Field Description of Wetlands and Related Ecosystems in British Columbia

DRAFT

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ABOUT THIS MANUAL

This guide is a technical addendum to standard ecosystem sampling methodology laid out in Describing Ecosystems in the Field (Province of BC 1998). This paper outlines additional codes, classifications and methods to assist in accurate description of wetland and riparian ecosystems.

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"Describing Ecosystems in the Field [DEIF]" (Luttmerding et al. 1990) outlines the standard methodology for describing terrestrial ecosystems in British Columbia. To account for changes in methodology and information requirements, a new revised ecosystem field data form (FS882) and accompanying DEIF field manual have been written (Province of BC, 1998). This new manual includes new fields and additional codes that did not appear in the original DEIF. Some of these fields and codes are specifically included for better description of wetland and riparian ecosystems. Because the new DEIF is a field manual, the description of these new codes and fields and sampling methodology are brief. This paper is a supplement to the field manual and provides definitions and descriptions of new units and data fields as well as a field sampling methods specific to wetlands.

Wetlands and riparian ecosystems differ from terrestrial ecosystems in three major ways:

- They are strongly influenced by hydrological factors;
- They most commonly occur as complexes of community types at moderate spatial scales (1: 10 000); and
- They are more closely tied to upstream or landscape level factors.

To advance our knowledge of these types of ecosystems, it is important that field data collection and evaluation include some description of the above three factors. This information may be part of specific data fields or, as for any ecosystem data collection, **observations about the plot recorded in the notes provide essential information for future interpretation of the plot data.**

The new 1998 FS882 includes some new fields for describing hydrology and ecosystem type. In addition, some lists of descriptive codes in existing fields have been expanded to accommodate factors relevant to wetland and riparian ecosystems. These fields are listed below.

New Fields on the 1998 FS882 relevant to wetland and riparian description.

- **Realm/Class**
- **Hydrogeomorphic Classification**
- **Water source**
- **Flood Regime**
- **Von Post**
- **pH**

Fields with additional lists of descriptors relevant to wetland and riparian ecosystems

- **Surface Topography (shape)**
- **Drainage**

Fields for which specific assessment methods or interpretations are required in wetlands and riparian ecosystems include the:

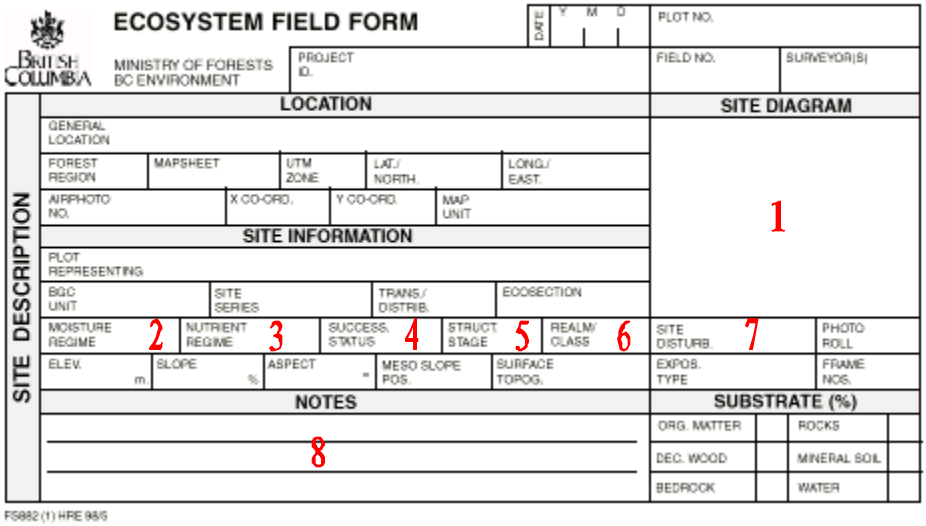
- **Site Diagram**
- **Moisture Regime**
- **Nutrient Regime**
- **Structural Stage**
- **Successional Status**
- **Humus and Soils horizon description**
- **pH and conductivity**

The methods and new definitions for each of the above listed fields are described below in the order they appear on the FS882 Field Card.

LOCATING A WETLAND ECOSYSTEM PLOT

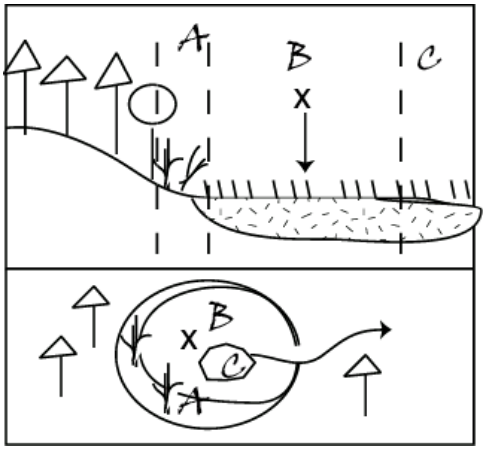
Plots should be placed in homogenous areas within wetlands; sites that cross community lines and are heterogeneous are not useful for ecosystem classification. A standard 20mx20m plot is ideal, however wetland communities often occur as narrow bands within a wetland. Plots should be made-to-fit in these community types. Ideally, an ecosystem plot should be placed within each ecosystem type. A diagram and description should always be made showing and describing the spatial and ecological relationship between the different ecosystem types within the wetland. These notes are valuable for creation of ecological descriptions as well as landscape and mapping units.

SITE CARD



1 SITE DIAGRAM

The site diagram should show and label adjacent ecosystems, water bodies, and channels. If room allows, a plane view of the wetland in addition to a cross-sectional diagram can provide a valuable perspective on community relationships. Associated ecosystems should also be described in the notes section of the Site Card.



2 MOISTURE REGIME

Most wetlands are Subhydric or Hydric relative soil moisture regime (RSMR) or wet to very wet absolute soil moisture regime (ASMR). However, Flood ecosystems and some wetland classes such as marshes have a fluctuating water table. Single visit assessment of SMR on these sites should rely on soils and vegetation as much as possible. For Flood ecosystems, early season water tables will be above the surface and appear to be subhydric or hydric but water level falls to well below the surface and soils are hygric or subhydgric in late season because of well-drained sandy or gravelly soils. For these sites, assessment of the duration of flooding may be a more important factor (see Flood Regime field below). The assignment of SMR should be based on mid-season water regime not on spring flood or fall drought states.

A list of species that commonly occur on wet and very wet sites is presented in Appendix I.

Some definitions of wetland moisture regimes.

Subhydric/wet

Sites on mineral soils where the water table is near but below the soil surface for most of the growing season as indicated by prominent mottles or gleying within 30cm of the surface.

Sites with organic soils have a water table that may drop below 30cm during the growing season but surface peat remains wet due to capillary action and moisture retention by the organic material.

Hydric/very wet

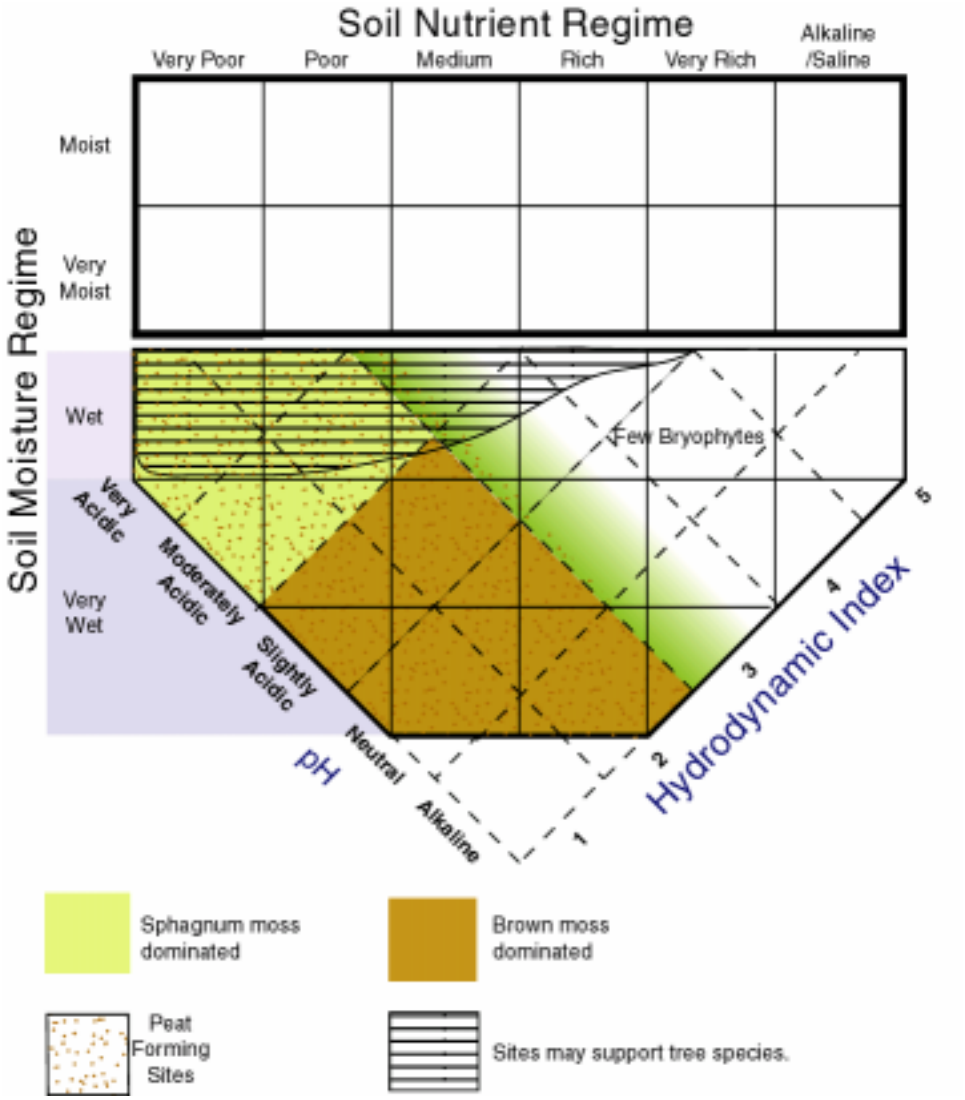
Sites on mineral or organic soils where the water table is at or above the soil surface for the majority of the season as indicated by being flooded to mid-season, blue-grey gleyed horizons at the soil surface, or organic soils on floating mats or saturated at the surface in midseason.

3 NUTRIENT REGIME

Assessment of SNR requires different factors than upland sites. Water pH is one measure often used to assess nutrient status but other factors such as nitrogen and phosphorus availability, aeration and vertical and lateral ground water movement through the substrate are important (Table 1). A modified edatopic grid incorporates pH and water flow (hydrodynamics) and can be useful for assessing nutrient regime (Figure 1). Some wetland species may be used as indicators of nutrient regime. A draft list is outlined in Appendix II

Table 1. Nutrient regime classes and relationships to site factors

SNR	A very poor	B poor	C medium	D rich	E very rich	F saline
Available nutrients	very low	low	average	plentiful	abundant	excess alkali or salt accumulation
Water pH	<4.5	4.5-5.5	5.5-6.5	6.5-7.4	7.4 – 8.4	8.4+
VonPost of surface tier	1-2	3-4	5-6	7-10	8-10	
Ground water flow through site	Stagnant Seasonal Seepage Continuous seepage					
C:N ratio	High Medium Low					
Surface tier material	Fibrimor Mesimor Saprimoder Mineral Marl					
Water Color	tea colored; yellowish-deep brown and turbid green-brown and clear green-brown and turbid					blue-green and very clear (alkaline)
Color of surface Organics	pale dark					
Surface tier saturation	always saturated seasonal exposure of substrate diurnal exposure of substrate					



The hydrodynamic index (HI) is a qualitative measure of water movements within a site. Magnitude of vertical fluctuation and lateral ground movements are used in the assessment of HI.

Table 2. Characteristics of the Hydrodynamic index (HI)

INDEX	Description	Palustrine	Lacustrine	Fluvial	Estuarine	Typical wetland classes
1	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.	None	None	None	Peatlands; Bogs and Fens
2	Gradual groundwater movement through peat or fine textured mineral soils along a hydrological gradient.	Hollows, Slopes, or water tracks in	Lake flats not directly influences by	None	None	Peatlands; Fens and poor Swamps

	Minor vertical water table fluctuations. Semi-permanent soil saturation with some elevated micro-sites or brief periods of surface aeration.	basins; peripheral locations.	the water body			
3	Significant groundwater movement through mineral soils or peat. Moderate vertical water table fluctuations. Often with surface flooding and late season drawdown.	Peripheral and shore locations in basins. Open hollows. Potholes with stable and stagnant water table	Protected lake embayments	Protected backwater channels that flood rarely	None	Swamps and Marshes
4	Significant and relatively free groundwater movement through mineral soils. Strong vertical water table fluctuations. Periods of significant surface flooding by mobile surface water followed by partial drawdown.	Potholes in arid climates that experience significant draw down	Wave-exposed shores	Flood plain depressions	Protected sites in the estuary	Marshes, Swamps, Shallow Open Water
5	Highly dynamic surface water regime; diurnal (tidal) water table fluctuations with significant periods of substrate exposure and aeration.	Potholes in arid climates that experience significant draw down	Wave exposed shores	Directly adjacent to river course and influenced by normal river flow	Most sites within estuary	Marshes, Estuarine, Shallow Open Water

4 STRUCTURAL STAGE

Wetlands with stunted trees on them are defined as Coniferous Tall Shrub. This is the equivalent of the term "treed" used in the Canadian Wetland classification and the Wetland and Riparian Ecosystem Classification (MacKenzie and Banner 1999).

5 REALM/CLASS

The Realm and Class have been defined for wetlands and related ecosystems (MacKenzie and Banner 1999). These units are broad level grouping of plant associations with similar vegetation and environment characteristics. Descriptions of each of the units in Table 4 is described below and a key to these same units is found in Appendix 1.

Table 3. Wetland and related ecosystems defined in WREC.

Ecosystem Realm	Ecosystem Group	Ecosystem Class	Code
Wetland (W)	Peatland	Bog	**Wb**
		Fen	**Wf**
	Mineral	Swamp	**Ws**
		Marsh	**Wm**
Fresh water (W)		Shallow water	**Ww**
Terrestrial (T)	Flood (F)	High bench	**Fh**
		Mid bench	**Fm**
		Low bench	**Fl**
		Active channel	**Fa**
	Transition(T)	Shrub-carr	**Tc**
		Graminoid Meadow	**Tg (was Tm)**
		Forb meadow	**Tf (was Th)**
Estuarine(E)	Low	Estuarine Marsh	**Em**
		Estuarine Tidal Flat	**Ef**
	High	Estuarine Meadow	**Ed**
		Estuarine Swamp	**Es**

5.1 Ecosystem Site Realms and Groups

The Ecosystem Realms are the broadest site units of WREC. They describe broad similarities in site conditions based mostly on water source and other hydrological factors that are expressed in the sites biological communities (Table 4).

Table 4 Comparison of ecological characteristics between Ecosystem Realms described in this document

Ecosystem Realm	Hydrophyte % of total vegetation cover	Primary Watersources	Actual SMR (Relative SMR)	Soil saturation duration	Soil Drainage
Wetland	>20%	Groundwater and precipitation	Wet- Very wet	prolonged	very poor to poor
Terrestrial	0-19%	Groundwater and Precipitation	Moist – Very Moist	brief	poor to rapid
Estuarine	0-20+%	Marine and Freshwater flooding	Moist to Wet	brief to prolonged	very poor to very well
Freshwater	100%	Flooding	Aquatic	permanent	very poor

Groups define a set of ecosystems within a Realm that share more specific environmental traits that distinguish them from other Groups within the Realm. In the Terrestrial and Freshwater Realms there are several groups that are similar to wetland ecosystems because they are strongly influenced by hydrological factors. We describe only these particular groups in conjunction with wetland and Riparian ecosystems (Table 4).

Wetland Realm (W)

Wetlands are defined by specific criteria. They occur where:

> *soils are water-saturated for a sufficient length of time such that excess water and resulting low soil oxygen levels are principal determinants of vegetation and soil development.*

Wetlands must have:

- *plant communities characterized by species that normally grow in soils water-saturated for a major portion of the growing season ("hydrophytes"); and*
- *soils with surface peat ("O") horizons or gleyed mineral horizons (Bg or Cg) within 30cm of the soil surface.*

Wetland Classes include Bogs, Fens, Swamps, and Marshes

Wetland Peatland Group

Peatlands are characterized by the accumulation of poorly decomposed (fibric or mesic) dead surface organic material. Peatlands are typically those wetlands with more than 40cm of peat accumulation; however, in cold climates (high elevation or latitude) some peatland ecosystems occur on thinner peat layers.

Wetland Mineral Group

Mineral wetlands occur where:

- Mineral soils are influenced by excess water but, for climatic, edaphic, or biotic reasons, accumulate little or no peat. Gleysolic soils or peaty phases of Gleysolic soils are characteristic of these wetlands.
- Deep but well-humified, woody, or limnic peats where there is significant ground water movements are also placed in the Mineral groups.

