framework for understanding the processes and functions of wetlands.

The five wetland classes are **bog**, **fen**, **swamp**, **marsh** and **shallow water.** Bogs and fens are categorized as organic wetlands, while swamps, marshes and shallow water wetlands are generally considered mineral wetlands.

Bogs are characterized by the presence of fibric (derived from moss) peat with a depth of greater than 30 centimetres. Fens, however, can have peat types ranging from fibric to mesic sedge or moss peat.

Swamps typically have woody or mossy peat with a depth of less than 30 centimetres. An occasional exception is swamps with greater than 30 centimetres of peat (well-humified), which are considered organic wetlands. Marshes may contain up to 30 centimetres of sedge or limnic (lake sediment) peat. Shallow water wetlands usually have some amount of limnic peat (also called muck).

2 Wetland identification tools

Criteria used to identify wetlands can vary depending on their distinct characteristics. Some wetlands are easily recognizable due to the presence of surface water or obligate wetland species, while others may appear similar to surrounding upland areas, making their identification more challenging. The water table may be below the surface, making it less observable. This section provides reference tools to aid users in quickly identifying key characteristics of wetlands and wetland classes.

- **Table 1** "First pass" key to identifying wetlands based on features of the soil or vegetation that are indicative of wetland hydrology
- **Table 2** Summary of characteristics of wetland classes
- **Table 3** Key to wetland classes
- **Figure 1** Wetland edatopic grid

2.1 "First pass" key to identifying wetlands

Clear criteria are necessary to determine whether a site qualifies as a wetland. **Table 1** (following) should be used as an initial guide to evaluate **hydrology**, then **vegetation** and finally **soil features.** The key is adapted from Tiner (1993), where any **one** of the primary indicators can lead to classification as a wetland.

The following guidance will assist the user with applying **Table 1** to classify wetlands.

1. Wetlands often experience seasonal fluctuations in water tables, from early snowmelt to late summer, basing identification solely on a single observation of the water table can lead

to classification errors. If the water table level is uncertain from a single observation, continue stepwise through the table.

2. For vegetation criteria, consult the list of wetland indicator species available for the Yukon. A comprehensive list of wetland indicator species available from Government of Yukon, Department of Environment, Fish and Wildlife Branch at fish.wildlife@yukon.ca or 867-667-3645.
3. Vegetation cover is determined by evaluating the foliage cover of one or more species at the outer boundary of the plant's "drip line". It is important to note that the presence of overtopping species such as shrubs or trees does not affect the cover assessment of the understory species.
4. Soil depth measurements should be taken from several places and averaged to represent the overall site conditions. For example, peat depth measurements should be obtained from both hummocks and hollows and the area sampled should be representative of the wetland and capture the variation within the plot.
5. Wetland identification requires assessing a combination of hydrology, vegetation and soil features. However, there will be situations in which one or two of the elements cannot be directly observed.

Table 1 First pass key to wetland identification: sequential steps for identifying a site as a wetland using indicator criteria.

Indicator Group	Step	Indicator criteria to determine if it is a wetland	Yes	No, or not sure
Wetland Hydrology	1	Site with the water table at, near (within the rooting zone), or above the surface, but less than 2 m deep, that exists for a prolonged period during the growing season which is long enough to promote wetland processes.	Wetland	go to step 2
Wetland Vegetation	2	Obligate [1] (OBL) or facultative wetland [2] (FACW) vascular plant species > 50% of abundant vascular plant species [3]	Wetland	go to step 3
	3	OBL vascular plant species at least 10% areal cover in community	Wetland	go to step 4
	4	OBL + FACW species areal cover at least 25% and the remaining cover is predominately facultative species [4] (FAC)	Wetland	go to step 5
	5	Peat mosses or brown mosses dominate the ground cover (≥ 50% cover)	Wetland	go to step 6
	6	Algae encrust the surface	Wetland	go to step 7
Wetland Soil	7	Peat (organic soil) > 30 cm	Wetland	go to step 8
	8	Organic surface layer > 20 cm thick with permafrost within 50 cm [5]	Wetland	go to step 9
	9	Gleyed or mottled soils (prominent or distinct mottles) [see Appendix 5] within 30 cm of the soil surface OR directly below the surface organic or Ah horizon and within 45 cm of soil surface	Wetland	go to step 10
	10	Smell of hydrogen sulphide gas (rotten eggs) within 30 cm of the surface	Wetland	go to step 11

11	Sandy soils with a surface layer of peat or limnic peat (muck)	Wetland	go to step 12
12	Mudflat with gleyed soils	Wetland	go to step 13
13	Any unknown criteria (from above)	Unknown [6]	Upland

[1] Obligate wetland plant species: Almost always occur in wetlands (Lichvar et al. 2012).

[2] Facultative wetland plant species: Usually occur in wetlands but may occur in non-wetlands (Lichvar et al. 2012).

[3] Abundant plant species: 20% or more areal cover in plant community (Tiner 1993).

[4] Facultative plant species: plants occur in both wetlands and uplands.

[5] Depth at maximum seasonal thaw.

[6] Obtaining an unknown answer requires further investigation of more in-depth wetland indicators on site.

6. Some sites exhibit clear wetland characteristics, even if the vegetation does not meet the criteria outlined in **Table 2** (below). Examples include shallow water ponds or wet marshes with low vegetation cover that falls below the established thresholds. **In such cases, the presence of a persistent water table and specific soil properties can confirm the site as a wetland.**
7. In other instances, vegetation may not meet the wetland criteria due to a higher abundance of upland or facultative species. Various factors can contribute to this, such as drier microsites or a history of site disturbance that favours the establishment of upland plants. **In these cases, the soil features need to be evaluated to determine if the site is a wetland.** While vegetation is typically more visible and observable above ground, evaluating vegetation criteria requires knowledge of the species present, which can be challenging due to factors such as vegetation condition, seasonal variations, the assessor's expertise and taxonomic complexities associated with some vegetation.

2.2 Identifying wetland classes

Classifying wetlands helps to better understand their ecological functions, manage human activities effectively and guide land-use planning. To assist in this process, key characteristics of the five wetland classes are summarized in **Table 2**, and **Table 3** provides a dichotomous key to determining the wetland class. This dichotomous key guides practitioners through a systematic process of elimination based on specific wetland features. It is advisable to consult **Table 2** to confirm the classification, and to review the detailed description of each class in Section 3 (Characteristics of Yukon wetland classes) in order to thoroughly understand the features of each wetland class and apply this understanding to identification using the wetland key (**Table 3**).

When using the **Table 3** key, start at the first pair of contrasting statements (1a and 1b) and choose the one that best describes the wetland. This decision will either lead to a classification or direct you to another set of statements for further clarification. For example, the average peat depth is a starting point: if peat is 30 centimetres or thicker, the key directs you towards organic wetlands, while shallower peat leads to mineral wetlands. Follow each step carefully, noting the characteristics such as peat decomposition, pH levels, water presence and dominant vegetation. The key includes conditions for bogs, collapse scar bogs, fens, swamps, marshes and shallow water wetlands, ensuring a comprehensive classification approach.

Table 2 Summary of characteristics of wetland classes.

Class	Types and Forms	Soil	Vegetation	Water Regime	Nutrient Regime	Landscape Setting
Bog [B]	**Types** Treed [T] Shrubby [S] Open [O] **Forms** Coniferous [C]	• *Poorly decomposed** organic soil (peat) ≥ 30 cm • Near-surface (30 to 60 cm) permafrost usually present *Von Post < 5	• Plants in bogs are adapted to low nutrients and high acidity • Characterized by a groundcover of *Sphagnum* (peat) mosses or lichen and stunted *Picea mariana* (occasionally *Picea glauca*), *Betula glandulosa* and ericaceous shrubs such as *Rhododendron groenlandicum* and *Vaccinium vitis-idaea*; *Rubus chamaemorus* is common • Plant diversity is relatively low	• Water inputs primarily from precipitation • Relatively stable water table usually within 30 cm of the ground surface • Stagnant to very slow water flow	• Acidic (pH typically less than < 5) (limited data) • Poor	• Elevated (or domed) above the surrounding terrain due to peat accumulation or permafrost formation • Generally found on flat to gentle slopes • May occur on some very steep cold aspect slopes • Commonly referred to as muskeg
Fen [F]	**Types** Treed [T] Shrubby [S] Graminoid [G] Mossy [M] **Forms** Coniferous [C]	• *Poorly to moderately decomposed** organic soil (moss and sedge peat) ≥ 30 cm • Permafrost often present *Von Post ≥ 4	• Characterized by diverse graminoid species including sedges and *Eriophorum* as well as *Sphagnum* and brown mosses • *Menyanthes trifoliata* or *Maianthemum trifolium* (in SE YK) are indicators when present • Shrubs (0.5 to 2 m) such as *Betula glandulosa*, *Salix* spp. or *Chamaedaphne calyculata* are typical of drier fens often with sparse to open stunted *Picea* spp. (and sometimes *Larix laricina*) on hummocks of the driest fens	• Variety of water inputs (precipitation, • surface water, groundwater) • Consistently high (near-surface) water table • Slow-moving flow, including both surface and subsurface water movement (when wet, significant flow is possible)	• Varying pH (> 5) • Nutrient status ranges from Poor to Rich	• Gently sloping to level landscape positions, often integrated into larger wetland complexes • Hummocky microtopography caused by moss and sedge tussocks creates microhabitats • Commonly referred to as muskeg

Class	Types and Forms	Soil	Vegetation	Water Regime	Nutrient Regime	Landscape Setting
Swamp [S]	Types Treed [T] Shrubby [S] Forms Coniferous [C] Mixedwood [M] Deciduous [D]	• Mineral soils (clay, silt or sand) within 30 cm of surface or occasionally with organic soils with *highly decomposed** peat • Mineral soils are wet (Hydric to Subhydric), with indicators such as mottling and gleying and often a mossy and woody peaty surface horizon < 20 to 30 cm • When peat > 30 cm it will be highly decomposed (organic wetland) • Permafrost may be present *Von Post > 5	• Diverse systems characterized by either *Picea*, *Larix laricina*, *Betula* spp., and *Populus balsamifera*, or tall or medium shrubs such as *Alnus* spp. and *Salix* spp. • Understory cover typically forbs, grasses and bryophytes (that is, mosses and liverworts) • Tree species ≥ 10% or shrubs ≥ 20% cover	• Variety of water inputs (precipitation, surface water or groundwater) • Water table fluctuates within the rooting zone of plants • Fluctuating water levels often cause seasonal flooding • Slow moving flow including both surface and subsurface water movement: however, when wet, significant flow is possible	• Nutrient regime variable; reflects nutrients in mineral-enriched water	• Variable; common in floodplains or other transitions between creeks, rivers, lakes and uplands; toe and lower slopes; margins of peatlands; and perched water tables over permafrost • Swamps may exhibit hummocky microtopography with water pooling in depressions in springtime • Located in transition to uplands and floodplains • Swamps adjacent to rivers and lakes are often referred to as riparian areas

