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FOREWORD

The development of a Canadian system for classifying organic soils has been reasonably successful, and the system has been published in proceedings and other publications sponsored by the Canada soil survey committee. However it is felt by pedologists and by users of soil data that pedologists have not adequately classified and described the landscape in which the soil profile has developed. Therefore two working groups, one concentrating on mineral soil landforms, the other on organic soil landforms, have attempted to develop suitable classification systems. The bulk of the organic landform has been conducted by regional groups that include specialists in the disciplines of pedology, botany and geology.

This workshop was organized by the Canada-Manitoba soil survey group in Winnipeg and convened under the auspices of the Canada Soil Survey committee in order to assemble a group of pedologists to discuss and evaluate a proposed organic landform classification.

Approach and Development of Peatland Mapping in Manitoba

R. E. Smith

The approach to mapping peatlands in Manitoba recognizes three essential elements of components within its structure. These are:

1. Peat Landforms - Landforms are broadly analogous to mineral soil landforms. Their recognition and definition, however, is distinctly different. Definition and recognition is based on morphology (flat, sloping, raised, patterned, etc.); composition of peat material; and genetic factors responsible for peatland development (hydrology, water chemistry, drainage, climate).

2. Floristics - Vegetative communities or groups of associated plant species determine the composition of peat material. They are extremely important in determining the nature of ecosystems or habitat in peatlands.

3. Soils - An essential element sinze recognition of soils permits a physical-chemical evaluation of site for plant growth relationships and for engineering construction and traffic problems. It is the missing element in most non-pedological inventories of peatlands.

Since the classification of these three elements depends upon a hierarchical arrangement of taxonomic units at various levels of generalizations, we have, in a sense, a built-in hierarchical structure to the mapping of peatlands as well. It is not hierarchical as in the case of biophysical classifications where elements of climate, physiography, vegetation and soils are arranged into progressively more precisely defined units from broadly defined Land Regions to narrowly defined Land Units or Types. It is hierarchical in that one can select a level of generalization within each component to suit a specific project at a specific scale of mapping. Hopefully, this concept will emerge more clearly by discussion and example through the course of this workshop.

The recognition of these elements in the mapping of peatlands is based on the following assumptions and principles:

1. Most organic soils in Manitoba will be utilized in their native state for such extensive uses as forestry, wildlife habitat and recreation.

2. It is necessary to key on significant ecological relationships that exist in peatlands if maximum utilization of pedological inventories are going to be made by such potential users as foresters, wildlife biologists and other natural resource evaluators. For example, vegetation characteristics and landform are more important than soils in evaluating peatlands for wildlife habitat. It is the character of vegetative communities that determine habitat suitability. Soils certainly are very important in evaluating sites for plant growth potential but not essential as is vegetation in this example.

3. The mapping technique be flexible enough to permit broad generalizations with respect to soil condition and soil behavior and also to permit very specific predictions for intensive uses as well. The hierarchical structure of all three elements permits this flexibility.

4. A high dependence on aerial photo interpretation is necessary since most peatlands in Manitoba are very inaccessible and for such reason, difficult to acquire ground truth control in the mapping process.

This approach just didn't happen. It emerged as a result of a long, slow process that began in the late 50's and early 60's when Soil Survey first interfaced with forest ecoligists in the southeastern corner of the province. The influence of that early effort still strongly influences the attitudes of most of us working in Manitoba.

In this early attempt at recognizing some order in peatlands (other than depth of organic deposits) recognition was given to 3 kinds of peatland types which, in our opinion, reflected significant differences in ecological condition. While the map itself did notshow the distribution of these types, use was made of annotated air photos to show a typical situation covering much of the peatland in the region.

As mapping progressed in the peatland dominated regions of central Manitoba, this crude, simplistic approach was obviously found to be lacking. An attempt at some sophistication occurred when we tried to utilize Radforth's vegetation class system to predict significant ecological differences in peatlands. However, this too did not work out too well, since the structure and composition of his classification system emphasized the physical relationships that exist in peatlands. It also did not predict soil condition adequately enough as well.