Terrestrial Realm

Terrestrial ecosystems occur on sites where water is not in surplus for extended periods of the growing season (actual moisture regime very dry to very moist). These sites are characterized by the dominance of drought tolerant vascular plants, bryophytes and cryptograms. Decomposition is primarily aerobic by fungi, bacteria, and soil fauna.

Terrestrial Flood Group (F)

Flood ecosystems are defined as:

sites flooded for short duration during the growing season where soils are freely drained and anoxic conditions (if they occur) are quickly relieved after subsidence of floodwaters. Vegetation tolerant of brief flooding events but not prolonged soil saturation are typical. Flood ecosystems occur specifically where:

- *water bodies periodically flood their banks depositing or eroding fluvial or lacustrine materials; and*
- *water tables are within the rooting zone during part of the growing season, but not for sufficient duration to cause gleying within the top 30 cm soil depth.*

Terrestrial Transition Group (T)

Transition ecosystems are defined as:

sites with a moist or very moist actual moisture regime that have a natural climax community dominated by grasses or shrubs. Moist soil conditions combined with other environmental factors such as low soil temperature, prolonged snow pack, accumulation of cold air, or soil salinity preclude establishment of forest ecosystem species groups that would normally occur under these soil moisture regimes.

Estuarine Realm (E)

Estuarine ecosystems are defined as:

> *coastal sites dominated by plants and other organisms tolerant of wet, brackish soils found at the confluence of a freshwater source and the marine environment and affected by occasional or diurnal tidal inundation. Estuarine ecosystems occur specifically where:*
>
> - *at least periodically, the land supports predominantly hydrophytic plant species or brackish water adapted invertebrates.*
> - *the substrate is predominantly undrained hydric soil. Soils may be organic or inorganic. In mineral soils, gleying occurs within the top 30cm.; or the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season.*
> - *the site is tidally influenced and at least occasionally affected by brackish water.*

Four Estuarine ecosystem classes are defined under the Estuarine ecosystem realm; Estuarine Swamp, Estuarine Meadow, Estuarine Marsh, Estuarine Tidal flat

High Estuarine Group

Ecosystems of the High Estuarine group have affinities to the Transition and Flood groups of the Terrestrial Realm. High Estuarine ecosystems are those sites that are flooded by brackish waters occasionally (less than daily). Climax vegetation is treed, shrubby or herbaceous. Rarely, these sites will have peat formation. Estuarine meadows and Estuarine swamps are the two currently recognized High estuarine Classes

Low Estuarine Group

Ecosystems of the low estuary group occur below the high tide level where sites are flooded and exposed daily. Length of inundation and substrate type (affected by sediment source and tidal current strength) are important determinants of community composition. The Estuarine Tidal flat and the Estuarine Marsh are the two recognized Low Estuarine classes

Freshwater Realm

The Freshwater Realm ecosystems include permanently inundated inland aquatic ecosystems including deep or shallow, flowing or standing water bodies. This Realm includes the Shallow Water class previously described as a wetland ecosystem (NWWG 1997). The Fresh water realm is defined by a biota dominated by plants and animals adapted to permanent submergence and intolerant of exposure to the atmosphere. This includes aquatic vascular plants, algae, plankton, aquatic insects, and fish. Decomposition is primarily by arthropod detritivores.

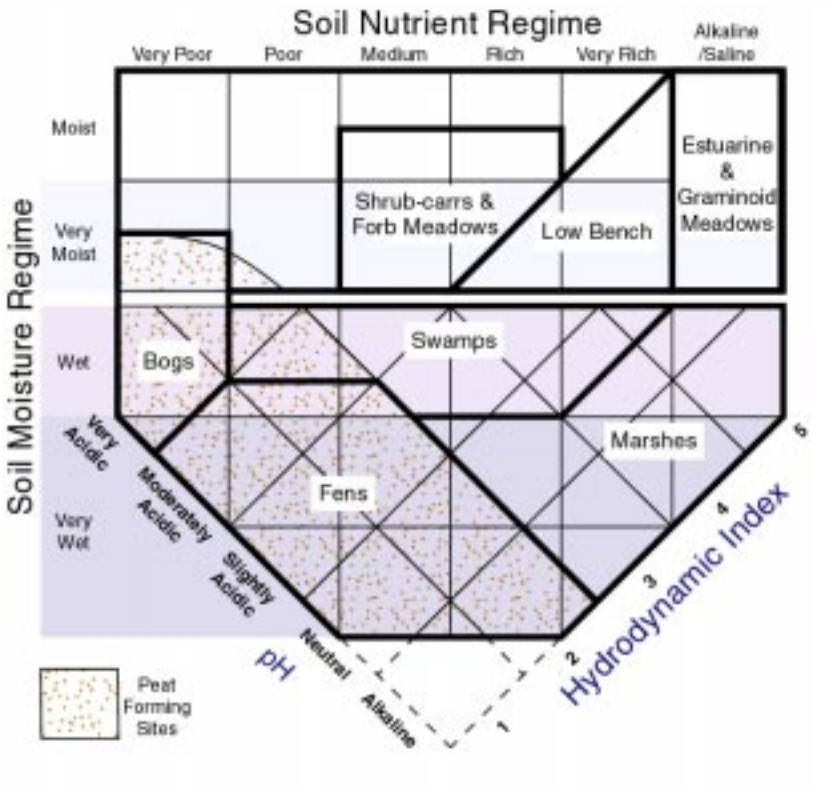


Figure 1. Diagrammatic relationship between wetland classes and other related ecosystems using a modified edatopic grid

Table 5 Comparison of ecological characteristics between Wetland and Freshwater Classes

Group	Wetland Class	Group characteristic	Environmental Features	Vegetation
Peatland	**Bogs**	Peat accumulation > 40cm surface tier fibric or mesic;	Ombrotrophic. pH <5.0	Coniferous treed or low shrub; occasionally bryoid; dominated by ericaceous shrubs and Sphagnum mosses
	Fens		Groundwater fed. pH>5.0	Sparsely treed, graminoid or low shrub; dominated by deciduous shrubs, sedges, and brown mosses
Mineral	**Swamps**	Mineral soils with < 40cm of peat accumulation or well-humified surface organic tier (Oh)on deeper peat	Significant surface and groundwater flow	Tall shrub or treed; dominated by willows, alders, forbs, grasses, leafy mosses
	Marshes		Protracted shallow flooding (0.1-1.0 m)	Graminoid or Forb; usually dominated by a single emergent sedge, grass, forb, or horsetail species. Shrub or tree layer <10% of total cover
Freshwater	**Shallow Water**		Permanent deep flooding (0.5m to 2m)	Submerged or floating aquatics. Emergent vegetation < 10% total cover.

Bog Wetland Class (Wb)

Bogs are shrubby or treed, nutrient-poor peatlands with distinctive communities of ericaceous shrubs and hummock-forming *Sphagnum* plant species adapted to highly acid and oxygen-poor soil conditions. Bogs develop in basins where peat accumulation has raised the surface peat above groundwater flow or less commonly where groundwater is very low in dissolved nutrients (e.g. flows from granitic parent material). Surface peat remains saturated through most of the year through the capillary action of living and dead *Sphagnum* mosses. Bogs are never flooded.

Fen Wetland Class (Wf)

Fens are peatlands where groundwater inflow maintains relatively high mineral content within the rooting zone. These sites are characterized by non-ericaceous shrubs, sedges, grasses, reeds and brown mosses. Fens develop in basins, lake margins, river floodplains, and on seepage slopes where the water table is usually at or just below the peat surface for most of the growing season.

Swamp Wetland Class (Ws)

A swamp is a forested, treed or tall shrub, mineral wetland dominated by broadleaf shrubs and trees on sites with a flowing, semi-permanent, near surface water table. Tall shrub swamps are dense thickets with standing pools of water while forested swamps have large trees occurring on elevated microsites and lower cover of tall deciduous shrubs. Both types of swamps have abundant available nutrients from ground water. Swamps may be underlain with peat but this is usually well decomposed, woody, and dark.

Marsh Wetland Class (Wm)

A marsh is a shallowly flooded mineral wetland dominated by emergent grass-like vegetation. A fluctuating water table is typical in marshes with early season high water tables dropping through the growing season. Exposure of the substrate in late season or during dry years is common. The substrate is usually mineral, but may have a well-decomposed organic veneer derived primarily from marsh emergents. Nutrient availability is high (eutrophic to hyper-eutrophic) due to circum-neutral pH, water movements, and aeration of the substrate. Marshes characteristically show elevationally banded or mosaic surface patterns composed of pools or channels interspersed with clumps of emergent sedges, grasses, rushes, or reeds. Frequently, marshes are species poor and dominanted by thick stands of a single species

Fresh water Classes

Shallow water Class (Ww)

Shallow waters are aquatic ecosystems dominated by rooted, submerged and floating aquatic plants. These communities are always associated with permanent still or slow-moving water bodies such as shallow potholes or borders of deep water habitats. Shallow water sites are usually permanently flooded; rarely they may become exposed during extreme drought years. Shallow water communities most commonly occur where standing water is less than 2m deep in mid-summer. Aquatic plants may root in mineral soils or in well-humified sedimentary peat.

Terrestrial Transition Classes

Table 6 Comparison of ecological characteristics between Terrestrial Transition Classes

Wetland Class	Characteristic Physiognomy	Required environmental feature	Vegetation
Shrub-carr	Low shrub	Frost prone depressions with fine- to medium-textured moist soils	Deciduous low shrubs, grasses, and forbs
Graminoid meadow	Graminoid	Slightly to highly saline soils usually with a brief period of inundation. Cold air ponding sites and fine textured soils in grassland areas	Grasses, rushes, sedges, and forbs
Forb meadow	Forb	Heavy snowfall regions; snow accumulation areas and prolonged seepage	Subalpine forbs

Graminoid meadow Transition Class (Tg)

Graminoid meadows are grass, rush, or halophyte dominated sites that develop on periodically saturated and occasionally inundated mineral soils in depressions and pond margins. After early season saturation and perhaps a brief period of inundation, the water table drops below the rooting zone during most of the growing season, resulting in a well-aerated rooting medium. In some areas, repeated inundation followed by evaporation lead to accumulation of salts. Graminoid meadows often can occur in frost-prone sites or with moist or very moist saline or alkaline soils.

Shrub-carr Transition Class (Tc)

A Shrub-carr is a shrub-dominated ecosystem that develops on frost-prone sites with moist or very moist soils. These sites are seasonally saturated but rarely inundated (see Flood

ecosystems) and may have water tables perched at depth. Shrub-carrs are frequently bordering wetlands or in frost prone hollows in cold and dry climatic regions. The substrate is dominantly mineral, but thin accumulations of organic matter of up to 15 cm may overlie the mineral soil. Accumulation and decomposition of this surface organic layer takes place under mainly aerated conditions. Consequently, it is not usually peat but more similar to the surface organic layers of upland forests or grasslands. A strongly mounded soil surface is typical and shrubs of 1 to 2 meters occur mainly on these elevated microsites. The herb and moss layers can be very diverse and frequently contain species often associated with dry upland sites.

Forb Meadow Transition class (Tf)

A Forb meadow is a forb-dominated ecosystem that occurs mainly in cold environments of montane and subalpine regions of the province where a persistent snow pack and prolonged growing season seepage preclude tree establishment. Forb meadows commonly occur on slopes and in valley bottoms where there is cold-air drainage and persistent ground water flow. Tall forbs and sedges dominate these high elevation meadows. Soils are mineral but can have thin, dark organic veneers.

Terrestrial Flood Classes

Table 7 Comparison of ecological characteristics between Terrestrial Flood Classes

Wetland Class	Required environmental feature	Defining Physiognomy	Defining Species Groups
High bench	Flooded for brief periods; primarily sub-irrigation	Coniferous treed at climax	Conifers and upland species typical of seepage areas
Mid bench	Temporarily flooded in spring. Elevated benches above normal waterflow; mainly areas of sedimentation	Deciduous treed at climax	Flood tolerant deciduous trees and shrubs
Low Bench	Moderate flooding in spring. Site directly adjacent to water course and experience significant annual erosion and deposition.	Tall deciduous shrub communities	Flood tolerant shrubs
Active channel	Prolonged flooding. Sites within normal channel coarse and experience significant sediment shifting.	Sparse shrub or herbaceous communities	Erosion resistant herbs and annuals

High bench Class (Fh)

High bench ecosystems occur where flooding rivers produce lengthy subsurface flow in the rooting zone but only periodic, brief inundation. Plant communities on these sites are similar to of adjacent upland seepage ecosystems. Surface flooding may occur from as frequently as several times annually to only during extreme flood years (Beaudry and Hogan 1990). These periods of flooding are generally not restrictive of plant species and many species common to upland seepage sites can occur. The high bench is elevated well above the average growing season water level on accumulated alluvium. This Class occurs most commonly on the flood plains of larger coastal river systems where high winter (dormant season) floods build large

levees and terraces that are elevated above most growing season floods or on smaller interior rivers that have a brief, intense spring runoff.

Middle bench Class (Fm)

Middle Bench ecosystems occur on sites that are flooded every 1 to 6 years and experience some floodwater scouring. Inundation duration is relatively short (total annual duration 10-25 days) but restricts many upland plant species and favors those that are better adapted to flooded conditions. Broadleaf trees such as black cottonwood and red alder usually dominate these ecosystems with scattered flood tolerant conifers occurring on higher micro-sites.

Low bench Class (Fl)

Low Bench ecosystems are flooded at least every other year for moderate periods of the growing season and experience moderate flood scouring. Tall willows and alders generally dominate communities with sparse understories dominated by annuals and erosion resilient forbs and grasses. Low bench communities are the most common Flood Class and occur on large river systems as well as the floodplains, bars, and levees of small streams.

Active channel Class

Active channel ecosystems are flooded every year for extended periods of the growing season. Severe scouring by high water flows results in low vegetative cover of very flood tolerant species or annuals that germinate after cessation of flood conditions. Active channel communities are frequently expressed as depositional bars that appear during low flows. Ecosystems that experience high velocity flooding, which scour the soil substrate, generally fall within this class.

Estuarine Classes

Estuarine swamp Class (Es)

Estuarine swamps are treed or shrubby mineral ecosystems that occur in brackish lagoons, channel and estuary edges with occasional tidal flooding and waterlogged, slightly saline soils. Thickets of tall shrubs and trees tolerant of wet, slightly saline soils are typical. Soils are usually mineral though some sites may have a significant well-humified organic horizon.

Estuarine meadow Class (Ed)

Estuarine meadows are ecosystems dominated by tall forbs and graminoids that develop in the high intertidal and supratidal zones of estuaries where tidal flooding is less frequent than daily. These sites are flooded during higher high tides, storm events, or during river flood. Soils are often waterlogged during portions of the growing season and are oligo- to eusaline mineral soils. The Estuarine meadow is the equivalent to the High Marsh described by Tarnocai in Glooschenko and others (1993).

Estuarine Marsh Class (Em)

An Estuarine marsh is an intertidal ecosystem dominated by salt-tolerant emergent graminoids and succulents. They occur in the middle to upper tidal zones of estuaries where fresh water and salt water mix. Sites are alternately flooded and exposed with daily. Elevationally banded surface patterns that reflect degree of tidal inundation are common. Estuarine marshes are the equivalent of the Low Marsh of Tarnocai (in Glooschenko et al. 1993)

Estuarine Tidal flat Class (Et)

Estuarine Tidal flat sites are intertidal ecosystems dominated by benthic/burrowing fauna and macro algae. They occur in the mid to lower tidal zones of estuaries where freshwater and saltwater mix. Sites are flooded and exposed with most tidal cycles. Large flats of silts, sands, or pebbles is common.

6 SURFACE MICROTOPOGRAPHY

Pattern Type

Describes the micro topographical variation that affects vegetation patterns within a site. The pattern type usually reflects formation processes within the wetland.

Table 8

Microtopography type	Code	Description
Channeled	**Cha**	Sites where drainage gullies have formed leaving incised water tracks or channels. Channels usually have distinct plant communities
Domed	**Dom**	Peatland sites (usually bogs) with convex surface dome raised above the surrounding landscape. Usually an indication of an mature bog where Sphagnum peat accumulation has occurred over a long period of time. These sites may be underlain with permafrost.
Hummocked	**Hmk**	Peatland sites with wetland pattern characterized by raised organic mounds created by differential vegetative growth. Hummocky sites often have different communities established on the hummocks from those growing in depressions.
Lobed	**Lob**	Sloping sites with mineral or peat lobes. Mineral lobes usually as a result of permafrost thaw (solifluction lobes). In peatlands, a pattern of peat accumulation occurring at the toe of seepage slopes.
Mounded	**Mnd**	Site with mounds of mineral soil as a result of original parent material deposition, differential sediment deposition during flooding, frost heaving, etc. On wet sites or flood plains, trees are frequently only found rooting on these elevated sites
Polygonal	**Pol**	Sites with polygonal patterns associated with permafrost areas. Sites may be high centered or low centered polygons.
Ribbed	**Rib**	Peatland sites with distinctive pattern of raised ridges and shallow water pools.. Occurs on gradually sloping peatlands (fens) with the ribs forming perpendicular to the direction of water flow.
Smooth	**Smo**	Sites are relatively flat
Tussocked	**Tus**	Site characterized by tussocks formed by tussock forming graminoids

Microtopographic features size and frequency

This modifier of the surface pattern types describes the degree of expression of surface topographical pattern type.