Class	Types and Forms	Soil	Vegetation	Water Regime	Nutrient Regime	Landscape Setting
Marsh [M]	Types Graminoid [G] Forms N/A	• Mineral soils (clay, silt, sand) within 30 cm of surface • Mineral soils are wet (Subhydric to Hydric), with indicators such as mottling and gleying • If peat is present, it is usually < 30 cm and *moderately to highly decomposed*	• Characterized by water tolerant, often emergent graminoid species such as sedges, grasses, reeds, rushes and forbs including *Equisetum* spp. • ≥ 25% emergent species, tree species < 10% and shrubs < 25%	• Variety of water inputs (precipitation, surface water, groundwater) • Fluctuating water levels frequently cause seasonal flooding • Usually, no permafrost due to dynamic subsurface water flow	• Rich	• Marshes are adjacent to rivers and streams, often found at lake shorelines and as transition zones to shallow open water bodies
Shallow Water [W]	Types Aquatic [Aq] Open Water [O] Forms N/A	• Soils are wet (Hydric to Aquatic), usually under water, with clear gley indicators • In dry regions, shallow water may dry up exposing mudflats • Soils usually have limnic sedimentary peat • In northern wetland complexes, drained ponds sequence from shallow water to marsh to swamp to bog	• Characterized by submersed or floating aquatic vegetation in open water • < 25% emergent or woody species • Common plants are *Potamogeton* spp., *Ceratophyllum demersum*, *Nuphar* spp., *Myriophyllum* spp., *Hippuris* spp., *Utricularia* spp., *Chara* spp., water moss or macroalgae	• Open water less than 2 m deep • May be shallower parts of deep-water lakes • Dynamic systems often with seasonally fluctuating water levels • Includes some shallow water which may dry up periodically leaving exposed mud during drawdown	• Usually Rich • May include some more acidic organic wetland ponds	• Found in landscape depressions, commonly referred to as ponds and sloughs • May also be found within bog, fen, marsh or swamp complexes

Table 3 Wetland classification key.

#		Observation or measurement	Instruction or class
1		*Assess average peat depth**	
	1a	Average peat depth > 30 cm	go to 2
	1b	Average peat depth < 30 cm	go to 4
2		*Organic wetlands (Ombotrophic peatlands)*	
	2a	Peat poorly decomposed (Of horizon; von Post < 5**); site raised above water table; pH < 5; vegetation ground cover dominated by peat mosses (sometimes lichens) typically with stunted Black Spruce; other woody species are also common; the peat surface is usually dry; permafrost close to the surface	Bog
	2b	Peat poorly decomposed; pH 4 to 5; water at the surface; surrounded by dry permafrost bog (collapse scar bog)	Bog
	2c	Not as above	go to 3
3		*Organic wetlands (Minerotrophic peatlands)*	
	3a	Peat poorly to moderately decomposed (Of or Om horizon; von Post ≥ 4); site influenced by slow-moving to sluggish subsurface water; pH variable, usually > 5; ground vegetation dominated by sedges (≥ 10%) and brown mosses or peat mosses; shrubs and trees are present on drier fens; permafrost is common	Fen
	3b	Peat well decomposed (Om or Oh; von Post > 5), may be mossy or woody; site influenced by mineral-enriched seepage; site characterized by fluctuating water table; vegetation dominated by woody species (trees > 10% cover or shrubs > 20% cover); peat mosses, if present, are those of Rich sites; brown mosses may occur	Swamp
4		*Mineral wetlands*	
	4a	Very Moist to Very Wet sites, prominent to distinct mottling or gleyed soil, within 30 cm of the surface surface or meets other criteria in Table 1 (see sections 9-12); soils Cryosols or Gleysols	go to 5
	4b	Soil moisture is Moist or drier; variable soil classifications	Non-wetland
5		*Vegetation – woody species*	
	5a	Vegetation characterized by woody species (trees ≥ 10% cover or shrubs ≥ 20% cover	Swamp
	5b	Not as above	go to 6
6		*Vegetation – non-woody species*	
	6a	Vegetation characterized by ≥ 25% sedges, grasses or emergent forbs; trees < 10% cover; shrubs < 20% cover	Marsh
	6b	Not as above	go to 7
7		*Vegetation – aquatics*	
	7a	Vegetation primarily floating or submersed aquatic plants, algae or aquatic mosses; emergent or woody species < 25% cover; water table persistent above surface and up to 2 m deep (includes shallow water margins of deeper water bodies)	Shallow water wetland
	7b	Mudflats with < 25% emergent plants and characterized by seasonal or periodic water < 2 m in depth	Shallow water wetland
	7c	Water > 2 m deep	Deep water (lake or pond)

* Average peat depth: average several to many peat depth measurements, including the range of microsite conditions, for example, hollows, hummocks and tussocks. Weight towards predominant microsite condition.

** Evaluate von Post in the middle of the dominant surface peat layer (see Appendix 4).

2.3 Understanding wetland classes using an edatopic grid

An edatopic grid is a two-dimensional representation of soil moisture and soil nutrient regimes used for describing terrestrial ecosystems—with an addition to include wetlands by incorporating an acidity (pH) scale and a hydrodynamic index (degree of water movement and fluctuation through the growing season). The five wetland classes of bog, fen, swamp, marsh and shallow water are shown in an edatopic grid in **Figure 1**. The grid visually represents wetland classes based on their characteristics using these gradients. Definitions for these gradients' categories are in Appendix 1 and summarized below.

The x-axis represents the soil nutrient regime (SNR), which considers the essential soil nutrients available to vascular plants (Pojar et al. 1987). It indicates, in a relative way, the soil's ability to supply the major nutrients required for plant growth over a period of several years. It includes six classes that range from Very Poor (A) to Saline (F). Many factors can influence the ability of the soil to store nutrients, including soil depth, texture and coarse fragment content, seepage water, humus form and geological source of the parent material. Wetlands can occur throughout the range of soil nutrient regimes.

On the y-axis, are the actual and relative soil moisture regimes (SMR). The actual soil moisture regime (ASMR), shown in a bar on the right-hand side of the grid, refers to the average amount of soil water available for evapotranspiration by vascular plants over several years—it is a measure of the moisture regime of a site using a more quantitative, water balance approach (Klinka et al. 1989). ASMR represents the amount of soil water annually available over several years, which considers the supply and utilization of soil water and, for wetter sites, the depth of the water table. There are nine actual soil moisture categories from Very Dry to Very Wet. Wetlands are found on Wet to Very Wet sites and sometimes on Very Moist sites. The wetland edatopic grid is therefore limited to this range. Non-wetland ecosystems are also found on Very Moist sites. Relative soil moisture regime (RSMR), shown on the left side of the y-axis, refers to the relative amount of soil moisture available for plant growth in a specific location and can be determined from slope position and gradient, soil depth and texture, coarse fragment content, aspect, and sources of seepage. There are ten classes, ranging from driest (Very Xeric or 0) to wettest (Aquatic or 9). Wetlands are found on relative soil moisture classes 6 to 9.

The diagonal gradient from upper left to lower right represents the pH scale. Five categories are recognized from very acid to alkaline. This is primarily important for peatlands and less important for hydrologically dynamic systems. Generally, as acidity increases, available base cations decrease, resulting in reduced site productivity.

The diagonal gradient from lower left to upper right represents the hydrodynamic index, which has five categories that describe the magnitude of vertical and lateral water movements in the soil on wet and very wet sites from stagnant to very dynamic.

Importantly, the edatopic grid provides a qualitative representation of the classes relative to the gradients, without overlap. In cases where classes may occur under the same soil and nutrient conditions, their distribution on the grid is shown by the sharing of grid cells. The wetlands sharing a cell occupy the entire set of SMR/SNR/pH/hydrodynamic conditions represented by the cell.