The emergence of the CSSC system of organic soil classification in the late 60's marks another significant plateau in our system of mapping, since it provided an extremely useful mechanism to show detailed ecological subdivisions in peatlands. It was not until the work of Zoltai, Tarnocai and Oswald in the Cormorant Lake Land Classification Pilot Study in the late 60's, however, that development of this three element approach to mapping emerged. While few examples of this mapping approach are available for study, the work in the Riverton, Roseau and Cranberry Peatlands should provide sufficient data to demonstrate the usefulness of this technique.

Peat Landforms and Associated Vegetation

C. Tarnocai

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Peat Landforms and Associated Vegetation in Manitoba

C. Tarnocai

PEAT LANDFORMS

Introduction

The landform is one of the most stable and easily recognizable components of the peatland environment. It provides a single expression in which all physical and biological factors are integrated. The peat landform can be recognized on the ground, from the air and on remote sensing data.

Peat landforms are primarily named according to their surface morphology and are described according to their morphological characteristics, biotic and abiotic components (e.g., vegetation, hydrology, peat material and stratigraphy of the peat deposit and the associated soil (Tarnocai, 1970)).

The criteria for peat landform classification on the class, subclass and type levels are as follows:

CLASS: Broad morphological characteristics based on the surface and subsurface properties of the landform according to the type of peat materials. The class also represents a unique ecological unit, characterized by biotic and abiotic factors, water and nutrient regime. Classes also represent two basic environmental units: ombrotrophic (bogs) and minerotrophic (fens and swamps).

SUBCLASS: Based on the surface morphology of the landform (e.g., convex, concave, plateau-like, flat, rolling and sloping) ans surface pattern (e.g., parallel ridges, patterned due to discharge area). The subsurface morphology of the landform is based on the subtype and degree of decomposition of peat materials and their sequence of deposition (stratigraphy of peat deposit).

TYPE: Detailed surface and subsurface morphology of the landform. The internal characteristics are reflected by the type of organic soil. Size, water regime and surface patterns of the landform and the associated vegetation are also criteria used to characterize the landform type.

1. BOG

A bog is a peat-covered or peat-filled area, generally with a high water table. Since the surface of the peatland is slightly elevated, bogs are either unaffected or partly affected by nutrient-rich ground waters from the surrounding mineral soils. The ground water is generally acidic and low in nutrients (ombrotrophic). The dominant peat materials are sphagnum and forest peat underlain, at times, by fen peat. The vegetation consists of productive stands of black spruce-feathermoss-*Ledum* or stunted black spruce-*Sphagnum*-*Ledum*, black spruce-tamarack-

Carex or Sphagnum-Ledum types. The associated soils are Fibrisols, Mesisols and Organo Cryosols.

1.1 DOMED BOG

This bog has an elevated, convex, central area, much higher than the margin. The water supply is from precipitation and thus the peat is low in nutrients and pH. The dominant peat materials are fibric Sphagnum (fuscum) peat or mesic Cladonia forest peat underlain by mesic feathermoss forest peat and/or mesic fen peat. The vegetation consists of Sphagnum-Ledum, black spruce-Cladonia-Ledum and black spruce-feathermoss-Ledum types. The associated soils are the Organo Cryosols.

1.1.1 PALSA

Palsas, mounds of peat with a frozen peat and/or mineral core, occur on waterlogged, treeless or sparsely wooded fens. In Manitoba the height of a palsa generally varies from 1 to 3 meters, while the width varies from one palsa to another but is generally of the order of some tens of meters. The surface of the palsa can be covered with vegetation of black spruce, Ledum sp., Sphagnum spp., feathermoss and Cladonia spp. (Zoltai and Tarnocai, 1969; 1971), or it can be a barren peat surface (Pewe, 1969; Sjors, 1961).