Table 9. Size and frequency modifiers for microtopography (from Luttmerding et. al 1990)

Size/Frequency	Code	Description
Micro	**mc**	Low relief feature with minimal effect on vegetation. Height of features < 0.3m
Slightly	**sl**	Prominent features (0.3 – 1.0m high) with notable effects on vegetation but widely spaced (>7m apart).
Moderately	**md**	Prominent features (0.3 – 1.0m high) with notable effects on vegetation; spaced 3 to 7m apart.
Strongly	**st**	Prominent features (0.3 – 1.0m high) with notable effects on vegetation; spaced 1 to 3m apart.
Severely	**sv**	Prominent features (0.3 – 1.0m high) with notable effects on vegetation; spaced <1m.
Extremely	**ex**	Very prominent features (> 1.0 m high) spaced >3m apart.
Ultra	**ul**	Very prominent features (> 1.0 m high) spaced <3m apart.

7 SITE DISTURBANCE

A list of some likely site disturbance factors in wetlands

B-b : beaver tree cutting

B-d : domestic grazing

B-w : wildlife grazing

D–e : effluent disposal

S-a : cultivation or agriculture

W-i : inundation (beaver dam construction or accidental flooding by road construction)

W-d : water table control (intentional diking or damming)

W-e : water table depression (water level reduction from removal of dams or draining)

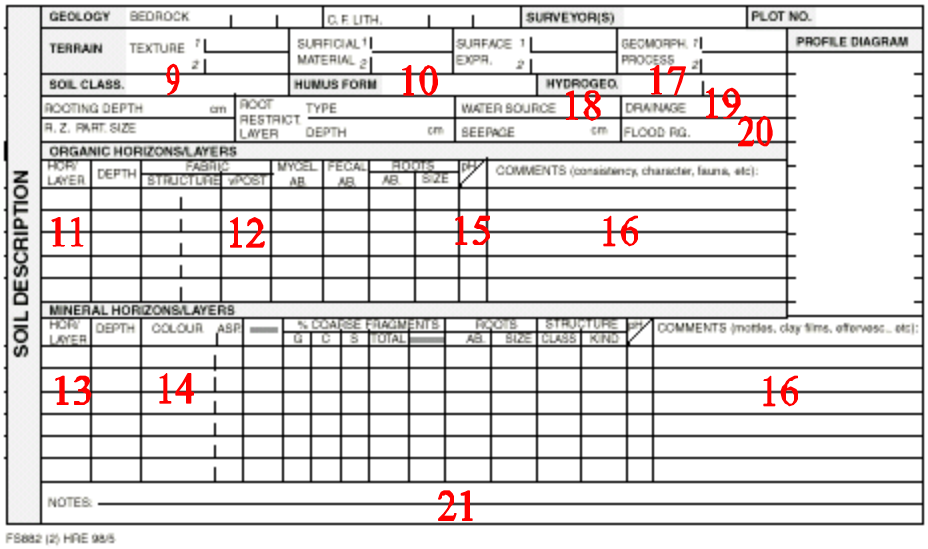
8 SITE NOTES

As previously stated, observations about the plot recorded in the notes provide essential information for future interpretation of the plot data.

Some points to include in notes:

- Associated/adjacent ecosystems
- Representativeness of the site to what the observer has seen before
- Unusual features of the site
- Any suspected impacts or disturbance to the site
- Suspected changes in hydrology
- Potential successional pathways on the site suggested by current vegetation and peat profile.
- Possible wildlife habitat values
- Position in wetland, lake or, riparian area (see Appendix IV)

SOILS CARD



9 SOIL CLASSIFICATION

"The Canadian System of Soil Classification " (CSSC 1987) "Towards a Taxonomic Classification of Humus Forms" (Green et al. 1993) and "Describing Ecosystems in the Field [DEIF]"(Luttmerding et al 1990 and Trowbridge et al. 1998) are the principle references for description of wetland and riparian soils. These references provide the majority of the information on sampling and classification. A comfortable knowledge of the CSSC is important for effective soil description and classification. The information contained in Chapter 2 (page 19-31), "soil, pedon, control section, and soil horizons" is especially helpful.

The following sections attempt to provide supplementary information and ideas.

9.1 General Data Collection Procedure (modified from DEIF, 1998)

First Designate horizons on soil form (organic and mineral horizons). Record for each horizon:

- Average starting and ending depths in centimeters
  - For mineral and organic soils zero is the top of the mineral or organic horizon respectively, and the horizons are listed in ascending order.
  - Organic litter layers (LFH) and shallow Of/Om layers (<60cm) or Oh (<40cm)—except those that are buried—are listed in descending order of depth.
- von Post of "O" horizons
- Fabric, mycelia and fecal abundance, rooting, and pH of organic and mineral horizons
- Important observations about each organic horizon.
  - Type of fibers found in peat such as sedges, *Sphagnum*, brown moss, twigs, logs, *Nuphar* or *Menyanthes* seeds, etc. Record as many as necessary to describe the composition of the horizon, and possibly record them in decreasing order of abundance.
  - Density. Terms such as dense, consolidated, unconsolidated and tenacious to describe how well each horizon holds together--structure.

  - Presence of Hydrogen Sulfide (H_2S) and/or methane (CH_4)--the smell of rotten eggs. Indicates decomposition in a highly anaerobic environment.
  - Approximate texture of mineral enrichment. If mineral enrichment is observed in an organic horizon, its texture may provide information regarding fluvial processes, flood history, etc. However, due to the difficulty of texturing soils with high organic content, it may be easier to record general textures such as fine, medium and coarse.
  - Limnic materials (coprogenous earth—color, consistency, etc.)
- Hand-texture mineral soil samples and determine colors.
- Percent and shape of coarse fragments, rooting, structure, and pH for mineral horizons
- Important observations about each mineral horizons (see DEIF, 1990)
  - soil fauna
  - mottles—abundance (none, few, common, many), size (fine, medium, coarse), and color
  - clay films
  - nature of organic enrichment (woody, rooty, etc.)
  - Limnic materials (calcareous marl, visible shells, etc.)

Second Sketch a profile diagram to approximate scale. Include as much detail as possible to give an accurate impression of the profile.

Third Record:

- rooting depth, particle size, and root restricting layer
- water source, seepage depth, drainage class, and flooding regime

Fourth Classify:

- bedrock geology and coarse fragment lithology type(s)
- terrain unit(s), soil pedon, humus form, and hydrogeomorphic unit

Fifth Use the "Notes" section to summarize or describe important soil features not otherwise collected on the form.

- Not all observations are conveniently noted within predetermined attributes. Therefore one must be prepared to make observations that are unique or could be of particular significance to the study, or classification. Any characteristic that helps to describe the nature of a humus form or soil may help to understand its formation and dynamics (Green et. al, 1993).
- Refer to soil description pages in DEIF, 1990 for codes and further details regarding soil sampling

Sampling Equipment and Methodology

Peat probe
Shovel
Field pH/Conductivity meter or Sample bottles
Munsell Color Chart
Measuring Tape
Knife
Golf tees or other horizon markers

Peat Sampling

High water tables, saturated conditions, and the pit depths required for classification (160cm) favor special soils sampling tools in peatlands. Where the peat is relatively dry, a pit dug to 160cm by shovel is possible but arduous. On saturated sites it is impossible. Instead, use a peat sampler is preferred. Although there are various types available, the Hiller-type peat sampler can be used to provide undisturbed peat samples from any depth. The sampler consists of a cylindrical chamber that is closed when the probe is inserted into the peat. At the desired depth, the probe is given a half turn, cutting the peat. Once the sample has been taken, the

probe is given a half turn in the opposite direction to close the chamber, enclosing the sample to protect it from contamination, as the sampler is withdrawn from the peat. These probes are effective, however, dry fibrous moss or living roots can make it difficult to obtain samples from the top 30 cm of many peatlands. In these cases, a shallow pit can be dug and measurements and observations can be recorded using standard sampling methodology. Below this, the probe can be used to sample the remainder of the profile.

If a peat sampler is not available, a pit dug by shovel will still provide useful data. Unlike mineral soils, which require pit depth of 60cm, organic soils require pits at least 120cm deep with 160cm being optimal. This may not be possible on certain sites, but pits should be dug as deep as possible and a profile section extracted and laid out on the ground. This allows the recorder to view the lower tier of the profile in full light and removes peat from the lower sections before they flood.

Mineral Soil Sampling

Sampling saturated and flooded mineral soils is difficult. Where the materials are fine textured, it is possible to use a soil or peat probe to obtain useful samples. However, coarse-textured materials will be more difficult require the use of a shovel. In situations such as these, it may be necessary to dig a pit and then extract samples by hand, reaching down as far as possible. It is not always possible to sample the full 60cm in such conditions. Consequently, it is important that the soils are described as fully as possible, —even if on hands and knees—and that notes and observations are thoroughly recorded.

9.2 Classification of Wetland and Riparian Mineral Soils

For mineral soils in general, the control section extends either from the mineral surface to 25cm below the upper boundary of the C or IIC, or to a depth of 2 m, whichever is less (CSSC, 1987). However, field sampling procedures defined in DEIF (1998) only require a 50 to 75cm deep pit.

Regosols

Regosolic soils are young soils with little or no horizon development. They are common on active fluvial sites where flood events deposit sediment layers. On these sites, Regosols are often "cumulic" with layers of sediments from different flood events.

Gleysols

Gleysols are the predominant wetland mineral soil type. These soils are defined by the presence of a gleyed B or C horizon. Gleying occurs under water-logged, anaerobic conditions. A "Bg" or "Cg" horizon may be gleyed as indicated by a distinct dull blue-grey color or prominently "pseudo-gleying" with distinct mottles. "Pseudo-gleying occurs where the horizon occurs in a fluctuating water table. True gleying usually indicated near permanent saturation.

Classification of Organic Soils

See Chapter 9 (pages 82-92) in Canadian System of Soil Classification (CSSC 1987) for detailed descriptions of organic soil classes. The soils of the Organic order include the Fibrisols, Mesisols, Humisols, and Folisols (upland organic soils); the first three are wetland soil Great Groups. These soils are largely composed of accumulated organic materials derived from hydrophytic plants. Most Organic soils are saturated with water for prolonged periods. They occur widely in poorly and very poorly drained depressions and level areas in regions of cool or wet climates.

For wetland organic soils, the control section (the section of the pedon used for classification) extends from the soil surface to a depth of 160 cm or to a lithic contact which ever comes first (CSSC, 1987). The control section is divided into the surface tier (0- 40cm), the middle tier (40-120cm) and the bottom tier (120-160 cm) (Figure 1). Classification at the great group level (Fibrisol, Mesisol, or Humisol) is based primarily on the dominant horizon of the middle tier.

The Subgroups is determined by the subdominant horizon in the control section or the presence of specific 'non-horizon' soil layers. The humus form classification is based on the surface tier.

The maximum depth for features relevant to classification –great group and subgroup—is 160 cm. However, it is useful to probe to the greatest depth possible, preferably to lithic or mineral soil contact, and record measurements and observations.

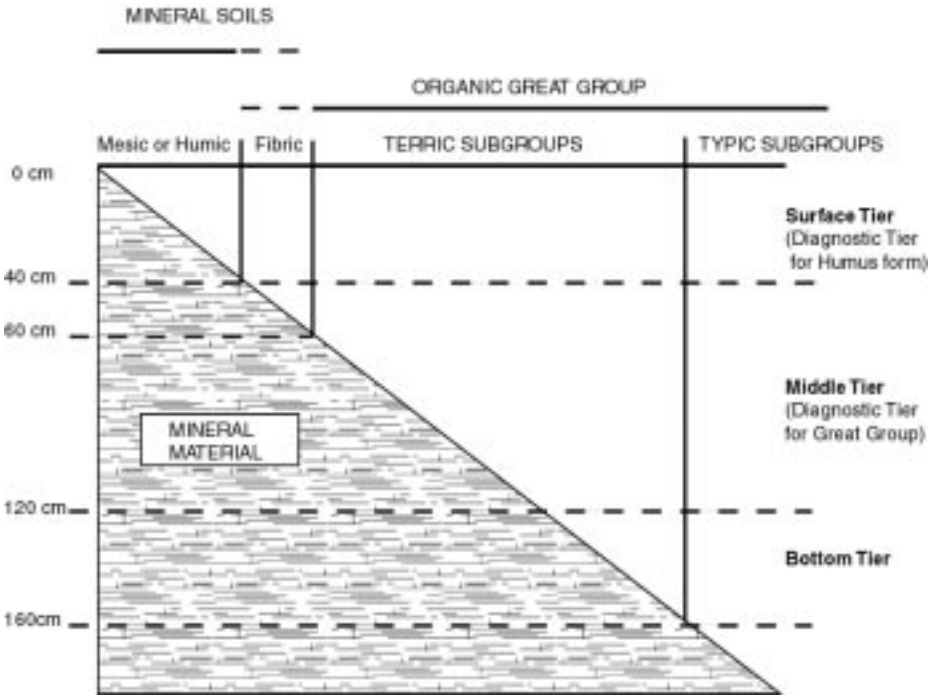


Figure 2. Diagrammatic representation of depth relationships in the control section used to classify Fibrisol, Mesisol, and Humisol great groups (CSSC, 1987).

10 HUMUS FORM

Humus form and soil classification fields, when taken together, offer a concise 'snapshot' of the soil profile and should be used to their fullest potential. The humus form is an important component of both mineral and organic soils and is often a better indicator of nutrient status than the underlying mineral horizons. Because there is no minimum vertical dimension to humus forms, they should be classified no matter how thin.

10.1 Control Section in Organic soils

The humus form control section for peatlands is the upper 40cm of the profile (Figure 2). If the organic material is less than 40 cm deep, the control section extends from the surface to a lithic, paralithic, permafrost or fragmental contact.

10.2 Control Section in Mineral soils

A humus form sampling unit has vertical and lateral dimensions. Green et al (1993) define the control section or sampling unit for humus form classification to extend to 65 cm below the surface, depending on the total thickness of the combined organic horizons or depth to nonsoil contacts (Figure 2). There is no minimum vertical dimension as long as any organic or Ah horizon is present.

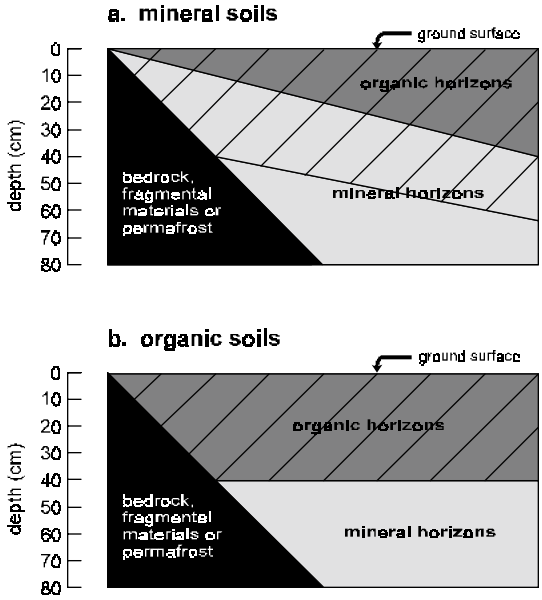


Figure 3 .Vertical dimension of the humus form sampling unit in mineral (a) and organic (b) soils. Hatched area designeates the sampling unit. (Green et al, 1993).

Wetland Humus Forms

Wetland humus forms are distinguished by occurring on poorly drained sites and having an "O" horizon in the humus control section or a gleyed upper (top) mineral horizon.

Hydromull

Site poorly drained; humus forms < 2cm with an Ah horizon > 2cm.

Hydromor

Site poorly drained; humus forms dominated by Fm and H horizons (FH>50% of the total thickness of the F, H, and O horizons)

Hydromoder

Site poorly drained; humus forms dominated by Fa, Fz and H horizons (FH>50% of the total thickness of the F, H, and O horizons).

Fibrimor

Humus forms dominated by O horizons and Of>50% of the O horizons

Mesimor

Humus forms dominated by O horizons and Om >50% of the O horizons

Saprimoder

Humus forms dominated by O horizons; and Oh >50% of the O horizons

Humus Form Phases

In addition to the recognized Humus Groups, phases may be described for any taxon of the system. Phases provide flexibility by considering properties or the range of properties not used as differentiate in forming taxa. They can be applied at any categorical level and allow the classification to be expanded informally to account for humus forms not explicitly represented by the recognized taxa (Green, et al, 1993). A list of prefixes can be found on page 13 of Green et al (1993), or new ones can be created to describe specific characteristics.

For more detailed information on humus form description and classification as well as a key to humus form taxa refer to Green et al (1993).