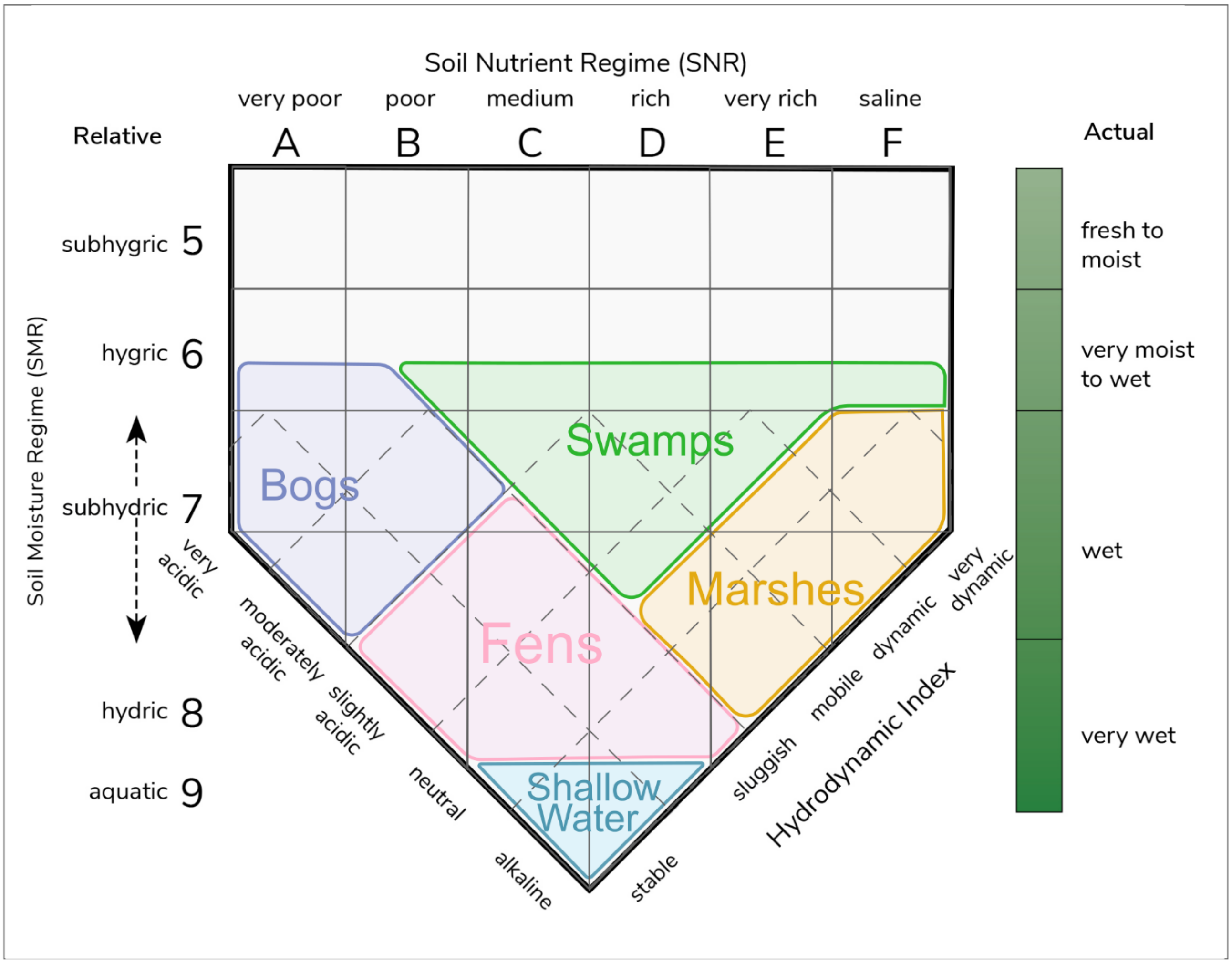

Figure 1 Distribution of wetland classes based on acidity, hydrodynamics, soil nutrients and soil moisture using an edatopic grid.

2.4 Considerations for wetland identification

While many wetlands are straightforward to identify as a wetland and classify into a specific class, it is important to consider the dynamic nature of wetland environments. Wetlands can undergo transitions between classes, exhibit hydrological gradients, or experience disturbances such as fires or thawing permafrost. Additionally, it is important to note that the tools provided address most situations, but exceptions are a possibility. Factors like forest regeneration, wildfires, severe drought, cultivation, changes in water flow or other disturbances can influence wetland classification.

When identifying a wetland, it is recommended to consider your location within the wetland and the potential existence of multiple wetland classes along a moisture gradient. Select representative and uniform vegetation zones within which to conduct the identification process. **If the area appears to hold more than one class of wetland, ensure you sample each representative vegetation type.** Additionally, when measuring the depth of organic materials or the active layer thickness in cold and permafrost environments, it is crucial to consider that the active layer thickness reaches its maximum depth at the end of the thaw season. Thaw season typically occurs between August to October in most of the Yukon: soils sampled in June or early July may contain seasonal frost which can limit the accuracy of measurements.

Wetlands can develop on reclaimed areas if the hydrology is no longer actively manipulated. In these cases, the keys, tables and descriptions in this document can be used to determine the wetland class.

3 Characteristics of Yukon wetland classes

This section describes characteristics of the wetland classes found in the Yukon and will facilitate the application of previously introduced tools and criteria for identifying a wetland's class. Focusing on the primary classes—bog, fen, swamp, marsh and shallow water—each description highlights key aspects such as hydrological regimes, terrain and soil profiles, vegetation conditions, and the influences of natural disturbances.

3.1 Bog class

Bogs are characterized as nutrient-poor organic wetlands with a rooting zone typically isolated above the mineral-enriched groundwater and surrounding wetlands. Bogs in the Yukon are usually frozen (that is, have permafrost) and can have treed, shrubby or moss-dominated vegetation, with the moss layer primarily composed of peat moss. Bogs are mainly found in level to gently sloping landscapes and occasionally on steep cold north slopes, where conditions allow for peat accumulation or permafrost formation. The water regime of bogs is primarily precipitation-based, as the surface peat is above the water table. The capillary action of the peat moss can draw moisture from water sitting on the permafrost table. Water movement is stagnant or moving very gradually and the soil drainage is poor to very poor. The soil moisture regime is Hygric or Subhydric and the soil nutrient regime is Very Poor to Poor. Bogs are sensitive to fire disturbances, which can result in the thawing of permafrost and subsequent collapse of the ground surface.

3.1.1 Hydrology and water regime of bogs

Water regime

- Water enters primarily as precipitation (ombrotrophic) as surface peat is above the water table, however, the surface also receives moisture from the permafrost table due to the capillary action of the peat moss.
- The surface may be dry.

Water movement and fluctuation

- Water is stagnant or moving very gradually (sluggishly).
- Very minor vertical fluctuation of the water table occurs during the growing season.
- Soil drainage is poor to very poor (see Appendix 3).

Soil moisture regime (SMR)

- The actual soil moisture regime is Very Moist to Wet.
- The relative soil moisture regime is Hygric (6) to Subhydric (7).

Soil nutrient regime, pH and electrical conductivity

- Surface water is low in dissolved minerals.
- Soil water pH is usually between 4 and 5 (very acidic to moderately acidic).
- Bog water acidity is enhanced by organic acids formed during peat decomposition and from acids present within the peat moss.
- The soil nutrient regime is Very Poor or Poor.

3.1.2 Terrain and soils of bogs

Landscape position

- Bogs occur most commonly on level to gently sloping landscapes, where peat accumulation or permafrost formation has raised the surface peat above the water table.
- Can occur with shallower peat where the groundwater is closer to the surface, but water is very low in dissolved minerals and nutrients.
- Bogs also occasionally occur on moderate to steep north-facing slopes particularly in the central and northern Yukon.

Mottling, gleying of mineral soil, depth

- Mineral soils below peat are generally frozen.

Peat depth, decomposition and role of peat

- Peat is greater or equal to 30 centimetres thick. The lower depth of peat is often difficult to determine due to permafrost.
- "Surface" peat is poorly decomposed (von Post < 5) and primarily derived from peat moss; sedge peat may occur below the surface peat or in small pockets in the bog (see Appendix 4 for von Post scale of decomposition).
- Capillary action in living and dead peat moss provides moisture to surface peat, but the peat surface can dry out and is sometimes dominated by feathermosses or lichens.
- Peat mosses acidify their environment through production of organic (humic) acids during decomposition and absorption of cations in exchange for anions. This acidic substrate in turn slows decomposition, which promotes peat accumulation.

Permafrost

- Permafrost is generally present due to thick peat isolating the surface above the water table; moist peat allows cooling during cold fall and winter temperatures but dry peat at the surface insulates the frozen peat as temperatures warm in the spring and summer. Note that 88% of northern peatlands contain permafrost, including almost all bogs (Tarnocai et al. 2011).
- Permafrost is usually present within 35 to 60 centimetres below the surface.
- Because of the high ice content of permafrost underlying bogs, the peat surface can be 1 metre or more above the surrounding landscape. This contributes to the domed or raised appearance of these wetlands, resulting in isolation from groundwater or surface water inputs.
- Disturbances to bogs may cause thawing of permafrost and collapse of the ground surface.
- In the southern Yukon, peatlands and wetlands with peaty surface horizons are some of the only areas with near-surface permafrost. Moving further north, the prevalence of permafrost increases.

Soil classification

- Soils are mostly Organic Cryosols and sometimes Fibrisols.

3.1.3 Vegetation of bogs

Structural layers

- Mostly treed or shrubby physiognomy but may include peat moss-dominated open bogs.
    - Treed bogs have trees with a cover ≥ 10%.
    - Shrub bogs have trees < 10%, with a shrub cover ≥ 20%.
    - Open bogs (trees < 10%, shrubs < 20%) generally lack trees and shrubs.
- Physiognomic types are treed bog, shrubby bog and open bog.

Composition

- Bogs are often treed. Stands are mostly open, and trees are often low in stature (< 10 m) with a sparse to well-developed shrub layer, generally dominated by *Rhododendron groenlandicum*. Peat mosses characterize the moss layer.
    - Trees are mostly *Picea mariana*, occasionally *Picea glauca*, or mixed. Some bogs in the southeast Yukon and the Peel River drainage contain *Larix laricina*.
    - Common shrubs in bogs are *Rhododendron groenlandicum*, *Rhododendron tomentosum*, *Betula glandulosa* and *Vaccinium uliginosum*.
    - Dwarf shrubs are common, including *Vaccinium microcarpum*, *Vaccinium vitis-idaea* and *Empetrum nigrum*.
    - Peat mosses usually dominate the mosses, although on bogs where the peat surface dries out, lichens or feathermosses can dominate.
        - *Sphagnum fuscum* is the most common and abundant peat moss; other common peat mosses include *S. angustifolium*, *S. capillifolium* and *S. devienum*.
        - In the northern Yukon, lichen on top of *Sphagnum* peat dominates a lot of bogs.
- The forbs *Rubus chamaemorus* or *Drosera rotundifolia* often occur.
- Sedges often occur, but do not dominate.

3.1.4 Special notes and exceptions for bogs

- When bogs occur in the Southern Lakes subzone of the Boreal Low bioclimate zone (BOLsl), they usually have a higher pH due to calcareous parent materials in the area.
- Permafrost in the southern Yukon is close to 0°C and is therefore particularly sensitive to increased mean annual temperatures due to climate change, or disturbance to the insulating peat.
- Bogs can transform into collapse scar bogs as a result of permafrost thawing, which causes ground subsidence and creates depressions that collect water. Collapse scar bogs are isolated from regional water inputs and are extremely wet.
- Forest fires in bogs can initiate thermokarst especially where ground ice temperatures are close to 0°C. This can lead to the formation of fens due to the subsidence of the bog surface. Post-fire, the active layer often thickens, ponding may occur and changes in species composition are observed. For example, *Betula neoalaskana*, shrub and feathermoss cover typically increase.
- Permafrost can significantly influence the physical appearance and characteristics of bogs, giving rise to various distinct forms as detailed in Warner and Rubec (1997).