Some phases that may be encountered in wetland and riparian sites are:

Charcic – presence of significant volumes of charcoal (>35%)

Compactic – dense and concentrated humus forms

Cryic – influenced by permafrost

Histic – Hydromors or Hydromoders with O horizons comprising 25-50% of the humus form

Lignic – wood comprises 35-80% of the humus profile

Mineric – with significant mineral soil intermixed

Tenuic – atypically thin humus form (as on flood plain sites)

Velic – initial stage of humus development consisting of >80% litter layer

Xylic - >80% wood in the humus form

11 ORGANIC SOIL HORIZONS

Deep "O" horizons define the Organic soil order (Except the Folisol Great Group). These peat horizons develop on poorly drained sites; and, are derived mainly from wetland bryophytes, sedges, and shrubs and trees. The characteristics of the middle tier from 40-120cm (60-120cm on site with a Fibric surface tier) are used to classify to the Great Group. The three organic horizons classes are distinguished by the degree of decomposition as defined by the von Post scale (See Field: von Post below)

See page 23-28 in CSSC (1987) for further description of soil horizons and other layers.

S

Horizon composed of living bryophytes or "soil crusts"

Of

Horizons of poorly decomposed peat that are readily identifiable as to origin. von Post 1 to 4.

Om

Horizons of partly decomposed peat that where some non-woody fragements are identifiable. von Post 5 to 6

Oh

Horizons of well decomposed peat where only woody fragments are identifiable. von Post 7 to 10

Organic "O" horizons differ from upland humus horizons (LFH) that develop under primarily aerated conditions from the accumulation of leaves, twigs and woody materials of upland plants. On some transitional sites with well-humified surface horizons, designation of the horizon as an H or Oh may be difficult. Determination should be based on site hydrology and presence of hydrophytes. Notes should be taken about the rationale for designation.

Other non-horizon layer descriptors for Organic soils

The following non-horizon layers are recorded in the field card as O, B, C, R, or W horizons but are given special names and status for defining organic soil Subgroups.

Cumulo layer (C horizons)

This consists of a layer or layers of mineral material in Organic soils. Either the combined thickness of the mineral layers is more than 5 cm or a single mineral layer 5-30 cm thick occurs. One continuous mineral layer more than 30 cm thick in the middle or bottom tier is a terric layer. Defines a Cumulic subgroup.

Terric layer (C horizon)

This is an unconsolidated mineral substratum not underlain by organic matter, or one continuous unconsolidated mineral layer (within less than 17% organic C) more than 30 cm thick in the middle or bottom tiers underlain by organic matter, within a depth of 160 cm from the surface. Defines a Terric subgroup

Lithic layer (R horizon)

This is a consolidated mineral layer (bedrock) occurring within 10-160 cm of the surface of Organic soils. Defines a Terric subgroup

Hydric layer (W horizon)

This is a layer of water that extends from a depth of not less than 40 cm from the organic surface to a depth of more than 160 cm. Defines a Hydric subgroup

Limno layer (Oco or C horizon)

This is a layer or layers > 5 cm of coprogenous earth (sedimentary peat), diatomaceous earth, or marl. Except for some of the coprogenous earths containing more than 30% organic matter, most of these limno materials are inorganic. Defines a Limnic subgroup

A limnic layer should be described by is constituents in the comments section of the horizon and in the Soils Notes field. There are several types of Limnic material that should also be defined

Coprogenous Earth: is composed of fecal pellets or aquatic plant debris modified by aquatic animals. It makes slightly viscous water suspensions and is slightly plastic, but not sticky. The material shrinks upon drying to form clods that are difficult to rewet and often tend to crack along horizontal planes. It has very few or no plant fragments recognizable to the naked eye, a pyrophosphate index of 5 or more, and a dry color value less than 5. Common in Palustrine systems such as infilled basins. It is designated Oco in horizon descriptions.

Diatomaceous Earth: is composed mainly of the siliceous shells of diatoms. It has a matrix color value of 4 ± 1, if not previously dried, that changes on drying to the permanent, light grey or whitish color of diatoms. The diatom shells can be identified by microscope (440 X) examination. Diatomaceous earth has a pyrophosphate index of 5 or more. It is frequently more nearly mineral than organic in composition. It is designated C in horizon descriptions.

Marl: is a soft, unconsolidated earthy deposit consisting of calcium carbonate or magnesium carbonate, or both, and often shells of aquatic animals, usually mixed with varying amounts of clay or other impurities. It has a moist color value of 6±1 and effervesces with dilute HCl. The color of the matrix usually does not change on drying. Marl contains too little matter to coat the carbonate particles. Common in karst topography such as the northern Rocky Mountain trench. It is designated Ck in horizon descriptions.

12 VON POST SCALE OF DECOMPOSITION

The von Post ten-point scale of decomposition is the principal method used to describe organic O horizons. It is a field test in which a small handful of peat is firmly squeezed (too large a sample does not yield consistent results). Three factors are observed: the color of the solution that is expressed between the fingers, the distinctness of the remaining organic fibers, and the proportion of the original sample that remains in the hand. The ten von Post classes are described on page 29 of CSSC (1987) and on page 37 of the 1998 field DEIF.

Peat water content can have a significant impact on the outcome of von Post. A dry, dense humic peat may be only squeeze to a 4 or 5 and a saturated mesic peat may flow easily out of the fist. It is important that the results of the squeeze test be tempered with a more close examination of the residue fibers by rubbing a sample between the thumb and forefinger.

Table 10. The von Post scale of decomposition

Code/Class	Description
1	Undecomposed; plant structure unaltered; yields only clear water colored light yellow brown
2	Almost undecomposed; plant structure distinct; yields only clear water colored 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 pear escapes between the fingers; residue strongly mushy.
7	Strongly decomposed; plant structure indistinct, but recognizable; 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 fibers 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 peat escapes between the fingers.

13 MINERAL SOIL HORIZONS

The criteria for field determination of a gleyed horizon are outlined below.

A Bg or Cg horizon has, for all but red soil material (hue of 5YR or redder).

- dominant chromas of 1 or less or hues bluer than 10Y with or without mottles, or
- dominant chromas of 2 or less in hues of 10YR and 7.5YR accompanied by prominent mottles 1 mm or larger in cross section and occupying at least 2% of the exposed, unsmeared 10 cm layer, or
- dominant chromas of 3 or less in hues yellower than 10YR accompanied by prominent mottles 1 mm or larger in cross section and occupying at least 2% of the exposed, unsmeared 10 cm layer
- For red soil materials (hues of 5 YR or redder)
- distinct or prominent mottles at least 1 mm in diameter occupy at least 2% of the exposed, unsmeared 10 cm layer (CSSC, 1987)

Mottle contrast of mottles refers to the degree of visual distinction between mottles and the "matrix". Gleyed horizons will have "prominent" mottles. DEIF (Luttmerding et al, 1990) defines three mottle contrast classes in terms of various combinations of Munsell color units of hue, value and chroma.

- **Faint:** Evident only on close examination. Faint mottles commonly have the same hue as the color 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 nut low chroma and value can differ by 2.5 units of hue.
- **Distinct:** Readily seen, but contrast only moderately with the color to which they are compared. Distinct mottles commonly have the same hue as the color 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 color to which they are compared by 2.5 units of hue but by no more than 1 unit of chroma and 2 units of value.

- **Prominent:** Contrast strongly with the color to which they are compared. Prominent mottles are commonly the most obvious color feature in a soil. Prominent mottles that have medium chroma and value commonly differ from the color to which they are compared by at least 5 units of hue if chroma and value are the same; at least 4 units of value or chroma if the hue is the same; or at least 1 unit of chroma or 2 units of value if hue differs by 2.5 units.

14 SOIL COLOR

A detailed procedure is given in DEIF (1990) on page 83-85.

The Munsell system uses three elements of color—hue, value, and chroma—to make up a specific color notation.

- **Hue** describes color. The symbol for hue is the letter abbreviation of the color of the rainbow (R for red, YR for yellow-red, and Y for yellow) preceded by numbers from 0 to 10. Within each letter range, the hue becomes more yellow and less red as the number increases.
- **Value** described the strength of the color or degree of lightness. Value ranges from 0 (for absolute black) to 10 (for absolute white).
- **Chroma** indicates the relative purity of color strength (degree of dilution by neutral grey of the same value) and ranges from 0 for neutral grey to 8, the strongest expression of color used for soils.

The notation for a specific color should be recorded in the order of hue, value/chroma. For example, "pale brown" is designated 10YR 6/3.

15 MEASURING AND DESCRIBING PEAT PH AND CONDUCTIVITY

pH and conductivity of water are important parameters to measure in wetlands. pH gives a good indication of nutrient availability in peatlands and should be measured where possible. Conductivity is more important in mineral wetlands, such as marshes, where salinity can be an important ecological constraint. Water samples may be tested in the field or collected for testing in the lab. Collected samples should be kept cool and tested as soon as possible since microbial decomposition may alter the pH of the sample. In peatlands, the pH and conductivity is usually measured from water squeezed from peat of the surface tier. On flooded sites the surface water is measured.

Electronic pH meters are preferred over litmus paper for field testing pH. Low ionic strength pH probes are more expensive but provide more accurate results in acidic peatlands. Field conductivity meters are more expensive but salinity remains relatively constant in stored samples so collection for later lab testing is recommended.

Descriptive terms have been standardized for ranges of measured pH and conductivity values.

pH

- Alkaline (pH > 7.4)
- Circumneutral (pH 6.5 - 7.4)
- Weakly acidic (pH 5.5 - 6.5)
- Moderately acidic (pH 4.5 - 5.5)
- Very acidic (pH < 4.5)

Conductivity

Hydrochemical term	Conductance (uMhos or Seimens @ 25)	Salinity (ppt)
Hypersaline	>60 000	>40
Eusaline	45 000 - 60 000	30.0 - 40
Mixosaline	800 - 45 000	0.5 - 30
polysaline	30 000 - 45 000	18.0 - 30
mesosaline	8 000 - 30 000	5.0 - 18
oligosaline	800 - 8 000	.5 - 5
Fresh	<800	<0.5

16 HORIZON COMMENTS

Comments made for each horizon can provide useful interpretative information.

For Organic horizons

- Type of fibers found in peat such as sedges, *Sphagnum*, brown moss, twigs, logs, *Nuphar* or *Menyanthes* seeds, etc. Record as many as necessary to describe the composition of the horizon, and possibly record them in decreasing order of abundance.
- Density. Terms such as dense, consolidated, unconsolidated and tenacious to describe how well each horizon holds together--structure.
- Presence of Hydrogen Sulfide (H_2S) and/or methane (CH_4)--the smell of rotten eggs. Indicates decomposition in a highly anaerobic environment.
- Approximate texture of mineral enrichment. If mineral enrichment is observed in an organic horizon, its texture may provide information regarding fluvial processes, flood history, etc. However, due to the difficulty of texturing soils with high organic content, it may be easier to record general textures such as fine, medium and coarse.
- Limnic materials (coprogenous earth—color, consistency, etc.)

For Mineral horizons

- soil fauna
- mottles—abundance (none, few, common, many), size (fine, medium, coarse), and color
- clay films
- nature of organic enrichment (woody, rooty, etc.)
- Limnic materials (calcareous marl, visible shells, etc.)

17 HYDROGEOMORPHIC CLASSIFICATION

The hydrogeomorphic classification describes topographic position and geomorphic form of a whole wetland complex, lake or stream reach. This field describes the System, Element Group, and Element of the Wetland and Riparian Ecosystem Classification Framework (MacKenzie and Banner 1999). Six Systems are recognized in WREC: Upland, Palustrine, Lacustrine, Fluvial, Estuary, and Marine. The System defines sites that share the influence of similar dominant water source(s) and hydrological processes, and are characterized by particular geomorphological forms. The Element Group and Element describe the form of landscape unit. The hydrogeomorphic classification put the site in the context of a larger hydrological system.

Table 11 Characteristics of the Hydrogeomorphic Systems relevant to wetlands and related ecosystems

System	Code	Topographic position	Primary Water source	System Hydrology
Palustrine	**P**	Small (< 1ha) or shallow lakes (> 75% area < 2m deep), basins, and seepage slopes	Groundwater, Precipitation, or Stream and Lake flooding	Low energy flooding or groundwater fed
Lacustrine	**L**	Large (> 1ha) and deep water bodies	Lake flooding	Subject to flooding by wave action; fed by circulating lake waters
Fluvial	**F**	Adjacent to creeks, streams, or rivers.	Stream flooding	Subject to annual stream flooding and erosion/ deposition forces; stream fed
Estuary	**E**	Confluence of freshwater inflow into marine environment	Stream and ocean flooding	Subject to diurnal or periodic flooding and brackish water
Marine	**M**	Ocean	Ocean flooding	Intertidal and subtidal locations
Upland	**U**	Any	Precipitation and groundwater	Soil moisture not in excess.

Palustrine System

Palustrine Systems occur in basins, depressions, or slopes with poor drainage that collect water flows from surrounding lands or other locations where excess water inputs lead to prolonged soil saturation. Palustrine systems are often peatlands in cool and moist climates, and shallow water ponds and marshes in more arid climates. Palustrine sites have low hydrological flow relative to other Systems described here. Open water bodies < 1ha or larger water bodies where >75% of the aerial extent is shallow waters < 2m depth at mid-summer are part of the Palustrine system. Open water bodies greater than one hectare in size and deeper than 2m for > 25% of their aerial extent are part of the Lacustrine system. Ponds that are affected by seasonal floodwaters (such as some oxbow lakes) are considered to be part of the Fluvial System. Sites affected by tidal cycles are considered part of the Estuary System.

Lacustrine System

Lacustrine Systems are lakes and adjacent sites directly affected by lacustrine processes, such as exposure to wave action, sedimentation and relatively high nutrient content of floodwaters. The Lacustrine System includes water bodies with the following characteristics:

- situated in a topographic depression;
- open water covers over one hectare;
- water depth in the deepest part of the basin exceeds 2m at low water, and
- Water less than 2m or extent of area occupied by emergents or floating leaved aquatics(which ever is greater) occupies less than 25% of the total area.

Wetland ecosystems of the Lacustrine system generally occur along the shallow fringes of deeper water habitats. The amount of wetland associated with lakes depends on shore slope, water fluctuations, and erosional forces (Pieczynska 1990).

Fluvial System

The Fluvial System occurs along flowing watercourses and encompasses the watercourse itself as well as the surrounding (riparian) ecosystems. It includes those watercourses and their adjacent ecosystems where stream flow has erosive power (indicated by stratified mineral substrates or flood plains) and at least intermittent surface or subsurface water flow from the watercourse. Fluvial systems occur where processes such as seasonal flooding by flowing waters and sedimentation predominate in ecosystem function.

Flooding events create predictable disturbance patterns along stream corridors. Persistent but dynamic ecosystem complexes result that have high structural diversity and are very valuable for wildlife. Regional processes such as climate, physiography, geology and local geomorphic factors control the expressed pattern (Lotspeich 1980).

Estuary System

The Estuary System consists of intertidal habitats where ocean water is at least occasionally diluted by freshwater runoff from the land. Estuary systems occur at the confluence of rivers and oceans, and have unique characteristics that reflect the flooding and salinity gradients found there. The estuary system extends from those areas where salinity is high and fresh water inputs are minimal to upstream sites with minimal saltwater influence but regular tidal flooding. The salinity may be periodically increased above that of the open ocean by evaporation. Estuary systems generally have high nutrient and sediment inputs (Price 1990; Holland et al. 1990) Variation in salinity and flooding regimes are the important driving factors in these systems.

Marine System

Marine Systems are exposed to the waves and currents of the open ocean, and the water regimes are determined primarily by the ebb and flow of oceanic tides. Salinity exceeds 30 ppt with little or no dilution except outside the mouths of estuaries (see Wedge Ecosystem Realm).

The Marine system describes the open ocean overlying the continental shelf and its associated high-energy coastline. Shallow coastal bays with little freshwater inflow and rocky islands are considered part of the Marine system as are deepwater habitats adjacent to estuaries that have a freshwater lens. The marine system extends from the outer edge of the continental shelf shoreward to the landward limit of extreme high-water, the seaward limit of wetland emergents, or the seaward limit of the estuarine system (after Cowardin et al. 1979

Upland System

Upland systems occur on well-drained sloping, level, or depression sites. This system encompasses areas where soil moisture deficits are common and where prolonged soil saturation or flooding does not occur. Water source is predominantly from precipitation and ground water seepage.

Table 12. Hydrogeomorphic units and codes

System	Code	Element Group	Element	Code
Palustrine	**P**	Basin	Closed	Pbc
			Overflow	Pbo
			Linked	Pbl
		Slope	Slope	Pss
			Toe	Pst
			Delta	Psd
			Blanket	Psb
		Pond	Closed	Ppc
			Linked	Ppl
			Overflow	Ppo
			Terminal	Ppt

17.2 Palustrine Hydrogeomorphic units

There are three Element Groups described in WREC that reflect different hydrological regimes and developmental pathways for peatlands. Elements of the Palustrine System are adapted from Ivanov (in Ingram 1983) and Runka and Lewis (1981). These categories describe linkage as well as hydrological flow regime and likely developmental pathways for peatlands.

Basin Element Group

Basins are topographic depressions that collect water from precipitation, groundwater, or slow moving channels. These sites are generally semi-terrestrial peatlands but may have a minor cover of shallow water in the form of flarks or small peatland ponds. Sites dominated by shallow water are described by the Pond Element Group.

Closed Basin (Pbc)

Basin receives water from surrounding upland only; has no inlet or outlet channel. Peatland development often favors a domed form.

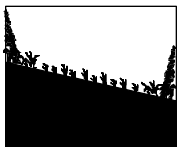
Overflow Basin (Pbo)

Basin receives water from upland only; excess water flows through an outlet channel. Peatland development of favors a domed form with a peripheral moat.

Linked Basin(Pbl)

Basin receives water from upland and an inflow stream; excess water flows though an outflow. Includes wetlands along slow streams where there is little or no erosion or sedimentation. Peat accumulation is often more advanced in peripheral locations.

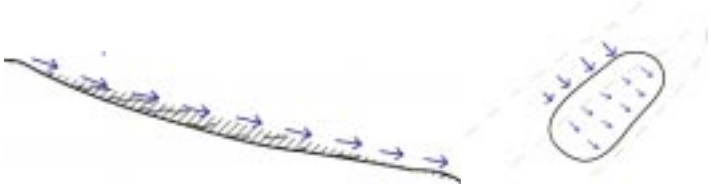
Slope Element Group



Palustrine Slopes are gradual to steeply sloping sites where constant seepage maintains permanently saturated conditions frequently leading to the accumulation of peat.

Seepage Slope (Pss)

Gradual to steep slopes where continual seepage remains near or at the surface.



Toe Slope (Pst)

Site occurring at a slope break where water is forced to the surface . Site is not confined to a basin; water received from upslope groundwater or channeled flow.

Delta slope (Psd)

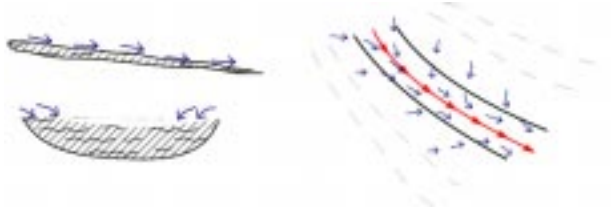
Sites similar to toe slope but where the water source radiates from the terminus of a channel or spring

Blanket Slope (Psb)

Site occur in subdued topography where a basin or slope is not definable. Wetland can occupy slopes, level ground and depressions.

Linked Hollow or Channel (Phl)

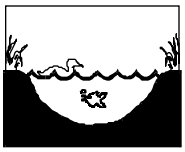
hollow receives water from upland and an inflow stream; excess water flows though an outflow. Includes wetlands along slow streams where there is little or no erosion or sedimentation



Overflow Hollow (Pho)

Hollow receives water from upland only; excess water flows through an outlet channel

Pond Element Group



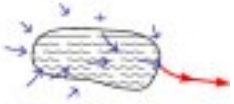
Palustrine sites that are primarily standing water for much of the growing season are defined by the Pond Element Group. Sites are generally not peatlands except for small lakes with a peatland fringe. Most sites are dominated by shallow water habitats and marshes.

Closed Pond (Ppc)

Pond has no obvious inlet or outlet and receives water from surrounding upland through surface and groundwater flow. Site probably has weak groundwater inflows and may be alkaline or saline due to evaporation.

Overflow Pond (Ppo)

Pond with outlet channel but no inflow. An outlet that remains flowing for much of the year or a raised topographic position may indicate that the pond is fed by springs.

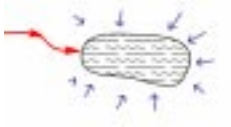


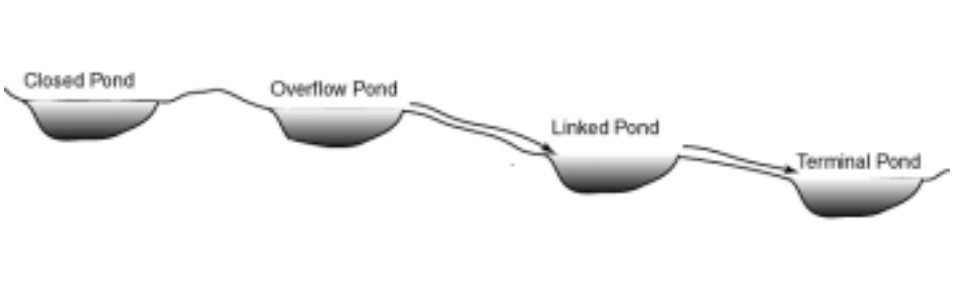
Linked Pond (Ppl)

Pond receives water from upland and an inflow stream; excess water flows though an outflow. Includes wetlands along slow streams where there is little or no erosion or sedimentation.

Terminal Pond (Ppt)

Pond receives water from upland and an inflow stream; no outlet. Excess water is lost through evaporation and pond is likely to be saline or alkaline.





17.3 Fluvial Hydrogeomorphic units

Table 13 Hydrogeomorphic element groups and element of the Fluvial system.

Element Group	Element	Code
	Anabranching	Fab
	Delta	Fad
	Fan	Faf
	Tortuous meander	Fat
Transport	Meander	Ftm
	Confined meander	Ftc
	Braided	Ftb
	Sinuous	Fts
	Wandering	Ftw
Headwater	Gully	Fhg
	Canyon	Fhc
	Slope	Fhs

Fluvial Elements

Fluvial Elements are the equivalent of the Stream Reach (Frissel 1986) but describe the riparian area as well as channel form. Fluvial Elements integrate a consistent range of physical and biological features, which are manifested in channel and flood plain pattern (Maxwell et al. 1995). Channel pattern and entrenchment are used primarily to describe the Element as they correlate to other important features such as channel materials, pool/riffle/glide ratios and gradient. The follow elements have been derived from Frissel (1986), Kellerhals and others (1976), and Rosgen (1994)

Alluvial Element Group (Fa)

Associated with low gradient streams where flood plain building processes predominate; flooding and subsequent deposition of alluvium leads to extensive flood plains of sandy or silty soils.

Anastamosing Elements (Faa)

Alluvial stream reaches where channels diverge and converge around many vegetated islands. The islands are vegetated and have surfaces that are relatively high above mean maximum discharge levels. Channels may be dry at moderate or low flows. This type of channel pattern is common on low gradient reaches of large systems where slowing currents and/or widening valley constraints result in deposition of stable gravel and sand islands. Anastamosing elements usually occur in systems where flood levels are substantially above mean flow for extended periods resulting in high midchannel depositional islands. Colonization of these islands by shrub and tree species promotes stabilization and further deposition. Anastamosing elements typically have a high percentage of riparian ecosystem on islands and along channel edges. Flood plains are also often associated with anastamosing systems resulting in broad and diverse riparian areas.

Tortuous Elements (Fat)

Alluvial stream reaches with a more-or-less repeated pattern characterized by angles greater than 90 between channel axis and the valley trend. These elements are commonly associated with sand-bed streams with vertical accretion of alluvial deposits (Church). Very low gradient and relatively low flood intensity are typical. Valleys with tortuous elements are generally broad (relative to stream width) and flat. This coupled with close association of adjacent meanders results in an abundance of slowly flowing subsurface ground waters that emphasizes the distribution of riparian and wetland communities in these elements.

Delta Elements (Fad)

Alluvial stream reaches at the confluence of streams and rivers and still waters. These elements are similar to Fan elements as they result from a lowering of gradient and valley constraint is such a way that the stream course becomes free to branch in many directions. However, deltas are characteristically built of fine sediments deposited as rivers flow into still waters giving them a characteristic form and community compliment. Deltas are frequently dominated by wetland ecosystems due to the high water levels; marshes are the most typical wetland class due to the high nutrient status of these systems.

Fan Elements (Faf)

Alluvial stream reaches that form where constrained reaches enter a less constrained plain forming a fan of alluvium. Fans may have one or more channels and channel course changes are common. Groundwater seepage throughout the fan is common. Unlike Deltas which flow into water bodies and are relatively flat, fans flow onto slopes and retain a shallow gradient. Fans are therefore dominated by seepage system wetlands or terrestrial seepage forests.

Anabranching Elements (Fab)

Alluvial stream reaches that have small channel widths less than three times the width of stable instream islands at mean water flows. These elements are common in meadow streams with little power to erode stable instream islands.

Transport Element Group

Associated with moderate gradient mix-load or semi-controlled streams where neither erosion or deposition forces predominate; flood plain development is related to the degree of stream meander (which emphasizes points of deposition) and degree of confinement but is usually limited and discontinuous. In-stream bars and gravelly soils common.

Meandering Elements (Ftm))

Transport stream reaches that have a clearly defined channel characterized by a regular and repeated pattern of bends with relatively uniform amplitude and wave length. Meanders occur where stream power is strong enough to erode banks. Irregular meanders occur where bank material changes resulting in differential erodability.

Confined Meandering Elements (Ftc)

Transport stream reaches that are similar to Regular Meandering Elements but are incised into bedrock or glaciofluvial deposits. Riparian communities are usually not extensive in these areas and are also somewhat isolated from the surrounding landscape.

Sinuous Elements (Fts)

Transport stream reaches that have a clearly defined channel with a slight curvature with a belt width of less than approximately two channel widths (Kellerhals et al. 1976)). Low gradient or erosion resistant banks prevent the formation of meanders. Riparian ecosystems occur on the fringe and occasionally lateral bars.

Wandering (Irregularly Sinuous) Elements (Ftw)

Transport stream reaches that have a single clearly defined main channel displaying irregular turns and bends without repetition of similar features; back channels may be common and minor side channels and a few bars and islands may be present but regular and irregular meanders are absent. Common on gravel-bed streams with high bedload.

Braiding Elements (Ftb)

Transport stream reaches that are characterized by many diverging and converging channels separated by unvegetated bars and temporary islands of gravel and sand. Many channels are dry at moderate and low flows, but during major floods the entire channel zone may be occupied by flowing water. These elements typically have erodable banks and gravel or larger cobble bedload. Periodic high flows shift this bed load suppressing the establishment of vegetation (Summerfield 1991). Riparian flood plains are not common since the active channels itself can accommodate a wide range of flows. Plant communities may establish on more stable gravel islands.

Headwater Element Group

Associated with high gradient streams where erosional processes predominate. Channel gradient generally precludes the formation meanders, flood plain or island formation. Cobble, stone, or bedrock substrates are typical. Fringe Classes predominate.

Gully elements (Fhg)

Headwater stream reaches that have constraining slopes of 40% gradient or more and generally have little sinuosity usually due to lateral constraints and high gradient (>20%). (Forest Practices Code 1995)

Canyon Elements (Fhc)

Headwater stream reaches that are deeply incised and slopes are precipitous.

Slope Elements (Fhs)

Steep headwater stream reaches that are relatively unconfined. Vertical steps with deep scour pools and waterfalls.

17.4 Lacustrine Hydrogeomorphic units (Draft)

The following units are derived primarily from the Hutchinson (1957) as presented in the Reconaissance Fish and Fish Habitat Inventory: Standards and Procedures (RIC June, 1997). The Lake Elements are listed under their most likely Element Group however some examples of an Element may have characteristics that would place the unit in another Element Group.

Table 14 Hydrogeomorhpic element groups and elements of the Lacustrine system

Element Group	Element	Code
Anthropogenic	Reservoir	Lar
	Quarry	Laq
	Dugout	Lad
Littoral	Peatland	Llp
	Levee	Lll
	Oxbow	Llo
	Ground moraine	Llm
	Glacial Kettle	Llk
	Dead ice complex	Lli
Deep water	Dammed	Ldd
	Glacial Ice	Ldi
	Glacial scour	Lds
	Cirque	Ldc
	Fjord	Ldf
	Piedmont	Ldp
	Moraine	Ldm
	Solution	Lds

Anthropogenic Lake Element Group (La)

Water bodies created by human activities including reservoirs, dugouts, and water-filled quarries.

Reservoir Lake Element (Lar)

Lakes formed when streams are dammed.

Quarry Lake Element (Laq)

Water-filled, abandoned open pit mines and rock quarries

Dugout Lake Element (Lad)

Small lakes excavated to create a water source for agriculture or aquaculture

Littoral Lake Element Group

Lakes with a high percentage (>25% and < 75%) of shallow water (< 2m usually evidenced by floating leaved aquatic plants).

Peatland Lake Element (Llp)

Lakes that are bounded by extensive blanket peatland.

Levee Lake Element (Lll)

Lakes formed behind a stream bank or lake levee. Frequently these sites will be shallow and therefore be described by the Palustrine system or part of the active flood plain (Fluvial system).

Oxbow Lake Element (Llo)

Lakes formed in oxbows formed by meander bend cut off and channel.

Ground Moraine Lake Element (Llm)

Lakes in basins of glacial till plains.

Glacial Kettle Lake Element (Llk)

Lakes formed in depression left by the eventual melting of large ice blocks that persisted in outwash plains during deglaciation. Commonly referred to as "potholes" these are often small in size. Smallest examples will fall under the Palustrine system

Dead Ice Complex Lake Element (Lli)

Similar to Glacial Kettle Elements but where more extensive sheets of ice left larger water bodies and multiple basins that are commonly crossed by eskers or kames.

Deepwater Lake Element Group

Lakes with relatively steep shorelines and little littoral area such as those formed by glacial scour, fjord flooding, and flooding of moraine depressions

Dammed Lake Element (Ldd)

Lakes form by damming by lava flows, rock slides, or alluvial fans

Glacial Ice Lake Element (Ldi)

Lakes in direct contact with ice or dammed by moraines in direct contact with ice.

Glacial Scour Lake Element (Lds)

Lake formed in basins scoured into rock, usually very irregular and have several basins.

Cirque Lake Element (Ldc)

Lakes situated in a cirque. Always in mountainous regions and often at higher elevations.

Fjord Lake Element (Ldf)

Lakes in long sinuous valleys with steep bedrock valley walls. Often large, extremely deep and with a low ratio of littoral area.

Piedmont Lake Element (Ldp)

Lakes located along the face of mountain ranges or on coastal plains.

Moraine Lake Element (Ldm)

Lakes formed by the damming of a valley or other depression by unconsolidated, glacially derived materials.

Solution Lake Element (Lds)

Lakes formed in basins formed by the dissolution of limestone, gypsum, or salt.

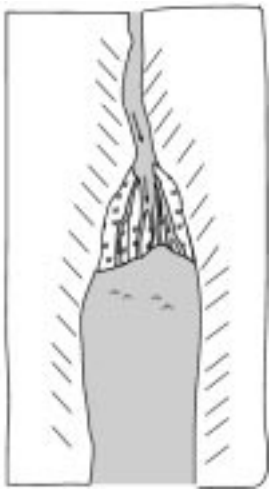
17.5 Estuary Hydrogeomorphic units

Table 15 Hydrogeomorhic element groups and elements of the Estuary system

Element Group	Element	Code
Constrained	Fjord	Fcf
	Fjard	Fcj
	Ria	Fcr
Protected	Coastal Plain	Epp
	Strand	Eps
	Lagoon	Epl
	Spit	Epl
Exposed	Delta	Eed
	Fan	Eef

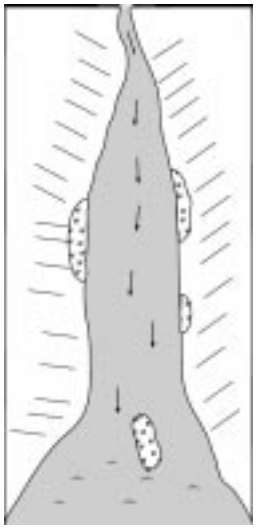
Constrained Estuary Element Group (Ec)

Estuary is constrained by steep valley walls. Often adjacent to deep water



Fjord Estuary Element (Ecf)

Estuary highly constrained by steep valley walls. Estuarine communities occur only at the head of Fjord



Fjard Estuary Element (Fcj)

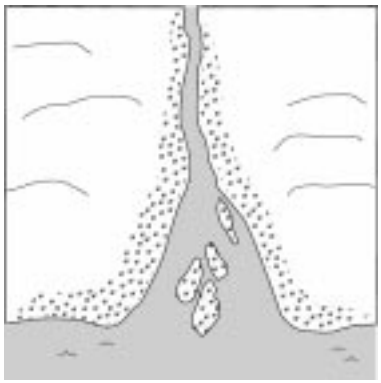
Constrained estuary as in a fjord but larger river systems push freshwater through most of the length of the inundated fjord. Lateral development of estuarine communities.

Ria Element (Fcr)

Eatuaries in broader valley that are moderately constrained usually with pronounced meanders at the river confluence.

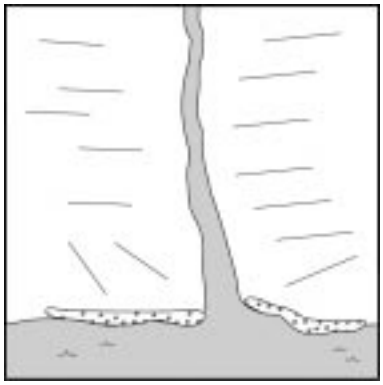
Protected Estuary Element Group

Estuary in a protected (but not constrained) location that is not subject to powerful wave action or tidal currents.