3.2 Fen class

Fens are organic wetlands with rooting zones that are influenced by mineral-enriched groundwater. With a ground cover dominated by sedges and brown mosses, fens can have treed, shrubby, sedge-dominated or moss-dominated vegetation structure. The water table movement in fens is typically stagnant or very gradually fluctuating and soil drainage is poor to very poor. Fens are generally very wet: the wettest fens are dominated by sedges or mosses and the driest fens are treed. Fens occur in groundwater-fed basins, on gently sloping seepage slopes with perched water tables over permafrost, or lake or pond margins where there is very limited wave action or drawdown over the growing season. Mineral soils may be present below the peat and if observed, they are typically gleyed or strongly mottled and may contain permafrost. Fire disturbances can affect fens by altering species composition and increasing the depth of the active layer, changing moisture conditions.

3.2.1 Hydrology and water regime of fens

Water regime

- Water in fens is primarily mineral-enriched groundwater (minerotrophic).

Water movement and fluctuation

- Water table movement in fens is stagnant or moving very gradually to gradually (sluggish) in groundwater and surface flow.
- While the water table may fluctuate, saturated soil conditions are maintained during the growing season.
- Surface flow may be directed in channels or pools creating characteristic patterns.
- Soil drainage is poor to very poor.

Soil moisture regime (SMR)

- The actual soil moisture regime is Wet to Very Wet.
- The relative soil moisture regime is Subhydric (7) to Hydric (8).

Soil nutrient regime, pH and electrical conductivity

- The nutrient regime is Minerotrophic (rich in dissolved minerals).
- The relative soil nutrient regime is Poor to Rich (B to D).
- The pH ranges from slightly acidic to alkaline with a range of 5 (poor fen) to 7.5 or higher (rich fen).
    - In fens, soil pH varies with the microtopography: the drier surface tends to be more acidic while moister lower parts with many roots have a more neutral pH.
- Electrical conductivity is low.

3.2.2 Terrain and soils of fens

Landscape position

- Fens occur in groundwater-fed basins, gently sloping seepage slopes with perched water tables over permafrost, or lake or pond margins where there is very limited wave action or drawdown over the growing season.

Mottling, gleying of mineral soil and soil depth

- Mineral soils occur below peat and if observed (i.e. peat is not too deep), they are gleyed or strongly mottled, and may be frozen (that is, contain permafrost).

Peat depth, decomposition and role of peat

Peat is ≥ 30 cm deep and often more.

- Peat is poorly to moderately decomposed (von Post ≤ 4; Of or Om horizons) and is derived from sedges and brown or peat mosses (see Appendix 4).
- Stratified peat, from well to poorly decomposed, sometimes indicates wetland development from shallow water to marsh to fen.

Permafrost

- Permafrost is often present, particularly at higher elevations in the central and northern Yukon, and in subarctic and arctic regions.
- If present, it is usually found within 25 to 60 centimetres of the surface but sometimes deeper.

Soil classification

- Mostly Fibrisols, Mesisols, or Organic Cryosols, but Turbic Cryosols, Static Cryosols and Humisols also occur.

3.2.3 Vegetation of fens

Structural layers

- Treed, shrubby, graminoid or mossy physiognomy:
  - Treed fens have tree species with a cover ≥ 10%.
  - Shrub fens have tree species < 10% cover and a shrub cover ≥ 20%.
  - Graminoid fens have trees < 10% cover, shrubs < 20% cover and are typically dominated by sedges or cottongrasses with brown or peat mosses.
  - Mossy fens have < 10% trees, < 20% shrubs and < 10% graminoids, and are moss-dominated.
- Physiognomic types are treed fen, shrubby fen, graminoid fen and mossy fen.
- The driest fens are treed, whereas the wettest fens are graminoid or mossy; shrub fens are intermediate.

Composition

- Fens are usually dominated by *Carex* or *Eriophorum* spp. groundcover with brown and peat mosses; they may be treed, shrubby graminoid, or mossy.
- *Picea mariana* is the main tree species in treed fens, often occurring with *Betula glandulosa*, *Salix* spp., *Rhododendron groenlandicum* and sedges, and generally with either *Carex aquatilis*, *Carex bigelowii* ssp. *lugens* or *Eriophorum* spp.
  - *Larix laricina* and *Picea glauca* are associated trees in some areas.
- Shrub fens are dominated by *Salix* spp., *Betula glandulosa*, *Myrica gale* or *Chamaedaphne calyculata*.
- Graminoid fens are dominated by *Carex* spp. or *Eriophorum* spp.:
  - Sedges can include *Carex alascanana*, *Carex aquatilis*, *C. bigelowii* ssp. *lugens*, *C. canescens*, *C. diandra*, *C. limosa*, *C. livida*, *C. magellanica*, *C. utriculata* or *C. saxatilis*.
  - Cottongrasses include *Eriophorum chamissonis*, *E. angustofolium* or *E. scheuchzeri*.
  - *Trichophorum* spp. or *Equisetum fluviatile* may dominate some fens.
- Brown mosses, of the genera *Tomentypnum*, *Aulacomium*, *Campylium*, *Drepanocladus*, *Scorpidium* and *Warnstorfia* dominate the mosses, although *Sphagnum* (peat) mosses can be abundant in some fens.

3.2.4 Special notes and exceptions for fens

- *Sphagnum* (peat) mosses indicating richer nutrient conditions can dominate the moss layer of some fens; however, the existing plot data does not have the level of detail to list these species.
- Fires can affect fens in different ways.
  - Very wet fens or seasonally wet fens may not be greatly affected.
  - Fire may increase the active layer depth creating drier conditions. However, if ponding occurs above the permafrost table, the fen could get wetter.
  - Fire may change the species composition; *Betula neoalaskana* and shrubs typically increase, and moss species may change.
  - Fire may also increase mineral-rich nutrients received from adjacent uplands.
- Fens with permafrost can be described as lowland polygon fens, patterned fens, sloping permafrost tussock fens, collapse scar fens, spring fens, or snowpatch fens (see Warner and Rubec 1997).
- Collapse scar fens can develop where depressions due to permafrost thaw become connected to local water flow.

3.3 Swamp class

Swamps are minerotrophic wetlands that are treed or shrub-dominated and influenced by mineral-rich groundwater. They are typically found on mineral soil but may also occur on well-decomposed organic soils. The nutrient regime in swamps can vary, but they are generally richer than the surrounding ecosystems due to their access to mineral-rich groundwater, seepage or flood waters. Swamps are common along smaller creeks, on floodplains of larger rivers, at the base of slopes, along the margins of peatlands and other wetlands, and associated with perched water tables over permafrost. Swamps receive water from various sources such as runoff, groundwater and flooding. Soil water movement is characterized by fluctuating water tables and seasonal flooding, ranging from slow-moving to dynamic. Swamps occur in various terrain including lowlands, valleys and the base of slopes. Fire disturbance can affect swamps by increasing the active layer depth, drying out the ground surface and creating site conditions favourable for species adapted to drier conditions.

3.3.1 Hydrology and water regime of swamps

Water regime

- Runoff, groundwater, seepage, stream sub-irrigation or flooding are the main water sources for swamps. These sources provide extra nutrients to plants in addition to what they receive from precipitation.

Water movement and fluctuation

- Swamps usually have a fluctuating water table, varying from mobile to very dynamic.
- The water table is generally below the ground surface but within 45 centimetres of the surface for long enough during the growing season to promote wetland conditions and influence plant growth.
  - Water levels may fluctuate daily, throughout the growing season, as well as annually.
  - May be subject to snowmelt or ice jam flooding.
  - May be subject to aufeis formation.
- Permafrost may control water movement.

- Swamps can exist at the interface of uplands and peatlands forming peat margin or lagg swamps[2].
- Hydrological features can include water at the surface, signs of flooding or fluctuating water levels: located on floodplain according to a surficial geology map, traces of silt on tree trunks or on the soil surface and buried organic layers or damage to trees from logs and ice blocks.
- Soil drainage is usually poor but sometimes imperfect.

Soil moisture regime (SMR)

- The actual soil moisture regime is Very Moist to Wet.
- The relative soil moisture regime is Hygric (6) to Subhydric (7).

Soil nutrient regime, pH and electrical conductivity

- Swamps are minerotrophic wetlands.
- Nutrient richness varies but tends to be richer than the surrounding ecosystems as swamps are usually fed by mineral rich groundwater, seepage or flood waters.
- Water pH can vary significantly depending on the source of water from acidic (5) to alkaline (calcareous) (8), but it is usually close to neutral (7) near the water table.
- Most have a Medium to Rich soil nutrient regime (C or D) but may be Very Rich (E) or Poor (B).
- Soils at the surface of some peaty swamps or on hummocks may be fairly acidic and support more acid-loving plant species (for example, ericaceous shrubs).

3.3.2 Terrain and soils of swamps

Landscape position

- Swamps are commonly found along smaller creeks, on floodplains of larger rivers, at the base of slopes (on lower slopes and toe slopes), along the margins of peatlands and other wetlands and in draws on slopes characterized by subsurface groundwater flow.

Mottling, gleying of mineral soil and depth

- Mineral soil shows prominent to distinct mottling and gleying, indicating fluctuating water tables within 30 centimetres of the soil surface or immediately below the organic and organic-enriched horizons within 45 centimetres of the surface. These features indicate a zone of saturation during the growing season.
  - Note that these soil indicators can be less obvious in darker and sandier soils.
  - Soils meet the soil wetland criteria (see Section 2).

Peat depth, decomposition and role of peat

- Peat may or may not be present in swamps.
- Peat, when present, is usually shallower than 30 centimetres, however some sites have thicker peat. and when peat is > 30 centimetres in a swamp, it is considered an organic wetland.
  - Peat is generally composed of mossy or woody debris.
  - Swamps on mineral soils can accumulate peat by the paludification process.
  - Swamps on organic soils have developed by a basin-filling process by paludification of previously drier mineral soils or by drainage changes in peatlands.

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[2] Lagg swamps occur in the zone between upland mineral terrain and a peatland (swamp, fen or bog). The lagg swamp is a wetland distinctly enriched by runoff from the upland. Surface water movement is parallel to the upland. (Warner and Rubec 1997)

    - When swamps are on organic soils, they are classified as Mesisols or Humisols and are often rich in woody peat, at least in the surface layers.
- Peat, when present, is generally drier than in fens and is often well-to moderately well-decomposed (von Post > 5; see Appendix 4).

Permafrost

- Permafrost is widespread and occurs in many swamps.
    - In the southern Yukon, many swamps at lower elevations do not have permafrost, as sub-irrigation water keeps the soils warmer.
    - In the central and northern Yukon and at higher elevations, permafrost swamps are very common.
- Thick organic layers insulate the underlying soil during warmer summers creating conditions favourable for permafrost development.
- Permafrost restricts infiltration of precipitation and seepage such that groundwater flow occurs beneath and on top of the permafrost. As a result, many slopes are wetter in a permafrost environment than they would be where permafrost is absent.
- The frost table is frequently close to mineral contact.
- In permafrost areas, there is usually a quicker response to snowmelt and precipitation events.
- Slopes and streams may be impacted by water flow perched on top of permafrost creating surface seepage and aufeis:
    - Aufeis frequently forms along creeks or at the base of slopes in permafrost areas when upslope or upstream water is forced to the surface during freezing of the active layer.
    - Aufeis may persist into the summer along creeks, leaving broad gravel flats or wet seepage zones once it melts.
    - Aufeis may cause issues with culverts or construction on permafrost slopes.
- Hummocky surfaces may be a result of flooding and differential erosion, tussocky vegetation or cryoturbation.
    - Hummocky surfaces create microhabitats which help increase species diversity.
- Large cracks at the soil surface may indicate irregular ground subsidence or release of soil pressure due to slope instability.
- Disturbance of the ground surface in permafrost areas often leads to permafrost thawing and soil collapse, slumping or erosion and changes to drainage patterns.

Soil classification

- Soils are usually Cryosols, Gleysols or Organic; however, Gleyed subgroups of Regosols, Brunisols or other soil orders also occur in swamps.

3.3.3 Vegetation of swamps

Structural layers

- Swamps are tree- or shrub-dominated wetlands.
- In the Yukon, treed swamps have tree cover ≥ 10% and usually a moderate to high cover of shrubs; there may be a high cover of brown, peat or feathermosses.
- Shrub swamps have < 10% tree cover and ≥ 20% shrub cover.
    - In the Yukon, some shrub swamps are dominated by tall shrubs (> 2 metres with a diameter at breast height (dbh) < 7 centimetres) while others are dominated by medium (0.5 to 2 metres) or even low shrubs (0.1 to 0.5 metres), especially in the north.

- Physiognomic types are treed swamp and shrub swamp.

Composition

- *Picea glauca*, *Picea mariana*, and occasionally *Larix laricina* are the main tree species found in swamps, but *Abies lasiocarpa*, *Betula neoalaskana* and *Populus balsamifera* also occur.
- Shrubs include *Alnus incana* ssp. *tenuifolia*, *Salix planifolia*, *S. pulchra*, *S. myrtillifolia*, *S. alaxensis*, *S. lucida* and others.
    - In colder locations, at higher elevations and further north, *Betula glandulosa*, *Rhododendron groenlandicum* and *Empetrum nigrum* are more common.
- Many swamps have a variety of forbs, grasses and mosses. Though many different forbs may be present they generally occur with low or trace cover:
    - *Arctostaphylos uva-ursi*, *Rubus arcticus*, *Equisetum* spp. and *Petasites* spp. often indicate swamp or riparian conditions, and their presence can help distinguish swamps from upland sites.
    - Grasses such as *Calamagrostis canadensis* are common (they also occur in some drier meadow marshes).
- The most common mosses in swamps are often the same as those of richer fens, including brown mosses (such as *Tomentypnum nitens*, *Aulacomnium palustre*, *Drepanocladus* spp. or *Calliergion* spp.), *Sphagnum* mosses (numerous species are common to richer fens and swamps), *Sanionia uncinata*, feathermosses, leafy mosses (for example, *Plagiomnium* spp. and *Mnium* spp.) and haircap mosses (for example, *Polytrichum* spp.).
- Many plant species found in Yukon swamps are facultative species that occur on uplands as well as wetlands and it is often necessary to look at underlying soils to determine the swamp condition.

3.3.4 Special notes and exceptions for swamps

- *Pinus contorta*, *Populus tremuloides*, and shrubs such as *Rosa acicularis*, *Juniperus communis* and *Shepherdia canadensis* usually indicate upland sites but have also been recorded in swamps.
- Fire affects swamps similarly to bogs and fens: it can increase the active layer depth, drying out the ground surface and creating site conditions favourable for species adapted to drier conditions.
    - Fire can also initiate thermokarst where there is a large amount of ground ice.

3.4 Marsh class

Marshes are mineral wetlands with fluctuating shallow surface water levels. They are commonly found between shallow water and swamps or upland areas. These minerotrophic and often eutrophic wetlands have water tables varying in relation to the ground surface and are rich in cations such as calcium (Ca^{2+}), magnesium (Mg^{2+}) and manganese (usually Mn^{2+}) as well as nutrients like nitrogen, phosphorus and potassium. In the Yukon, marshes occur in low-lying areas near water bodies or groundwater discharge zones, including river floodplains, deltas, pond margins, tidal marshes and permafrost slump bases. Saline marshes are found in groundwater discharge areas on deep calcareous glaciolacustrine deposits in the southern Yukon's dry interior. Marsh vegetation primarily consists of emergent graminoids and forbs, with dominant species such as *Carex utriculata*, *Carex aquatilis* and *Calamagrostis canadensis*.

3.4.1 Hydrology and water regime of marshes

Water regime

- Marshes receive water from surface water, runoff, stream inflow, flooding, precipitation, storm surges, groundwater discharge, longshore currents or tidal action.

Water movement and fluctuation

- Marshes are usually subject to significant water level fluctuations.
  - Water levels fluctuate daily, seasonally, annually, or from year to year.
  - Fluctuations may be due to tides, flooding, precipitation or snowmelt events, evapotranspiration, groundwater recharge or seepage.
- The water table is close to but may be above, at or below the ground surface at any time.
- The soil drainage regime is imperfect to very poor.

Soil moisture regime (SMR)

- The relative soil moisture regime is Subhydric (7) to Hydric (8).
- The actual soil moisture regime is Wet to Very Wet.

Soil nutrient regime, pH and electrical conductivity

- Marshes are nutrient-rich wetlands.
- The waters are minerotrophic with abundant cations.
- They are usually eutrophic with high nutrient levels such as nitrogen and phosphorus, due to periodic aeration and accelerated productivity and decomposition of the dead plant material.
- The pH ranges from close to neutral (7) to high, but on the coast and in dry parts of the interior Yukon, it may be saline with a high pH.
- The soil nutrient regime is Rich (D) to Very Rich (E), or sometimes Saline (F).
- Saline and coastal estuary marshes may have high to very high electrical conductivity levels.

3.4.2 Terrain and soils of marshes

Landscape position

- Marshes are found in low-lying areas adjacent to rivers, lakes, oceans and any other areas of groundwater discharge, including:
  - river and creek floodplains, deltas, and alluvial fans,
  - margins of ponds and lakes,
  - tidal marshes (which occur along the Beaufort Sea coast in river estuaries and deltas),
  - at the base of slumps in permafrost areas and
  - springs.
- Saline marshes are found in some groundwater discharge areas on deep calcareous glaciolacustrine deposits in the dry interior parts of the southern Yukon.

Mottling, gleying of mineral soil and depth

- The soil is generally mottled or gleyed to the surface or immediately below the surface organic layer.

Peat depth, decomposition and role of peat

- Soils are often a mix of mineral layers and thin limnic muck or organic layers.
- Marshes may have a surface organic layer < 30 centimetres thick. If peat layer is > 30 centimetres thick, they may be categorized as organic wetlands.

Permafrost

- Most marshes do not contain permafrost.
- Marshes may occur in recently active slumps caused by thawing of permafrost due to hydrological changes.

Soil classification

- Soils are usually classified as Rego or Humic Gleysols but may also be Gleyed Regosols.

3.4.3 Vegetation of marshes

Structural layers

- Marshes are dominated by emergent graminoid or forbs.
    - Tree cover is < 10%.
    - Total shrub cover is < 20%.
    - Emergent sedges, grasses, rushes, etc. ≥ 25%.
- Open water cover is ≤ 75%.
- Physiognomic type is graminoid marshes.

Composition

- Marshes are usually dominated by emergent graminoids:
    - The most common species include *Carex utriculata*, *Carex aquatilis*, *Equisetum fluviatile* and *Calamagrostis canadensis*.
    - Other species include *Carex saxatilis*, *Eleocharis palustris*, *Eleocharis acicularis*, *Glyceria* spp., *Deschampsia* spp., *Equisetum variegatum* and other sedges.
- Other important characteristic species include *Comarum palustre*, *Rumex* spp. and *Ranunculus* spp.
- Bryophytes may be present with low to high cover, or absent.
    - Mosses of richer and calcareous marshes include *Drepanocladus*, *Calliergon* and *Sanionia* spp.
    - Neutral marshes will more likely have *Aulacomnium palustre* and *Tomentypnum nitens*.
- Lichens are usually absent.
- Characteristic marsh species may also be found with low or trace cover in swamps, fens and shallow water wetlands.

3.4.4 Special notes and exceptions for marshes

- It has been suggested that saline marshes of the Takhini and Little Atlin valleys could be related to permafrost in the deep glaciolacustrine deposits influencing the groundwater circulation and discharge.
- The Yukon's Arctic region features distinct marsh forms that are influenced by salinity, as detailed in Warner and Rubec (1997).
    - Salt marshes, located along coastlines, develop in areas inundated by seawater.
    - Estuarine marshes form at river mouths where freshwater mixes with seawater.

3.5 Shallow water class

Shallow water wetlands are distinct transitional wetlands existing between saturated or seasonally wet wetlands and permanent, deep, water bodies. These wetlands typically feature standing or flowing water less than 2 metres deep. Water levels can vary, being seasonally stable, permanently flooded, or intermittently exposed during droughts, low flows, or intertidal periods. These ecosystems are known by various names such as ponds, pools, shallow lakes, oxbows, sloughs, bays, reaches or channels. Shallow water wetlands can be found in varying landscape positions including depressions, oxbows, sloughs, river and creek channels, or along the shallow margins of larger, deeper lakes. Soils are gleyed due to permanent saturation, creating unique plant growth conditions and influencing nutrient cycling. The vegetation in these wetlands is dominated by submerged or floating aquatic plants, algae and aquatic mosses These include *Potamogeton* spp., *Stuckenia* spp., *Hippuris* spp., *Nuphar* spp., *Ceratophyllum demersum* and mosses such as *Calliergon giganteum* or *Drepanocladus* spp. Natural disturbances include droughts, flooding and changes in water levels due to seasonal variations.