Coastal Plain Estuary Element (Epp)

Funnel shaped estuary with low relief and often with sediment islands and bars exposed to the ocean



Strand Estuary Element (Eps)

Estuary dominated by narrow estuary development on beach or shoreline adjacent to stream or river inflow

Lagoon Estuary Element (Epl)

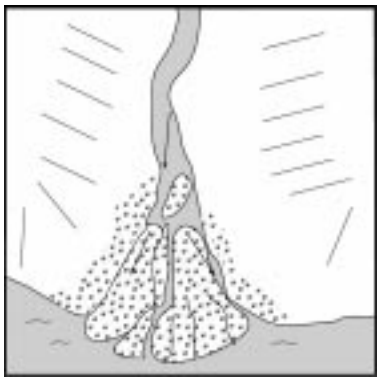
An enclosed bay fed by freashwater with little current, wind or, tidal mixing

Spit Estuary Element (Epl)

Estuary formed behind a spit. "L" shaped in plan view

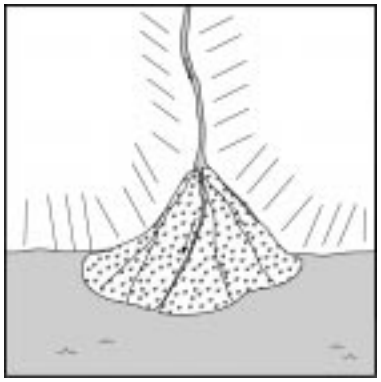
Exposed Estuary Element Group

Estuary on coastline and relatively unprotected from wave action or tidal currents but delta persists because of high sediment inputs (Deltas) or because sediments are mainly large coarse fragments (Fans).



Delta Estuary Element(Eed)

Estuary dominated by a delta formed by riverine sediments deposited into the ocean. Often very large systems.



Fan Estuary Element (Eef)

Small estuaries formed at the terminus of small headwater creeks. Estuary fan-shaped, sloping, and usually rocky rather than fine-textured.

18 WATER SOURCE

Describes water source for a wetland that has the dominant influence over its ecology.

Table 16 Water source code and description

Code	Description
E	Estuary; Tidal brackish water
F	Stream sub-irrigation and flooding
G	Groundwater
I	Ice or Permafrost Melt
L	Lake or pond flooding
M	Mineral Spring
P	Precipitation
S	Snowmelt (prolonged through the growing season)
T	Tidal, Freshwater

19 DRAINAGE

For organic soils, the following are Soil Moisture Subclasses that describe duration of saturation within a wetland. These descriptors are qualitative and must be inferred unless repeated assessments are made over the course of the growing season. Site assessment in the mid to late growing season will give some indication of the length of saturation.

Table 17 Drainage (soil moisture subclasses) for Organic soils

Drainage class	Code	Description
Humid	**hu**	Soils with slight growing season water deficits. Saturated for <0.5 months and moist for 8-11.5 months of the year. Usually sites that have declining water tables; occasionally plateau bogs. Upland species may be invading site or surface cryptograms may be abundant.
Perhumid	**ph**	Soils with no significant seasonal water deficits. Saturated for <2 months and moist for 8-11.5 months. Sites with declining water tables or raised bogs. May have invasions by upland species or have abundant surface cryptograms.
Subaquic	**sa**	Soils saturated for short periods. Saturated for <4mo and moist for 8-11.5 months. Very hummocky or slightly raised sites. Sites may have trees.
Aquic	**ac**	Soils saturated for moderately long periods. Saturated for 4-10 months and moist for 2-8 months. Sites that have free surface water during the early season but mid-season draw down because of evapotranspiration of falling water table leaves the upper tier with some aeration. Sites may have trees on elevated sites
Peraquic	**pa**	Soils saturated for very long periods. Saturated for >10 months and moist for <2. Sites that have free surface water during the early season but late season draw down leaves the upper tier with some aeration. Rarely treed unless significant aerated groundwater through flow

Aqueous	**aq**	Soils with permanent free surface water. Saturated for 11.5-12 months and moist for <0.5 months. Floating mats and areas directly adjacent to water bodies that do not have fluctuating water levels.

20 FLOOD REGIME

The Flood regime is described by frequency and Seasonal duration. Flooding is defined as immersion of substrate by water (ie. saturated peats that are not covered by surface water are not flooded). Flooding regime may be coded by single or two letter codes as appropriate (e.g. **AW** = annual flooding in winter (Cw - Slough sedge); **OB** = Occasional flooding for brief periods (Ss - False-lily-of-the-valley High Bench); **N** = never flooded (Pl - Ledum – Sphagnum Bog); **FT-AM** = frequently temporarily flooded to annually mainly flooded (Beaked Sedge - Water sedge Marsh)

Table 18 Flood frequency categories and descriptions

Code	Description
A	annually flooded (at least once/year)
F	frequently flooded (every 2-5 years)
O	occasionally flooded (> 5 years interval between flooding)
R	rarely flooded (only during extreme events)
N	never flooded

Table 19 Annual flood duration categories and descriptions

Code	Description
W	winter flooding (dormant season)
P	permanent or semi-permanent flooding during growing season
E	extended flooding (exposed only during last part (< 1 month) of growing season)
M	moderate flooding (flooded for > 1 month and < 3 months; exposed substrate for prolonged periods of the growing season)
T	temporary flooding (between 7 days and 1 month) of the growing season
B	brief flooding (<7 days) of the growing season
D	diurnal flooding

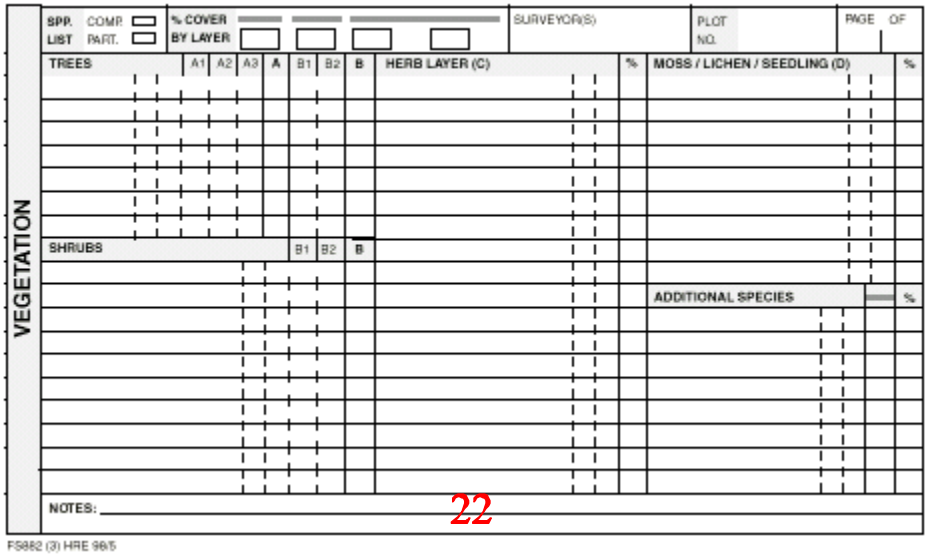
Table 20. Flood frequency characteristics (adapted from Luttmerding et al. 1990)

Description	Overbank deposits	Fluvially transported debris	Vegetation	Terrain and Topography	Soils and Humus
Annually Flooded most years	Recent deposits of new fluvial material evident	Fluvially deposited wood evident on ground and often in shrubs and trees	No vegetation, species typical of primary colonization or hydrophytes	Low lying areas in back channels or bars and flats in the active channel	Regosols; LFH, A and B layers absent. Gleysols on poorly drained sites
Frequently Flooded every 2-5 years	Recent deposits of new fluvial material evident. Buried LFH layers	Deposited wood evident on ground and often in shrubs and trees	Tall shrub and deciduous trees tolerant of prolonged flooding	Low lying areas on levees or floodplains often adjacent to the active channel	Regosols; A and B layers absent. Thin LFH and buried organics may be present. Gleysols on poorly drained sites
Occasionally Flooded at > 5 year intervals	Thin deposits of recent material and buried LFH layers are possible	Woody debris may be present	Deciduous and coniferous trees	Moderately elevated areas of floodplains or fans	Regosols occasionally Brunisols. Moderatelyh developed LFH and thick buried LFHs common
Rarely Flooded only during exceptional events	Thin fluvial lenses may be present	Usually not present	Upland vegetation	Low terraces and inactive portions of fans and floodplains	Typical upland soils usually derived from Fluvial materials
Never	None	Not present	Upland vegetation	Well above water course on glaciofluvial terraces or upland.	Typical upland soils.

21 SOILS NOTES

General notes about the soil and terrain should be made here. A synopsis of the soil pit and terrain, expected variability across the site, characteristics particular to the site, possible modifying factors or disturbance notes in the soil description can be explained here.

VEGETATION CARD



[to add--Methods and examples of assessing cover]

22 VEGETATION NOTES

General notes about vegetation community variability and other observations should be made here. Species specific information should be noted here though actual values should be marked beside species in the list. Some possible factors to note are:

- Homogeneity of vegetation;
- Height of shrubs and trees;
- Vegetation-microtopography relationships;
- Phenology;
- Land Cover type;
- Collection numbers;
- Species identification difficulties (e.g. lack of flowers).
- Indicate in the species list which species occur on the different positions.

The Cover Type

The cover type is a useful attribute for broad scale inventory, identifying and describing physiognomically similar site associations (i.e. Shrub swamps), and providing a "cross-walk" between airphoto signatures and species associations. These cover classes are outlined in RIC (1995)

23 REFERENCES

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APPENDIX I
KEY TO SITE IDENTIFICATION OF WETLAND AND RELATED ECOSYSTEM CLASSES

1a Soil drainage poor or very poor and soil moisture subhydric or hydric. Soils mostly Gleysols or Organics. Wetland indicator species > 20% of total herb cover or 60% of bryophyte cover. **Wetland Ecosystems**---------- 2

1b Soil drainage imperfect to rapid; soil moisture regime hygric or drier. Soil types variable. Wetland indicators < 20% of total herb cover or 60% of bryophyte cover **Terrestrial Ecosystems** 8

Wetlands

2a Sites with mineral soil or a surface tier of well-humified woody peat or limnic material, or site with > 20% swamp indicators **Mineral Group** 3

2b Sites with surface tier dominated by fibric or mesic sedge or moss peat. Swamp indicators < 20% **Peatland Group**---------- 6

- 3a Sites shrubby or treed (> 10% cover) ---------- **Swamps**
- 3b Sites with no or very sparse cover of shrubs and trees (< 10% cover)---------- 4
  - 4a Sites with > 10% cover of emergent graminoids or horsetails---------- **Marshes**
  - 4b Sites with < 10% cover of emergent graminoids or horsetails---------- 5
    - 5a Sites with > 10% cover of submerged or floating aquatics --- **Shallow water**
    - 5b Sites with < 10% cover of vegetation ------ **Unclassified aquatic ecosystem**
- 6a Minerotrophic indicators uncommon (<10% cover); hummock-forming *Sphagnum* species usually prominent. Peat pH < 4.5 ---------- **Bogs**
- 6b Minerotrophic indicators prominent (> 10% cover). Bryophyte layer commonly brown mosses or non-hummock forming *Sphagnum* spp. Peat pH > 5.0. ---------- **Fens**

Terrestrial Ecosystems

8a Sites always adjacent to rivers or large lakes and periodically or annually flooded and affected by sedimentation and erosion. Generally poorly developed soils (e.g. Regosols) of layered fluvial materials. Tall shrub or treed cover type. **Flood Group** --------10

8b Sites not inundated by flood waters. Soils non-cumulic and generally with some profile development.---------- 9

- 9b Sites affected by special site factors such as severe cold air ponding, avalanching, or soil salinity that lead to “disclimax” shrub or herbaceous communities on sites that would normally support forested climax ecosystems. **Transition Group**----------13
- 9a Sites not affected by special site factors such as severe cold air ponding, avalanching, or soil salinity. Normal forest or grassland climax communities or non-forested successional communities ---------- **Sites described by BEC**

Flood Group

10a Sites flooded annually for at least moderate periods (> 30 days), always immediately adjacent to water bodies and not much elevated. Soils of layered fluvial material with no horizon development. Tree cover < 10% ----------11

10b Sites flooded less frequently than annually and usually only for brief or temporary periods. May be adjacent to active channel or at some distance from open water on elevated benches and terraces. Soils of layered fluvial materials with some horizon development----------12

- 11a Sites with continuous shrub cover flooded for moderate periods ---------- **Low bench**
- 11b Sites with sparse shrub cover or dominated by herbaceous vegetation (>10% cover). Flooded for prolonged periods----------**Active channel**

12a Sites flooded only occasionally/rarely and for brief periods (<7days). Coniferous trees usually predominate. Understory vegetation resemble seepage sites in upland ---------- **High bench**

12b Sites flooded occasionally (every 2-5 years) for temporary periods (<30 days). Deciduous trees predominate; conifers limited to elevated microsites.---------- **Mid bench**

Transition Group

13a Sites with well developed shrub layer (>10% shrub cover)Frost hollows or gradual slopes experiencing cold air drainage. Mainly in cold and dry climates. Low willows and scrub birch common dominants ---------- **Shrub-carrs**

13b Sites with well developed graminoid or forb layers (< 10% shrub cover)----------14

14a Sites with graminoids > 50% of the herb layer. Mainly in subzones with natural grasslands. Soils often saline (e.g. IDF, SBS, BG, PP)**Graminoid meadows**

14b Sites with forbs > 50% herb layer < 50% non-graminoid. Mainly in cool, wet suzbones (e.g. ESSF, SBS, ICH). Soils never saline --- **Forb meadows**

APPENDIX II
A LIST OF SPECIES COMMON ON HYDRIC OR SUBHYDRIC MOISTURE REGIMES

Lifeform	Scientific Name	Scientific Name
Conifers	*Larix laricina*	*Pinus contorta var. contorta*
	Picea mariana	
Deciduous trees	*Alnus tenuifolia*	*Salix lucida*
	Betula occidentalis	*Salix lucida ssp. caudata*
	Malus fusca	*Salix lucida ssp. lasiandra*
	Salix amygdaloides	
Ericaceous shrubs	*Chamaedaphne calyculata*	*Ledum groenlandicum*
Deciduous shrubs	*Betula glandulosa*	*Salix hookeriana*
	Betula pumila	*Salix lanata*
	Cornus stolonifera	*Salix lanata ssp. richardsonii*
	Myrica gale	*Salix maccalliana*
	Physocarpus sp.	*Salix melanopsis*
	Salix arbusculoides	*Salix pedicellaris*
	Salix athabascensis	*Salix planifolia*
	Salix barclayi	*Salix pseudomonticola*
	Salix barrattiana	*Salix pyrifolia*
	Salix candida	*Spiraea douglasii*
	Salix commutata	*Vaccinium uliginosum*
Ferns and Horsetails	*Azolla filiculoides*	*Isoetes howellii*
	Azolla mexicana	*Isoetes maritima*
	Botrychium ascendens	*Isoetes nuttallii*
	Botrychium simplex	*Isoetes occidentalis*
	Equisetum fluviatile	*Isoetes truncata*
	Equisetum palustre	*Lycopodiella inundata*
	Equisetum sylvaticum	*Marsilea vestita*
	Equisetum variegatum	*Matteuccia struthiopteris*
	Huperzia miyoshiana	*Ophioglossum pusillum*
	Isoetes bolanderi	*Phegopteris connectilis*
	Isoetes echinospora	
Grasses and Sedges	*Agrostis scabra*	*Carex brunnescens*
	Alopecurus aequalis	*Carex buxbaumii*
	Arctophila fulva	*Carex canescens*
	Beckmannia syzigachne	*Carex canescens ssp. arctaeformis*
	Calamagrostis stricta	*Carex canescens ssp. canescens*
	Carex ablata	*Carex capillaris*
	Carex anthoxanthea	*Carex chordorrhiza*
	Carex aquatilis	*Carex comosa*
	Carex arcta	*Carex crawei*
	Carex atherodes	*Carex crawfordii*
	Carex athrostachya	*Carex cusickii*
	Carex aurea	*Carex diandra*
	Carex bebbii	*Carex disperma*

Lifeform	Scientific Name	Scientific Name
Grasses and Sedges	*Carex echinata ssp. phyllomanica*	*Carex vulpinoidea*
	Carex exsiccata	*Catabrosa aquatica*
	Carex feta	*Cyperus aristatus*
	Carex flava	*Cyperus erythrorhizos*
	Carex glacialis	*Distichlis spicata*
	Carex glareosa	*Dulichium arundinaceum*
	Carex gmelinii	*Echinochloa crusgalli*
	Carex gynocrates	*Eleocharis acicularis*
	Carex heleonastes	*Eleocharis atropurpurea*
	Carex hystericina	*Eleocharis kamtschatica*
	Carex illota	*Eleocharis ovata*
	Carex interior	*Eleocharis palustris*
	Carex interrupta	*Eleocharis parvula*
	Carex krausei	*Eleocharis quinqueflora*
	Carex laeviculmis	*Eleocharis rostellata*
	Carex lanuginosa	*Eleocharis sp.*
	Carex lapponica	*Eleocharis tenuis*
	Carex lasiocarpa	*Eriophorum angustifolium*
	Carex lenticularis	*Eriophorum brachyantherum*
	Carex leptalea	*Eriophorum callitrix*
	Carex limosa	*Eriophorum chamissonis*
	Carex livida	*Eriophorum gracile*
	Carex loliacea	*Eriophorum scheuchzeri*
	Carex lyngbyei	*Eriophorum virginicum*
	Carex macrochaeta	*Eriophorum viridicarinatum*
	Carex magellanica	*Glyceria borealis*
	Carex magellanica ssp. irrigua	*Glyceria canadensis*
	Carex membranacea	*Glyceria elata*
	Carex microchaeta	*Glyceria grandis*
	Carex microglochin	*Glyceria leptostachya*
	Carex nigricans	*Glyceria maxima*
	Carex obnupta	*Glyceria occidentalis*
	Carex pauciflora	*Glyceria pulchella*
	Carex pluriflora	*Glyceria striata*
	Carex podocarpa	*Juncus albescens*
	Carex prairea	*Juncus arcticus*
	Carex praticola	*Juncus bufonius*
	Carex retrorsa	*Juncus drummondii*
	Carex sartwellii	*Juncus effusus*
	Carex saxatilis	*Juncus ensifolius*
	Carex scoparia	*Juncus kelloggii*
	Carex simulata	*Juncus mertensianus*
	Carex sprengelii	*Juncus oxymeris*
	Carex stylosa	*Juncus regelii*
	Carex sychnocephala	*Juncus stygius*
	Carex tenuiflora	*Juncus supiniformis*
	Carex tracyi	*Kobresia sibirica*
	Carex trisperma	*Leersia oryzoides*
	Carex unilateralis	*Luzula groenlandica*
	Carex utriculata	*Muhlenbergia glomerata*
	Carex vaginata	*Phalaris arundinacea*