3.5.1 Hydrology and water regime of shallow water wetlands

Water regime

- Shallow water wetlands receive water from precipitation, runoff, groundwater, lakes and streams.
    - Characterized by standing or flowing water in ponds, shallow lakes and rivers, where the water table is above the surface and less than 2 metres deep in midsummer.
    - Natural impoundments such as beaver ponds or other open water wetland systems are included in this class, where water levels are not regulated.
- The shallow water wetland class excludes artificial water bodies (for example, reservoirs), with ongoing or repeated water level management or manipulation. Artificially created or reclaimed “wetlands” may become wetlands if they develop characteristics consistent with a wetland class as defined in this document.

Water movement and fluctuation

- Water levels may be stable or naturally dynamically fluctuating.

Soil moisture regime (SMR)

- The relative soil moisture regime is Hydric (8) to Aquatic (9).
- The actual soil moisture regime is Aquatic.

Nutrient regime, pH and electrical conductivity

- Shallow water wetlands are subject to aquatic processes typical of upper open-water (limnetic) and shoreline (littoral) lake zones, such as nutrient and gaseous exchange, oxidation and decomposition.
- Dissolved minerals, acid-base balances and nutrient levels are variable, influenced by hydrology, underlying geological materials, nutrient fluxes and plant communities.
- The pH is typically neutral (7) in many water bodies but may range from acidic in peatland ponds to alkaline and even saline on the coast and in drier regions with a lot of evapotranspiration.
- Usually Medium (C) to Rich (D) soil nutrient regime.

3.5.2 Terrain and soils of shallow water wetlands

Landscape position

- Shallow water wetlands occupy depressions, oxbows, sloughs, river and creek channels or shallow margins or bays of larger deeper lakes.
- They may also be present within or adjacent to any other wetland class.

Mottling, gleying of mineral soil and depth

- Soils under shallow water wetlands are typically gleyed to the surface due to permanent saturation.

Peat depth, decomposition and role of peat

- Under more stable water regimes, soils usually contain limnic peat, mixed limnic organic-mineral material or marl.
- Dynamic systems such as tidal areas, rivers and large lakes have little organic accumulation.

Permafrost

- Permafrost is generally not present in shallow water wetlands except in some areas of continuous permafrost in the northern Yukon where deep taliks (unfrozen ground) will occur under the lakes and ponds.
- Some shallow water wetlands may occur where ice-rich permafrost terrain has collapsed due to thermokarst. This is especially common in the MacKenzie delta and in some organic wetland complexes such as the Old Crow flats and the Whitefish Basin.

Soil classification

- Gleysols are found under shallow water wetlands and provide a substrate for rooted submerged and floating macrophytes, algae and aquatic mosses.

3.5.3 Vegetation of shallow water wetlands

Structural layers

- Layers include submerged and floating aquatic plants, sometimes including algae or aquatic mosses.
- < 25% emergent plant species (grasses, sedges, rushes, etc.).
- Shallow water wetland subtypes are open water and aquatic vegetation (representing 1% or more vegetation).
- Phase: “mudflat”—areas that are periodically “drained”.

Composition

- Vegetation is dominated by aquatic plants including rooted submergents, floating macrophytes, algae and aquatic mosses.
    - Common species include pondweeds (*Potamogeton richardsonii*, *P. alpinus*, *Stuckenia pectinata*, *S. filliformis* and others), *Hippuris vulgaris*, *Nuphar* spp., *Sparganium* spp., *Callitriche hermaphroditica*, *Sagittaria cuneata*, *Ceratophyllum demersum*, *Utricularia* spp., *Myriophyllum* spp, macroalgae (*Chara* spp., for example), and mosses such as *Calliergon giganteum* or *Drepanocladus* spp.
    - Low or trace amounts of any of these species may also be present in marshes.
- < 10% inundated trees; or < 20% inundated shrubs and trees.

4 Conclusion

The keys and descriptions in this guide serve as tools for identifying and classifying wetlands. Collecting vegetation and soil data is necessary to evaluate a site and determine its wetland status and class. Some wetlands may be straightforward to identify, while others that exist in transitional zones or exhibit mixed characteristics may require additional data for accurate classification. Wetlands are dynamic ecosystems that can undergo rapid changes, influenced by hydrological modifications in their surroundings. Consequently, wetland sites may display features that overlap with multiple wetland classes. This guide allows users to effectively interpret the vegetation, site and soil features of a wetland and make well-informed decisions regarding wetland status and classification.

5 Additional resources

The Field Manual for Describing Yukon Ecosystems (Environment Yukon 2017) describes methods for ecosystem field data collection and standardized forms for recording observations and these methods should be used to inform data collection for the purpose of identifying and classifying wetlands.

Field guides to ecosystems and ecosites of the Yukon are available for several Yukon regions. These field guides offer detailed descriptions of wetland classes as well as the diversity of vegetation, soil and site characteristics. They can be downloaded from Ecological and landscape classification page on Yukon.ca.

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APPENDIX 1 GLOSSARY

A

actual soil moisture regime (ASMR): Moisture categories representing the average amount of soil water available for evapotranspiration by vascular plants over several years at a given location. This can involve direct measurements of soil moisture content, often using tools like moisture sensors or field assessments.

anaerobic conditions: Conditions characterized by a lack of oxygen often found in water-saturated soils of wetlands, affecting soil chemistry and supporting specific microbial communities and plant types.

anion: Negatively charged ions, which means they have gained one or more electrons. Common anions in soil include chloride (Cl^-), nitrate (NO_3^-), sulfate (SO_4^{2-}) and phosphate (PO_4^{3-}).

aufeis: Sheets of ice formed by the freezing of overflow water, typically in braided streambeds north of about 63°N.

B

base cation: A base cation is a positively charged ion that contributes to soil alkalinity when it replaces hydrogen ions on the soil colloids. Common base cations include calcium (Ca^{2+}), magnesium (Mg^{2+}), potassium (K^+) and sodium (Na^+).

bog: Nutrient-poor organic wetlands (peatlands), typically isolated from mineral-enriched groundwater and often associated with permafrost in the Yukon. Characterized by vegetation dominated by moss, shrubs, or trees, they are primarily sustained by precipitation with stagnant water movement and very poor soil drainage.

C

cations: Cations are positively charged ions, meaning they have lost one or more electrons. Common soil cations include calcium (Ca^{2+}), magnesium (Mg^{2+}), potassium (K^+) and sodium (Na^+).

collapse scar bog: A type of bog that forms when permafrost thaws, causing the ground to collapse and form depressions that fill with water and organic materials.

cryoturbation: Mixing of soils by the freezing and thawing of the active layer.

D

drip line: The outer boundary of a plant's canopy where water drips onto the ground from the leaves. This line marks the circumference of the canopy coverage on the ground.

dbh: Diameter at breast height is measured at about 1.3 meters above the high side of the ground. This metric is widely used in forestry, ecology and land management to assess and record the size of a tree.

E

edaphic factors: Soil-related factors such as texture, structure, nutrient content and moisture that influence the distribution of plant communities.

edatopic grid: A visual tool used in ecosystem classification to represent the distribution of ecosystem types across a landscape based on variation in soil moisture and nutrient regimes. This grid displays different ecological units within a region (or bioclimatic zone), showing how specific site conditions like soil moisture and nutrient content influence the type of plant communities. For wetlands, the grid is extended to include acidity (pH) and hydrodynamics (water dynamics).

ericaceous: Low-to moderate height shrub in, or closely related to, the heath family Ericaceae (for example, blueberry).

eutrophication: The process by which a body of water becomes enriched in dissolved nutrients, often due to runoff from the land, which stimulates aquatic plant growth and can result in oxygen depletion.

evapotranspiration: Combined loss of water from soil by evaporation and water lost from the surfaces of plants, mainly via leaf pores (transpiration).

F

facultative wetland species: Plants that commonly grow in wetlands but can also survive in non-wetland areas, indicating less specialized ecological requirements.

fen: Organic wetlands (peatlands) influenced by mineral-rich groundwater, typically featuring groundcover dominated by sedges and brown mosses. These wetlands have variable vegetation and are fed by groundwater, with a water table that is stagnant or fluctuates slowly. Fens have a higher nutrient availability than bogs.

Fibrisol: In the Canadian System of Soil Classification, a Fibrisol is a type of organic soil primarily composed of lightly decomposed organic material, predominantly *Sphagnum*. These soils are characterized by their fibrous, undecomposed organic layers, which have undergone minimal humification.

Folisols: In the Canadian System of Soil Classification, Folisols are a distinct group of organic soils primarily composed of upland organic materials, usually of forest origin. They are either 40 centimetres or more in thickness or at least 10 centimetres thick if overlying bedrock or fragmented material.

forbs: Herbaceous broadleaf plants that are not grass-like (i.e., grass, sedge or rush).

G

gleying: A soil process occurring under prolonged waterlogged conditions resulting in a bluish-grey colouration due to the reduction of iron and other elements.

Gleysol: In the Canadian System of Soil Classification, Gleysols are defined as mineral soils that have undergone gleiing —a process characterized by the reduction of iron and other elements due to prolonged saturation with water. This saturation leads to the development of distinct mottling and colour changes typically blue-grey, greenish or reddish hues. Gleysols are commonly found in landscapes with poor drainage such as wetlands and depressions.

Gleysolic Cryosol: In the Canadian System of Soil Classification, Gleysolic Cryosols are defined as soils that combine characteristics of both Gleysols and Cryosols. Saturation with water and the effects of permafrost within 1 meter of the soil surface cause these soils to experience gleying. Gleysolic Cryosols develop in cold environments where poor drainage and permafrost intersect.

glaciofluvial material: Gravel and sand deposited by glacial meltwater.

glaciolacustrine: Silt and clay originally deposited within glacial lakes.

H

humified: In soil science, "humified" refers to the process or state in which organic matter has been decomposed by microorganisms and transformed into humus.

humus: Humus is a dark, organic component of soil, formed by the decomposition of plant and animal materials.

hydric soil: Water removed slowly enough to keep the soil wet for most of the growing season; permanent seepage and mottling; gleyed colours are common.

hydrodynamic index: A scale that describes the extent of water movement through soils in wetlands, ranging from stagnant to very dynamic, influencing soil and plant characteristics.

hydrological gradient: The change in water level and movement across a landscape or within a wetland system, affecting the distribution of habitats and ecological processes.

I

indicator species: These are species (typically vegetation) whose presence, absence, or abundance can indicate specific environmental conditions, helping to classify an ecosystem within a particular schema.

L

landscape position: The location or setting of an area within a larger ecosystem or landscape, which influences its hydrological and ecological dynamics.

littoral zone: The shallow zone of a body of water such as a lake or pond where light penetrates to the bottom.

M

marsh: A type of mineral wetland found at the edges of lakes and streams, characterized by waterlogged soils and dominated by marsh vegetation including emergent graminoids and forbs adapted to nutrient-rich, variable water conditions.

mesic: Organic materials that are intermediate in the degree of decomposition between fibric and humic materials. Mesic organic materials are more decomposed than fibric, consisting largely of relatively undecomposed plant fibers, but less decomposed than humic materials, which are highly decomposed and rich in humus

mineral wetlands: Wetlands characterized by mineral soils, which are less acidic and more nutrient-rich than organic soils, supporting a different set of plant and animal species.

minerotrophic: Applied to wet peatlands, such as swamps or marshes, that are supplied with mineral-rich groundwater.

Mesisol: In the Canadian System of Soil Classification, a Mesisol refers to a type of organic soil that is moderately decomposed. It sits between Fibrisols, which are minimally decomposed, and Humisols, which are highly decomposed.

mottles: Spots or blotches of contrasting colour in soil, indicative of variable wetness and redox conditions, useful for classifying and understanding soil properties in wetlands.

O

obligate wetland species: Plants and animals that depend exclusively on wetland environments for survival, indicating highly specialized ecological adaptations.

ombrotophic: Environments, particularly bogs, that receive all their water and nutrients from precipitation rather than from groundwater or surface water.

organic wetlands: Also called peatlands. Organic wetlands are 1 of the 2 groups of wetlands - the other being mineral wetlands. Peatlands contain at least 40 centimetres of peat accumulation on which organic soils (excluding Folisols) develop. The Yukon wetland classification criteria [this document] specify a lower, 30 centimetres threshold of peat accumulation required for classification as organic wetlands in the Yukon.

Organic Cryosols: A soil classification within the Cryosolic order, characterized by significant organic material content and the presence of permafrost within 1 meter of the surface. These soils must contain more than 17% organic carbon by weight and be at least 40 centimetres thick, or over 10 centimetres thick atop a lithic contact or an ice layer of at least 30 centimetres thickness. Organic Cryosols are typically associated with cold climate conditions and are prevalent in high latitude or alpine environments.

organic horizons: The O horizons or organic horizons are plant remains of varying degrees of decomposition and exist as distinct horizons or layers.

organic soils: The organic soil order consists of soils predominantly composed of decomposed plant remains. They are defined as soils with an organic layer 40 cm or deeper, often saturated with water for prolonged periods. These soils contain more than 17% organic carbon (or 30% or more organic matter) by weight.

P

palsa: Peat-covered mound with a perennially frozen core. Usually, ombrotrophic and generally much less than 100 metres across and from one to several metres high. In Fennoscandia palsas are generally treeless, but in North America they commonly support sparse stunted Tamarack or White or Black Spruce.

paludification: The process of bog formation where land becomes waterlogged over time, leading to the accumulation of organic material and the development of typical wetland ecosystems.

peat: Partially decomposed organic material accumulated in wet, saturated conditions that are characteristic of bogs and fens.

perched water table: An above-the-main water table caused by an impermeable layer that prevents water from seeping down, influencing soil moisture and plant growth.

physiognomy: Characterization of the overall appearance, structure, or form of the vegetation community, often described by terms like “trees”, “shrubs” and “herbs” to characterize the general appearance of a region’s vegetation. This physical appearance can be broadly correlated with environmental conditions.

R

relative soil moisture regime (SMR): Refers to the relative amount of soil moisture available for plant growth as influenced by factors such as landscape position, soil depth and texture, coarse fragment content and topography. It is a comparative measure, assessing how moisture conditions vary across different areas or conditions within the same climatic area.

relative soil nutrient regime (SNR): Describes the distribution and availability of nutrients in the soil compared to other sites or conditions within the same bioclimatic zone. It is often determined by factors like geology, soil type, topography and ecosystem type.

S

shallow water wetland: Mineral wetlands, such as ponds and sloughs, feature water less than 2 meters deep, with levels that fluctuate due to seasonal changes. Often located in landscape depressions or along lake margins, these ecosystems are characterized by vegetation including submerged plants and aquatic mosses.

Static Cryosols: In the Canadian System of Soil Classification, Static Cryosols are a subgroup of Cryosols that show minimal or no evidence of cryoturbation (soil mixing due to freeze-thaw processes). Unlike Turbic Cryosols, which are heavily mixed due to frost action, Static Cryosols have more stable, less disturbed soil profiles.

subhydric soil: Ground where water is removed slowly enough to keep the water table at or near the surface for most of the year; gleyed mineral or organic soils; permanent seepage < 30 centimetres below surface.

submergents: Plants that grow entirely below the surface of water bodies, such as lakes, ponds, rivers and marshes.

subsidence: The sinking or settling of ground surfaces, which can occur in wetland areas due to the drying out of soil or the melting of permafrost.

swamp: A minerotrophic wetland characterized by tree or shrub dominated vegetation, influenced by mineral-rich groundwater. Soil types are varied and nutrient-rich due to water from sources like runoff, groundwater and seasonal flooding.

T

thermokarst: Karst-like topography (sinkholes, thaw lakes and collapsed ground) produced in permafrost regions by local melting of ground ice and subsequent differential settling creating irregular surfaces.

Turbic Crysols: In the Canadian System of Soil Classification, Turbic Cryosols are a subgroup of Cryosols that are characterized by the presence of cryoturbation, or frost churning, wherein the soil is disturbed by the freezing and thawing action associated with permafrost. This process often results in a mixed soil profile with irregular, broken or indistinct horizon layers.

W

water table fluctuation: The rise and fall of the groundwater level in the soil, which can significantly impact the types of vegetation and overall ecology of a wetland area.

wetland classes: Categories used in wetland classification that describe the 5 major types of wetlands-such as bogs, fens, marshes, swamps and shallow waters-based on their hydrologic, vegetation, and soil characteristics.

wetland complex: Two or more wetland areas along with their adjacent lands that are related in a functional manner. A wetland complex is a series of multiple wetland classes, occurring gradually or abruptly along a hydrological gradient, and can contain variations in spatial patterns, vegetation and soil conditions.

X

Xeric: A very dry soil moisture regime (SMR).

APPENDIX 2 DEFINITION OF GRADIENT CATEGORIES USED BY THE EDATOPIC GRID

An edatopic grid is a two-dimensional representation of soil moisture and soil nutrient regimes used for describing terrestrial ecosystems including the “wetland edatopic grid” introduced by MacKenzie and Moran (2004). For wetland ecosystems, the pH and the magnitude of lateral water flow or vertical fluctuation of the water table (hydrodynamics) are additional factors added as tangential axes at the wettest end of the grid.

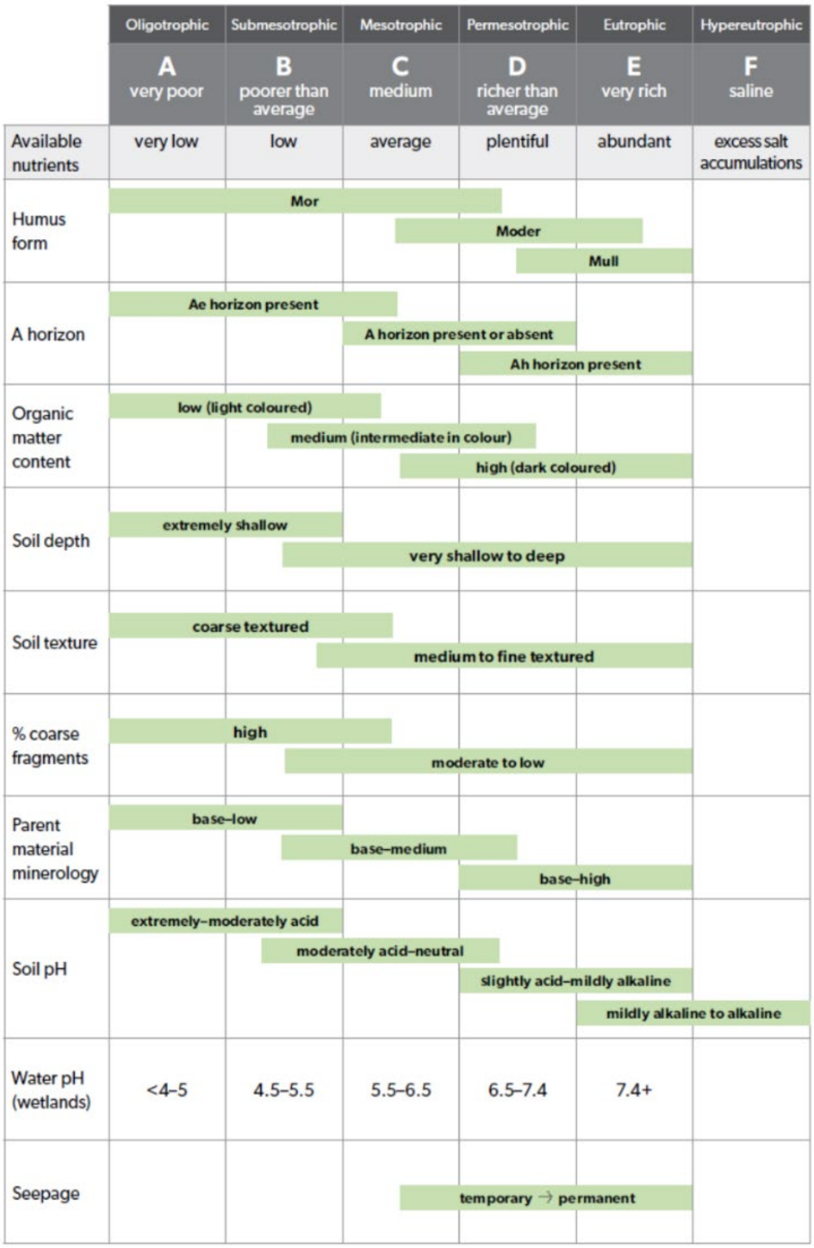

Figure A2-1 Soil nutrient regime (SNR) factors and relationship to factors.

Table A2-1 Soil pH categories used in the wetland portion of the edatopic grid and definitions.