Lifeform	Scientific Name	Scientific Name
	Carex viridula	*Phragmites australis*
Grasses and Sedges	*Pleuropogon refractus*	*Scirpus microcarpus*
	Poa eminens	*Scirpus nevadensis*
	Poa leptocoma	*Scirpus olneyi*
	Puccinellia distans	*Scirpus pallidus*
	Puccinellia nutkaensis	*Scirpus setaceus*
	Puccinellia nuttalliana	*Scirpus subterminalis*
	Puccinellia pumila	*Scirpus supinus*
	Rhynchospora alba	*Scirpus supinus var. saximontanus*
	Rhynchospora capillacea	*Scirpus validus*
	Scirpus acutus	*Scolochloa festucacea*
	Scirpus americanus	*Spartina gracilis*
	Scirpus cernuus	*Spartina patens*
	Scirpus cyperinus	*Torreyochloa pallida*
	Scirpus cyperinus var. brachypodus	*Torreyochloa pauciflora*
	Scirpus fluviatilis	*Trichophorum alpinum*
	Scirpus maritimus	*Trichophorum cespitosum*
	Scirpus maritimus var. paludosus	*Trichophorum pumilum*
Herbs and Forbs	*Acorus americanus*	*Centaurium exaltatum*
	Adoxa moschatellina	*Centunculus minimus*
	Alisma gramineum	*Ceratophyllum demersum*
	Alisma plantago-aquatica	*Ceratophyllum echinatum*
	Amerorchis rotundifolia	*Chrysosplenium tetrandrum*
	Ammannia coccinea	*Chrysosplenium wrightii*
	Ammannia robusta	*Cicuta bulbifera*
	Anemone occidentalis	*Cicuta douglasii*
	Angelica arguta	*Cicuta maculata*
	Angelica genuflexa	*Cicuta virosa*
	Aphragmus eschscholtzianus	*Coptis aspleniifolia*
	Aster borealis	*Coptis trifolia*
	Aster modestus	*Crassula aquatica*
	Berula erecta	*Cuscuta salina*
	Bidens amplissima	*Downingia elegans*
	Bidens beckii	*Drosera anglica*
	Bidens vulgata	*Drosera rotundifolia*
	Brasenia schreberi	*Drosera sp.*
	Butomus umbellatus	*Egeria densa*
	Calla palustris	*Elatine rubella*
	Callitriche hermaphroditica	*Elodea canadensis*
	Callitriche heterophylla	*Elodea nuttallii*
	Callitriche heterophylla ssp. bolanderi	*Epilobium palustre*
	Callitriche marginata	*Epipactis gigantea*
	Callitriche stagnalis	*Fauria crista-galli*
	Callitriche verna	*Floerkea proserpinacoides*
	Caltha leptosepala	*Galium labradoricum*
	Caltha leptosepala var. biflora	*Galium trifidum*
	Caltha natans	*Galium trifidum ssp. trifidum*
	Caltha palustris	*Gentiana douglasiana*
	Caltha palustris ssp. asarifolia	*Gentiana sceptrum*
	Cardamine pensylvanica	*Githopsis specularioides*
	Castilleja ambigua	*Hammarbya paludosa*

Lifeform	Scientific Name	Scientific Name
	Caucalis microcarpa	*Hesperochiron pumilus*
Herbs and Forbs	*Hippuris montana*	*Najas flexilis*
	Heteranthera dubia	*Myriophyllum verticillatum*
	Hippuris sp.	*Nasturtium officinale*
	Hippuris tetraphylla	*Navarretia intertexta*
	Hippuris vulgaris	*Nuphar polysepala*
	Hydrocotyle sp.	*Nuphar sp.*
	Hypericum anagalloides	*Nuphar variegata*
	Impatiens capensis	*Nymphaea alba*
	Impatiens ecalcarata	*Nymphaea mexicana*
	Iris pseudacorus	*Nymphaea odorata*
	Jaumea carnosa	*Nymphaea tetragona*
	Lathyrus palustris	*Oenanthe sarmentosa*
	Lemna minor	*Parnassia fimbriata*
	Lemna sp.	*Parnassia palustris*
	Lemna trisulca	*Parnassia parviflora*
	Leptarrhena pyrolifolia	*Pedicularis parviflora*
	Leucanthemum arcticum	*Pedicularis parviflora ssp. parviflora*
	Lilaea scilloides	*Petasites frigidus*
	Limnanthes macounii	*Petasites sagittatus*
	Limosella aquatica	*Phyllospadix scouleri*
	Liparis loeselii	*Phyllospadix serrulatus*
	Lobelia dortmanna	*Phyllospadix torreyi*
	Lobelia kalmii	*Pinguicula villosa*
	Lomatogonium rotatum	*Pinguicula vulgaris*
	Lotus pinnatus	*Plantago eriopoda*
	Ludwigia palustris	*Platanthera chorisiana*
	Lupinus rivularis	*Platanthera dilatata*
	Lycopus americanus	*Platanthera dilatata var. albiflora*
	Lycopus uniflorus	*Platanthera dilatata var. dilatata*
	Lysichiton americanum	*Platanthera dilatata var. leucostachys*
	Lysimachia thyrsiflora	*Platanthera hyperborea*
	Lythrum salicaria	*Platanthera stricta*
	Malaxis monophyllos var. brachypoda	*Polygonum amphibium*
	Malaxis monophyllos var. diphyllos	*Polygonum hydropiperoides*
	Menyanthes trifoliata	*Polygonum lapathifolium*
	Microseris borealis	*Polygonum punctatum*
	Mimulus guttatus	*Potamogeton alpinus*
	Mimulus lewisii	*Potamogeton amplifolius*
	Mimulus moschatus	*Potamogeton berchtoldii*
	Montia chamissoi	*Potamogeton crispus*
	Montia fontana	*Potamogeton epihydrus*
	Montia howellii	*Potamogeton filiformis*
	Myosotis laxa	*Potamogeton foliosus*
	Myosurus minimus	*Potamogeton friesii*
	Myriophyllum aquaticum	*Potamogeton gramineus*
	Myriophyllum farwellii	*Potamogeton illinoensis*
	Myriophyllum heterophyllum	*Potamogeton natans*
	Myriophyllum hippuroides	*Potamogeton nodosus*
	Myriophyllum quitense	*Potamogeton oakesianus*
	Myriophyllum sibiricum	*Potamogeton obtusifolius*
	Myriophyllum spicatum	*Potamogeton pectinatus*

Lifeform	Scientific Name	Scientific Name
	Myriophyllum ussuriense	*Potamogeton perfoliatus*
Herbs and Forbs	*Potamogeton richardsonii*	*Senecio hydrophilus*
	Potamogeton praelongus	*Senecio atropurpureus*
	Potamogeton pusillus	*Senecio congestus*
	Potamogeton robbinsii	*Senecio moresbiensis*
	Potamogeton sp.	*Senecio pauciflorus*
	Potamogeton strictifolius	*Senecio triangularis*
	Potamogeton vaginatus	*Sium suave*
	Potamogeton zosteriformis	*Sparganium angustifolium*
	Potamogetonaceae	*Sparganium emersum*
	Potentilla palustris	*Sparganium emersum ssp. emersum*
	Primula sibirica	*Sparganium eurycarpum*
	Ranunculus aquatilis	*Sparganium fluctuans*
	Ranunculus circinatus	*Sparganium glomeratum*
	Ranunculus flabellaris	*Sparganium hyperboreum*
	Ranunculus flammula	*Sparganium natans*
	Ranunculus gmelinii	*Sparganium sp.*
	Ranunculus hyperboreus	*Spiranthes romanzoffiana*
	Ranunculus lobbii	*Spirodela polyrhiza*
	Ranunculus orthorhynchus	*Stachys palustris*
	Ranunculus sceleratus	*Stellaria obtusa*
	Ranunculus sceleratus ssp. multifidus	*Subularia aquatica*
	Ranunculus sulphureus	*Subularia aquatica ssp. americana*
	Rorippa palustris	*Swertia perennis*
	Rotala ramosior	*Tofieldia pusilla*
	Rubus arcticus	*Trientalis arctica*
	Rubus arcticus ssp. acaulis	*Trifolium depauperatum*
	Rubus arcticus ssp. stellatus	*Triglochin concinnum*
	Rumex maritimus	*Triglochin concinnum var. concinnum*
	Rumex occidentalis	*Triglochin maritimum*
	Rumex paucifolius	*Triglochin palustre*
	Ruppia maritima	*Trollius laxus*
	Ruppia maritima var. maritima	*Typha angustifolia*
	Ruppia maritima var. occidentalis	*Typha latifolia*
	Ruppia sp.	*Utricularia gibba*
	Sagittaria cuneata	*Utricularia intermedia*
	Sagittaria latifolia	*Utricularia minor*
	Sagittaria latifolia var. latifolia	*Utricularia sp.*
	Sanguisorba canadensis	*Utricularia vulgaris*
	Sanguisorba menziesii	*Vallisneria americana*
	Sanguisorba officinalis	*Vallisneria sp.*
	Sarracenia purpurea	*Verbena hastata*
	Sarracenia purpurea ssp. purpurea	*Veronica anagallis-aquatica*
	Sarracenia sp.	*Veronica catenata*
	Sarraceniaceae	*Veronica scutellata*
	Saxifraga hirculus	*Viola palustris*
	Scheuchzeria palustris	*Wolffia borealis*
	Scheuchzeria palustris var. americana	*Wolffia columbiana*
	Scheuchzeria sp.	*Zannichellia palustris*
	Scheuchzeriaceae	*Zostera japonica*
	Scutellaria galericulata	*Zostera marina*

Lifeform	Scientific Name	Scientific Name
Mosses	*Amblystegium riparium*	*Drepanocladus revolvens var. revolvens*
	Amblystegium serpens	*Drepanocladus sendtneri*
	Amblystegium serpens var. juratzkanum	*Drepanocladus vernicosus*
	Amblystegium tenax	*Fontinalis antipyretica*
	Antitrichia curtipendula	*Fontinalis antipyretica var. antipyretica*
	Aulacomnium palustre	*Fontinalis antipyretica var. gigantea*
	Aulacomnium turgidum	*Fontinalis antipyretica var. mollis*
	Brachythecium salebrosum	*Fontinalis antipyretica var. oregonensis*
	Brachythecium turgidum	*Helodium blandowii*
	Bryum pseudotriquetrum	*Hypnum circinale*
	Bryum pseudotriquetrum var. bimum	*Hypnum lindbergii*
	Bryum pseudotriquetrum var. crassirameum	*Hypnum pratense*
	Bryum pseudotriquetrum var. pseudotriquetrum	*Meesia longiseta*
	Bryum uliginosum	*Meesia triquetra*
	Calliergon cordifolium	*Meesia uliginosa*
	Calliergon giganteum	*Myurella julacea*
	Calliergon richardsonii	*Paludella squarrosa*
	Calliergon sarmentosum	*Philonotis fontana*
	Calliergon stramineum	*Philonotis fontana var. americana*
	Calliergon trifarium	*Philonotis fontana var. fontana*
	Calliergonella cuspidata	*Philonotis fontana var. pumila*
	Campylium stellatum	*Plagiomnium ellipticum*
	Campylium stellatum var. protensum	*Plagiomnium medium*
	Campylium stellatum var. stellatum	*Plagiothecium undulatum*
	Campylopus atrovirens	*Pohlia nutans*
	Campylopus atrovirens var. cucullatifolium	*Pohlia sphagnicola*
	Catoscopium nigritum	*Pohlia wahlenbergii*
	Ceratodon purpureus	*Polytrichum strictum*
	Cinclidium stygium	*Rhizomnium pseudopunctatum*
	Cinclidium subrotundum	*Scorpidium scorpioides*
	Cratoneuron commutatum	*Scouleria aquatica*
	Cratoneuron commutatum var. falcatum	*Sphagnum angustifolium*
	Cratoneuron filicinum	*Sphagnum aongstroemii*
	Dicranum acutifolium	*Sphagnum austinii*
	Dicranum majus	*Sphagnum balticum*
	Distichium capillaceum	*Sphagnum capillifolium*
	Ditrichum flexicaule	*Sphagnum centrale*
	Drepanocladus aduncus	*Sphagnum compactum*
	Drepanocladus aduncus var. aduncus	*Sphagnum contortum*
	Drepanocladus aduncus var. kneiffii	*Sphagnum crispum*
	Drepanocladus aduncus var. polycarpus	*Sphagnum cuspidatum*
	Drepanocladus capillifolius	*Sphagnum fallax*
	Drepanocladus crassicostatus	*Sphagnum fimbriatum*
	Drepanocladus exannulatus	*Sphagnum fuscum*
	Drepanocladus exannulatus var. exannulatus	*Sphagnum henryense*
	Drepanocladus exannulatus var. purpurascens	*Sphagnum jensenii*
	Drepanocladus fluitans	*Sphagnum junghuhnianum*
	Drepanocladus fluitans var. fluitans	*Sphagnum lindbergii*
	Drepanocladus fluitans var. uncatus	*Sphagnum magellanicum*
	Drepanocladus lapponicus	*Sphagnum majus*
	Drepanocladus revolvens	*Sphagnum mendocinum*

Lifeform	Scientific Name	Scientific Name
	Drepanocladus revolvens var. intermedius	*Sphagnum pacificum*
Mosses (cont.)	*Sphagnum palustre*	*Sphagnum subsecundum*
	Sphagnum papillosum	*Sphagnum subsecundum var. andrusii*
	Sphagnum platyphyllum	*Sphagnum subsecundum var. rufescens*
	Sphagnum pulchrum	*Sphagnum subsecundum var. subsecundum*
	Sphagnum quinquefarium	*Sphagnum subtile*
	Sphagnum riparium	*Sphagnum tenellum*
	Sphagnum rubellum	*Sphagnum teres*
	Sphagnum russowii	*Sphagnum warnstorfii*
	Sphagnum schofieldii	*Sphagnum wilfii*
	Sphagnum sp.	*Sphagnum wulfianum*
	Sphagnum squarrosum	*Thuidium recognitum*
	Sphagnum subnitens	*Tomentypnum falcifolium*
	Sphagnum subobesum	*Tomentypnum nitens*
Liverworts	*Aneura pinguis*	*Cephalozia pleniceps var. pleniceps*
	Anthelia julacea	*Cephalozia pleniceps var. sphagnorum*
	Anthelia juratzkana	*Cephaloziella divaricata*
	Bazzania denudata	*Cephaloziella divaricata var. divaricata*
	Bazzania tricrenata	*Cephaloziella divaricata var. scabra*
	Bazzania trilobata	*Cephaloziella elachista*
	Blepharostoma trichophyllum	*Cephaloziella rubella*
	Calypogeia sphagnicola	*Cladopodiella fluitans*
	Calypogeia trichomanis	*Gymnocolea inflata*
	Cephalozia bicuspidata	*Herbertus aduncus*
	Cephalozia bicuspidata ssp. ambigua	*Mylia anomala*
	Cephalozia bicuspidata ssp. bicuspidata	*Mylia taylorii*
	Cephalozia bicuspidata ssp. lammersiana	*Odontoschisma denudatum*
	Cephalozia bicuspidata ssp. otaruensis	*Riccardia chamedryfolia*
	Cephalozia connivens	*Riccardia multifida*
	Cephalozia connivens var. bifida	*Ricciocarpos natans*
	Cephalozia connivens var. compacta	*Ricciocarpos sp.*
	Cephalozia connivens var. connivens	*Scapania bolanderi*
	Cephalozia lunulifolia	*Scapania irrigua*
	Cephalozia pleniceps	*Scapania paludicola*
	Cephalozia pleniceps var. caroliniana	*Scapania paludosa*
Lichens	*Siphula ceratites*	
Dwarf Shrubs	*Andromeda polifolia*	*Kalmia sp.*
	Gaultheria hispidula	*Loiseleuria procumbens*
	Kalmia microphylla	*Oxycoccus oxycoccos*
	Kalmia microphylla ssp. microphylla	*Oxycoccus sp.*
	Kalmia microphylla ssp. occidentalis	*Rubus chamaemorus*
Macroalgae	*Chara braunii*	*Chara sp.*
	Chara canescens	*Chara vulgaris*
	Chara globularis	

APPEDIX III
MINEROTROPHIC INDICATORS OF FEN AND SWAMP SITE CLASSES

Fen Indicators	Swamp Indicators
Betula glandulosa	Alnus tenuifolia
Campylium stellatum	Angelica genuflexa
Carex anthoxanthea	Atheryium filix-femina
Carex aquatilis/sitchensis	Aulacomnium palustre
Carex chordorhiza	Betula neoalaskana
Carex diandra	Betula occindentalis
Carex lasiocarpa	Carex disperma
Carex utriculata	Cornus stolonifera
Drepanocladus spp.	Equisetum arvense
Eleocharis quinquefolia	Equisetum pratense
Eriophorum angustifolium	Equisetum fluviatile
Lycopodiella inundata	Lonicera involucrata
Menyanthes trifoliata	Lysichiton americanum
Myrica gale	Mnium, spp.
Oenathe samentosa	Rhizomnium spp.
Paludella squarrosa	Plagiomnium spp.
Philonotis fontana	Petasites saggitatus
Picea glauca	Picea glauca x engelmannii
Potentilla palustris	Ribes spp.
Salix candida	Salix barclayi
Salix pedicellaris	Salix bebbiana
Scheuchzeria palustris	Salix lasiandra
Scorpidium scorpioides	Salix prolixa
Sphagnum warnstorfii	Salix sitchensis
Tofieldia glutinosa	Sphagnum girgensohnii
Tomenthypnum nitens	Thuja plicata
Trichophorum alpinum	Viburnum edule
Trichophorum cespitosum	
Triglochin maritimum	

APPENDIX IV
HYDROGEOMORPHIC FEATURES FOR PALUSTRINE, LACUSTRINE, ESTUARY AND FLUVIAL SYSTEMS.