Code	Class	Definition
VA	Very acid	< 4.5 pH
MA	Moderately acid	4.5 to 5.5 pH
SA	Slightly acid	5.5 to 6.5 pH
N	Neutral	6.5 to 7.4 pH
Ak	Alkaline	> 7.4 pH

Table A2-2 Hydrodynamic index categories and definitions used in the wetland portion of the edatopic grid.

Code	Class	Definition
St	Stagnant	Stagnant to very gradually moving soil water. Vertical fluctuations minimal. Permanent surface saturation but minimal or no surface flooding. Basins or hollows with stable water regimes. Abundant organic matter accumulation and high bryophyte cover.
Sl	Sluggish	Gradual groundwater movement through peat or fine- textured mineral soils along a hydrological gradient. Minor vertical water table fluctuations. Semi-permanent soil saturation with some elevated microsites or brief periods of surface aeration. Hollows, slopes and water tracks in basins or lake flats not directly influenced by the waterbody. Abundant peat accumulation and bryophyte cover.
Mo	Mobile	Distinct flooding and drawdown or pronounced lateral water movements. Peripheral areas of peatlands, sites adjacent to open water tracks, small rivulets or ponds, small potholes with relatively stable water regimes, protected lake embayments or back marshes in estuaries. Can have deep but well-decomposed accumulations of peat. Patchy bryophyte cover.
Dy	Dynamic	Significant lateral flow or strong vertical water table fluctuations through mineral soils. Potholes in arid climates that experience significant drawdown, wave-exposed shores, floodplain back channels and protected estuary sites. Little organic accumulation, few bryophytes.
VD	Very dynamic	Highly dynamic surface water regime. Exposed tidal sites, shallow potholes in arid climates that experience significant drawdown, wave-exposed shores and sites directly adjacent to and influenced by river flow. No organic accumulation or bryophytes.

Table A2-3 Relative soil moisture regime (SMR) class descriptions.

Code	Class	Description	Water Source
0	Very xeric	Water is removed extremely rapidly relative to supply; the soil is moist for a negligible time after precipitation.	Precipitation
1	Xeric	Water is very rapidly removed relative to supply; the soil is moist for brief periods following precipitation.	Precipitation
2	Subxeric	Water is removed rapidly relative to supply; the soil is moist for short periods following precipitation.	Precipitation
3	Submesic	Water is removed readily relative to supply; water is available for moderately short periods following precipitation.	Precipitation
4	Mesic	Water is removed somewhat slowly relative to supply; soil may remain moist for a significant, but sometimes short period of the year. Available soil moisture reflects climatic inputs.	Precipitation in moderate to fine-textured soils; limited seepage in coarse-textured soils
5	Subhygric	Water is removed slowly enough to keep soil wet for a significant part of the growing season; with some temporary seepage and possibly mottling below 20 cm.	Precipitation and seepage
6	Hygric	Water removed slowly enough to keep the soil wet for most of the growing season; permanent seepage and mottling; gleyed colours are common.	Seepage
7	Subhydric	Water is removed slowly enough to keep water table at or near the surface for most of the year; gleyed mineral or organic soils; permanent seepage < 30 cm below surface.	Seepage or permanent water table
8	Hydric	Water is removed so slowly that the water table is at or above the soil surface all year; gleyed mineral or organic soils.	Permanent water table
9	Aquatic	Water is well above the "sediment bed" all year.	Water body

To assess the moisture regime of a site quantitatively, the Yukon Bioclimate Ecosystem Classification System employs a water balance approach based on the methodology outlined by Klinka et al. (1984). In this system, actual soil moisture regimes (ASMR) are classified using the occurrence and duration of phases of water use, the ratio between actual and potential evapotranspiration (AET: PET) and the occurrence and depth of the water table (see tables A2-1 thru A2-4). The ASMR classes correlate with relative soil moisture regime (RSMR) classes associated with specific wetland classes in the edatopic grid. In Section 3 (Characteristics of Yukon wetland classes) both ASMR and RSMR are utilized to convey the spectrum of moisture regimes that a given wetland class may exhibit.

Table A2-4 Classification of actual soil moisture regimes.

Differentiating features	Class
1. Rooting-zone groundwater absent during the growing season	
a. Water deficit occurs (soil-stored reserve water is used up and drought begins if current precipitation is insufficient for plant needs)	
• Deficit > 5 months (AET/PET 55%)	Excessively dry
• Deficit > 3 months but ≤ 5 months (AET/PET ≤ 75 but > 55%)	Very dry
• Deficit > 1.5 month but ≤ 3 months (AET/PET ≤ 90 but > 75%)	Moderately dry
• Deficit > 0 but ≤ 1.5 months (AET/PET > 90%)	Slightly dry
b. No water deficit occurs	
• Utilization (and recharge) occurs (current need for water exceeds supply and soil-stored water is used)	Fresh
• No utilization (current need for water does not exceed supply; temporary groundwater table may be present)	Moist
2. Rooting-zone groundwater present during the growing season (water supply exceeds demand)	
• Groundwater table > 30 cm deep	Very moist
• Groundwater table > 0 but ≤ 30 cm deep	Wet
• Groundwater table at or above the ground surface	Very wet

APPENDIX 3 SOIL DRAINAGE CLASSES AND CODES

Code	Class	**Definition** (Source: Expert Committee on Soil Survey 1982)
VR	Very rapidly drained	Water is very rapidly removed from the soil relative to supply; water source is precipitation and water storage capacity following precipitation is essentially nil; soils are typically fragmental/skeletal, shallow steeply sloping or all.
R	Rapidly drained	Water is rapidly removed from the soil relative to supply; excess water flows downward if underlying material is pervious; subsurface flow may occur on steep gradients during heavy rainfall; water source is precipitation; soils are generally coarse-textured.
W	Well drained	Water is removed from the soil readily, but not rapidly; excess water flows downward readily into underlying pervious material or laterally as subsurface flow; water source is precipitation; on slopes, subsurface flow may occur for short durations, but additions are equaled by losses; soils are generally intermediate in texture and lack restricting layers.
MW	Moderately well drained	Water is removed from the soil somewhat slowly relative to supply because of imperviousness or lack of gradient; precipitation is the dominant water source in medium-to fine textured soils; precipitation and significant additions by subsurface flow are necessary in coarse-textured soils.
I	Imperfectly drained	Water is removed from the soil sufficiently slowly relative to supply to keep the soil wet for a significant part of the growing season; excess water moves slowly downward if precipitation is the major source; if subsurface water or groundwater (or both) are the main sources the flow rate may vary, but the soil remains wet for a significant part of the growing season; precipitation is the main source if water storage capacity is high; contribution by subsurface or groundwater flow (or both) increases as available water storage capacity decreases; soils generally have a wide range of texture and some mottling is common
P	Poorly drained	Water is removed so slowly relative to supply that the soil remains wet for much of the time that it is not frozen; subsurface or groundwater flow (or both), in addition to precipitation, are the main water sources; a perched water table may be present; soils are generally mottled or gleyed. Sites may be wetlands.
VP	Very poorly drained	Water is removed from the soil so slowly that the water table remains at or near the surface for most of the time the soil is not frozen; groundwater and subsurface flow are the major water sources; precipitation is less important, except where there is a perched water table and precipitation exceeds evapotranspiration; this class is typically associated with wetlands.

APPENDIX 4 THE VON POST SCALE OF DECOMPOSITION

Von Post decomposition ratings offer a method to determine the degree of organic soil decomposition in the field. To determine peat decomposition in the field, squeeze a handful of organic soil. The extent of decomposition is determined by:

1. the nature of the liquid that is squeezed out,
2. how much organic material is extruded from the hand; and,
3. the nature of the plant matter.

Table A4- 1 The von Post scale of decomposition (from Environment Yukon 2017).

Code/Class	Description
1	Undecomposed; plant structure unaltered; yields only clear water that is coloured light yellow-brown
2	Almost undecomposed; plant structure distinct; yields only clear water that is coloured light yellow-brown
3	Very weakly decomposed; plant structure distinct; yields distinctly turbid brown water, no peat substance passes between the fingers, residue not mushy
4	Weakly decomposed; plant structure distinct; yields strongly turbid water, no peat substance escapes between the fingers, residue rather mushy
5	Moderately decomposed; plant structure evident, but becoming indistinct; yields much turbid brown water, some peat escapes between the fingers, residue very mushy
6	Strongly decomposed; plant structure somewhat indistinct, but more evident in the squeezed residue than in the undisturbed peat; about one-third of the peat escapes between the fingers, residue strongly mushy
7	Strongly decomposed; plant structure indistinct, but recognizable; about one-half of the peat escapes between the fingers
8	Very strongly decomposed; plant structure very indistinct; about two-thirds of the peat escapes between the fingers, residue almost entirely resistant remnants such as root fibres and wood
9	Almost completely decomposed; plant structure almost unrecognizable; nearly all the peat escapes between the fingers
10	Completely decomposed; plant structure unrecognizable; all the peat escapes between the fingers

APPENDIX 5 DESCRIBING MOTTLES

Table A5- 1 Mottles: abundance codes and classes.

Code	Class	% of exposed surface
F	Few	< 2
C	Common	2 to 20
M	Many	> 20

Table A5- 2 Mottles: size codes and classes.

Code	Class	Diameter (mm)
F	Fine	< 5
M	Medium	5 to 15
C	Coarse	> 15

Table A5- 3 Mottles: contrast codes (from Environment Yukon 2017).

Code	Class	Description
F	Faint	Evident only on close examination; faint mottles commonly have the same hue as the colour to which they are compared and differ by no more than 1 unit of chroma or 2 units of value; some faint mottles of similar but low chroma and value can differ by 2.5 units of hue
D	Distinct	Readily seen, but only moderately contrast with the colour to which they are compared; distinct mottles commonly have the same hue as the colour to which they are compared, but differ by 2 to 4 units of chroma or 3 to 4 units of value, or differ from the colour to which they are compared by 2.5 units of hue, but by no more than 1 unit of chroma or 2 units of value
P	Prominent	Contrast strongly with the colour to which they are compared; prominent mottles are commonly the most obvious colour feature in a soil; prominent mottles that have medium chroma and value commonly differ from the colour to which they are compared by at least 5 units of hue, chroma and value are the same; they differ by at least 4 units of value or chroma if the hue is the same, or by more than 1 unit of chroma or 2 units of value if hue differs by 2.5 units

Figure A5-1A soil sample showing gleying (grey background) with prominent mottles (rusty red).

Figure A5-2A soil sample showing gleying (grey background) with prominent mottles (rusty red).