The feature is a hydrogeomorphic descriptor for location and simple landform within an element (MacKenzie and Banner 1999).

Table 21. Features of the Palustrine system

FEATURE	DESCRIPTION
Central	Occupies the central or deepest part of the wetland
Channel	A open water course through wetland
Flark	A the depression between elevated ribs in a patterned peatland
Intermediate	Site between peripheral and central features
Island	A raised site within a wetland
Lake	A deep water body within a wetland > 1ha and < 8ha in size.
Peripheral	Site adjacent to upland
Pond	A deep water body within a wetland < 1ha in size
Pool	A shallow water body other than a flark
Rib	A elevated peat ridge in a patterned peatland
Riparian	Upland directly adjacent to wetland
Shore	Site adjacent to open water body
Water Track	A non-open water drainage course through wetland

Table 22. Features of the Fluvial system

FEATURE	DESCRIPTION
Back Channel	Abandoned channel connected to the main channel at the downstream end.
Back Levee	Depression behind Levee
Beaver Pond	
Cascade	Region of channel with relatively high gradient and abundant whitewater
Falls	Region of channel with precipitous gradient
Flood plain	Vegetated fluvial plain
Glide	Region of channel with relatively deep and rapid waterflow
Instream bar	A mostly non-vegetated bar in the active channel
Island	A vegetated instream island
Lateral Bar	A mostly non-vegetated bar on shore of active channel
Levee	Raised ridge of mineral soils directly adjacent to stream channel
Oxbow	Oxbow pond that is connected during high flows with main channel
Pool	Region of channel with relatively deep and slow water
Riffle	Region of channel with relatively shallow and rapid waterflow
Side Channel	Lateral permanent or semi-permanent channel smaller than main channel

Table 23 Features of the Lacustrine system

FEATURE	DESCRIPTION
Bay	Semi-enclosed protected
Beach	Sand or gravel beach
Deep water	Pelagic habitat > 2m deep
Flats	Semi-terrestrial seasonally flooded flats often peatland
Island	
Lagoon	Almost totally enclosed embayment connected to main waterbody by narrow opening
Littoral zone	Shallow water flats < 2m in depth usually indicated by floating leaved aquatics and weed beds
Riparian zone	The shore adjacent to waterbody or wetland

Table 24 Features of the Estuarine system

FEATURE	DESCRIPTION
Back Channel	Stagnant back channels linked to the river channel at the down stream end only
Back levee	Depression or flats behind a beach ridge and protected from wave action
Bar	Mostly unvegetated in-channel island
Beach ridge	Raised berm or spit of sand or gravels created by wave or current processes
High Tidal Flat	Vegetated flats exposed except during high tides
Island	Vegetated in-channel island
Low Tidal Flat	Mud flat or algae dominated flats exposed during low tide
Pond	Oxbow or back levee depression with standing water
River channel	Main channel of river
Side channel	Secondary side channels to the Main channel
Tidal channel	Incised gully or channel on a tidal flat caused by tidal ebb and flow

GLOSSARY

Aerobic: Occurring in the presence of free oxygen, either as a gas in the atmosphere or dissolved in water.
Alkaline: Water or soil with a pH greater than 7.4. Relatively high concentration of available base cations.
Anaerobic: Occurring in conditions devoid of oxygen.
Annual flood: Flooding occurs at least once per year.
Biogeoclimatic subzone: A climatic region characterized by a unique climax plant association on zonal sites.
Biogeoclimatic zone: A climatic region with similar broad macroclimate characterized by the dominance of specific shade-tolerant "climax" tree species.
Brown mosses: A guild of peatland mosses usually indicating richer site conditions. Includes *Campylium stellatum, Drepanocladus spp., Scorpidium scorpioides,* and *Tomenthypnum nitens*.
Canopy: Cover of branches and leaves formed collectively by the crowns of trees, shrubs or other plants.
Capillary: In a soil, the fine spaces between soil particles.
Capillary action: Particles attract soil moisture and surface tension is strong enough to cause moisture to rise up through the soil, above the water table.
Class, site: Ecosystems with broadly similar vegetation physiognomy (or species guild), hydrology, and water quality (NWWG 1997).**Clayey:** Predominant textural classes are clay, silty clay, sandy clay or clay loam.
Climax community: A self-perpetuating community whose species composition is expected to be relatively stable and long lasting.
Closed basin or pond: Basin receives water from surrounding upland only, no inlet or outlet channel.
Coarse sedges: Large, broad-leaved sedge species including *Carex utriculata, Carex aquatilis, Carex sitchensis,* and *Carex exsiccata*.
Common: Occurs frequently, and representative ecosystems are readily found but it is not a predominant association of the region (Steen and Roberts 1988).
Common species: Species that can occur in a site association, but do not define the community. They usually have a presence > 20% and a cover > 1%.
Constant species: Species that occur in a classification unit with relatively high frequency but low mean cover that may help to define the community. They are defined as having presence of > 66% and cover <10%.
Diagnostic species: A species that occur primarily within a single classification unit.
Diatomaceous earth: Composed mainly of the siliceous shells of diatoms. It is frequently more nearly mineral than organic in composition.
Disclimax: A self-perpetuating community that strongly differs in species composition from the edaphic or climatic climax expected for the site; normal succession has been arrested by an external physical or anthropogenic factor. Results from changes to physical characteristics of the site, associated with disturbances such as fire, intensive grazing, or avalanche (Province of BC 1998).
Dominant species: The strucurally most dominant species within a site or the species which contributes greatest vegetation cover to the community.
Drawdown: Decrease in water level of lakes or steams, exposing substrate that is normally submerged.
Dwarf shrub: Plants with woody stems that are generally less than 15 cm tall at maturity. Includes *Andromeda polifolia, Arctostaphylos uva-ursi, Empetrum nigrum, Gaultheria hispidula, Kalmia microphylla, Linnaea borealis, Oxycoccus oxycoccos, Rubus chamaemorus, Rubus pedatus, Vaccinium caespitosum,* and *Vaccinium vitis-idaea* are the most common wetland dwarf shrub species.
Emergents: Upright plants rooted in water or exposed to seasonal flooding, emerging above water surface. Does not include some submergents which normally lie entirely underwater but have flowering parts which break the surface.
Ericaceous shrub: Shrubs of family Ericaceae. *Andromeda, Chamaedaphne, Gaultheria, Kalmia, Ledum, Oxycoccus* and *Vaccinium* are the most common wetland genera.
Eutrophic: Very rich nutritional status, abundant supply of nutrients.
Feathermosses: Upland moss species with a feather-like form including *Hylocomium splendens, Pleurozium schreberi,* and *Ptilium crista-castrensis*.
Fibric: Poorly decomposed peat with large amounts of well-preserved fiber readily identifiable as to botanical origin.

Flark: Elongated wet depressions separated by raised ribs in patterned peatlands. The long axis is always perpendicular to the direction of water flow.
Floating mat: Mat of peat held together by roots and rhizomes underlain by water or fluid, loose peat (NWWG, 1988).
Floating-leaved plants: Rooted or free-floating plants with leaves normally floating on water surface.
Flooding: Surface inundation by moderate to fast moving water. Usually associated with sedimentation and erosion.
Fluvial: Sites occurring along flowing water courses, the water course itself, and the surrounding (riparian) terrain and vegetation. Subject to flooding and sedimentation processes (Province of BC 1998).
Forb: Any herb that is neither a grass, sedge nor rush.
Frequent flooding: Flood return interval of 2-5 years.
Gleyed: A soil condition resulting from prolonged soil saturation, which is manifested by the presence of bluish or greenish colors throughout the soil mass or in mottles (usually orange spots or streaks).
Graminoid: Plants with a grass-like growth form including rushes (Juncaceae), grasses (Poaceae), and sedges (Cyperaceae).
Groundwater: Water passing through or standing in soil and underlying strata. Free to move by gravity (NWWG 1988).
Herb: Non-woody vascular plants.
Hollow: 1 A wet depression or pool found between hummocks or mounds. **2** A sunken basin or depression, often sloped and having an outflow. Includes gullies with slow streams where there is little sedimentation or erosion.
Humic: Highly decomposed organic material. Small amounts of fiber can be identified to botanical origin (NWWG 1988).
Hummock: A mound composed of organic materials. Often peat, *Sphagnum* or other moss. Slight hummocks are 0.3-1 m high and spaced >7 m apart. Moderate hummocks are 0.3-1 m tall and spaced 3-7 m apart. Strong hummocks are 0.3-1 m tall spaced 1-3 m apart.
Humus: Dead and decaying organic material at the soil surface.
Hydric: 1. A site where water removed so slowly that water table is at or above the soil surface all year. **2.** A Gleysol or Organic soil..
Hydrogeomorphic Classification: Classification of wetland and riparian ecosystems based on hydrological and geomorphological features and processes.
Hydrophytic plant species: Any plant adapted for growing on permanently saturated soils deficient in oxygen.
Hygric: Water removed slowly enough to keep soil wet for most of the growing season; permanent seepage and mottling usually below 30cm in depth.
Hypereutrophic: Sites with very high salinity or alkalinity.
Inundation: Surface flooding by standing or slow moving water.
Lacustrine: Sites adjacent to lakes and ponds directly affected by lake wave action, sedimentation, and flooding.
Lagg: Depressed margin of a bog or fen: generally wetter than surrounding area, often contains open water.
Lawn: Relatively flat expanse of wetland moss usually raised above water level. Contrast with hummock and hollow.
Lifeform: A plant growth form which displays an obvious relationship to important environmental factors (Mueller-Dombois and Ellenberg 1974).
Limnic material: Composed of coprogenous earth (sedimentary peat), diatomaceous earth, or marl.
Linked basin: Basin receives water from upland and an inflow stream; excess water flows through an outflow. Includes basins with slow streams where there is little sedimentation or erosion (Province of BC 1998).
Loamy: Textural classes are loam and sandy loam (Steen and Roberts 1988).
Marl: Sediments composed of shells of aquatic animals and $CaCO_3$ precipitated in water.
Mesic: 1. Organic material in an intermediate stage of decomposition where some fibers can be identified as to botanical origin. **2.** Average soil moisture regime
Microtopography: Small scale (i.e. < 2 m) variations in surface elevation (e.g. hummocks and hollows).
Moderately acidic: Having a soil pH value of 4.5 to 5.5.

Moist: No water deficit occurs. Current need for water does not exceed supply, temporary groundwater table may be present (Pojar et al. 1987).
Montane: A high elevation region occurring below the subalpine
Minerotrophic: Nourished by mineral water. Refers to wetlands which receive nutrients from flowing or percolating mineral groundwater (NWWG 1988).
Minerotrophic indicator species: Plant species requiring relatively high concentrations of nutrients associated with mineral groundwater. Intolerant of bog (ombrotrophic) conditions. Includes both swamp and fen indicators.
Mire: British term embracing all kinds of peatlands and peatland vegetation (modified from NWWG 1988).
Mound: Mounds composed of mineral materials.
Muskeg: Algonquin term for peatland. Usually applied to areas with Sphagnum mosses, tussocky sedges and an open growth of scrubby trees (Modified from NWWG 1988).
Neutral pH: Having a soil pH value between 6.5 and 7.4. Available base cation concentration is high enough to buffer acidic conditions.
Occasional flooding: Flood interval greater than 5 years.
Oligotrophic: Relatively poor in nutrients.
Ombrotrophic: Nourished by rain. Peatlands entirely dependent on nutrients deposited by precipitation (NWWG 1988).
Overflow basin: Basin receives water from upland only; excess water flows through an outlet channel (Province of BC 1998).
Paludification: Succession or conversion of upland or mineral wetland habitats to peatland through accumulation of peat.
Palustrine: Basins, depression, slopes, and small water bodies with a continually high water table and poor drainage Wetland landscape units.
Palustrine hollow: Hollow receives ground water from upslope; excess water flows through channel or watertrack.
Patterned peatland: Peatlands marked by distinct patterns of vegetation in a rib/flark, net/flark, or hummock flark form. with elevated adjusted to the seepage of water that carries nutrients essential to growth of plants forming the patterns.
Peat: Partly decomposed plant material deposited under saturated soil conditions.
Peatland: A generic term including all types of peat-covered terrain. Many peatlands are a complex of swamps, bogs, and fens, sometimes called a “mire complex” (NWWG 1988).
Physiognomic: Referring to vegetation structure or strata.
Rarely flooded: Flooding occurs only during extreme events.
Riparian: Along the bank of a river or lake.
Saline: The presence of soluble salts in the soil parent material. Salts are commonly visible as crystals or veins, or surface crusts but sometimes are not evident morphologically. The presence of salt-tolerant plants is a good indicator of excessive salts in the soil.
Sandy: Textural classes are loamy sand and sand (Steen and Roberts 1988).
Saturated: A soil condition in which all voids (pore spaces) between soil particles are filled with water.
Sedimentary peat (coprogenous earth): Peat formed beneath a body of standing water composed of aquatic plant debris modified by aquatic animals. Material is loosely consolidated, slightly sticky, dark brown to black and usually well decomposed (humic). Synonyms: aquatic peat, loonshit, allochthonous peat, detrital peat, gyttja. (NWWG 1988).
Seepage: Groundwater discharge having less flow than a spring.
Shrub: Perennial plants usually with more than one low-branching woody stem and < 10 m tall.
Silty: Predominant textural classes are silt and silt loam (Steen and Roberts 1988).
Site association: A group of related ecosystems physically and biologically similar enough that they have or would have similar vegetation at climax (Meidinger and Pojar 1991).
Slightly acidic: Having a soil pH value of 5.5 to 6.5.
Stand: A plant community that is relatively uniform in composition, structure and habitat conditions.
Subassociation: Subunits of an association that are relatively similar to other subassociations within an association but distinguished by the predominance of one to several differentiating species

Submergents: Plants which normally lie entirely beneath water. Some species can have flowering parts which break water surface.
Subhydric: Soil moisture regime where water is removed slowly enough to keep water table at or near the surface for most of the year; permanent seepage 0 to 30 cm below surface.
Subhygric: Water removed slowly enough to keep soil wet for a significant part of the growing season; some temporary seepage and possibly mottling below 20 cm.
Succession: Replacement of one community by another; often progresses to a stable terminal community called the climax.
Treed: Having >10% canopy cover of tree species > 2 m tall.
Tussock: A thick tuft of sedge or other vegetation forming a small mound of solid ground in a wetland (NWWG 1988).
Uncommon: Occurs infrequently in the region (Steen and Roberts 1988).
Very moist: Rooting-zone groundwater present during the growing season (water supply exceeds demand). Groundwater table > 30 cm deep (Pojar et al 1987).
Very acidic: Having a soil pH value less than 4.5. Low concentration of available base cations.
Very wet: Groundwater table at or above the ground surface throughout most of the growing season
Water table: The upper surface of the zone of saturation within the soil profile.
Wet: Rooting-zone groundwater present during the growing season (water supply exceeds demand). Groundwater table > 0 cm but ≤ 30 cm deep (Pojar et al 1987).
Wetland: Sites dominated by hydrophytic vegetation where soils are water-saturated for a sufficient length of time such that excess water and resulting low soil oxygen levels are principal determinants of vegetation and soil development.
Wetland complex: Consists of two or more wetland communities occurring in close proximity in the same system and influenced or linked by the same moisture and nutrient regime.