The dominant peat materials are forest and sphagnum peat with fen peat also occurring in the lower part of the frozen core. The active layer, which is approximately 30 to 45 cm deep, consists of relatively dry peat, but the permafrost core consists of frozen peat containing large amounts of segregated ice crystals and ice lenses (see Figs. 1, 7). The dominant soils are Fibric Organoc Cryosol and Mesic Organo Cryosol (Tarnocai, 1972).

1.1.2 PEAT MOUND

Peat mounds are found in the Continuous Permafrost Zone. These treeless mounds (see Fig. 1) are generally 0.5 to 1 meter in diameter and about 30 to 50 cm in height (Pewe, 1969; Zoltai and Tarnocai, 1969). They occur in water-saturated fens. The vegetation consists of some ericaceous plants and Sphagnum mosses. The dominant soils are Mesic Organo Cryosol and Humic Organo Cryosol.

1.2 PLATEAU BOG

This bog, which is relatively flat and slightly elevated, has minor surface irregularities and covers an area of several hectares. The water supply is from precipitation and thus the peat is low in nutrients and pH. The dominant peat materials are mesic feathermoss-forest peat and Cladonia forest peat or fibric sphagnum (fuscum) peat underlain by mesic fen peat. The vegetation consists of Sphagnum-Ledum, black spruce-Sphagnum, black spruce-Cladonia-Ledum and black spruce-feathermoss-Ledum types. The associated soils are Fibrisols and Organo Cryosols.

1.2.1 BOG PLATEAU

In Southern Manitoba these bog plateaus are generally tear-drop shaped (see Fig. 6). The height of a bog plateau varies from 0.5 to 1 meter and is due to greater peat deposition as compared to the surrounding wet fen areas. This peat landform is locally called a raised bog.

In northern Manitoba these bog plateaus are usually surrounded by peat plateaus. The ombrotrophic environment is the result partly of peat deposition as in the southern type of bog plateaus and partly of runoff waters from the slightly elevated ombrotrophic peat plateaus.

The dominant peat material is deep sphagnum peat, underlain by fen peat and the most common soil is Typic Fibrisol.

1.2.2 PEAT PLATEAU

In the Discontinuous and Continuous Permafrost Zones, in northern Manitoba, peat plateaus are associated with permafrost and their height (approximately 1 m) is dominantly due to ice lens formation in the frozen core. These frozen peat plateaus are covered with black spruce and they are commonly known as wooded peat plateaus (Zoltai and Tarnocai, 1969). The dominant peat material is forest peat while sphagnum and fen peat are also found in smaller amounts in this peat landform. The active layer, which is approximately 30 to 45 cm deep, consists of relatively dry peat while the permafrost core consists of frozen peat containing large amounts of segregated ice crystals (see Figs. 2, 7, 16 and 18). The dominant soils are Mesic Organo Cryosol and Fibric Organo Cryosol.

1.2.3 POLYGONAL PEAT PLATEAU

Polygonal peat plateaus (Zoltai and Tarnocai, 1974) resemble peat plateaus as they are elevated about 1 m above the neighbouring fens. They are, however, associated with a polygonal pattern due to ice wedge formation (see Figs. 3 and 21). The surface morphology of the polygonal peat plateau is dominanated by polygon trenches and the adjacent shoulders. The centre of the polygon is level or slightly concave. The bedding of peat layers is disturbed near the ice wedge. The stratigraphy of the peat deposit is similar to that of the peat plateaus. The basal deposits are usually woody fen or aquatic peats followed by Drepanocladus fen peat. The top layer is composed of Sphagnum peat. The vegetation is mainly a thick carpet of lichens (mainly Cladonia sp., Cetraria sp. and Alectoria sp.), with only a few scattered and stunted black spruce. The dominant soils are Fibric Organo Cryosol and Mesic Organo Cryosol.

1.3 FLAT BOG

The bog has insignificant differences in the level of the peat surface. It is incluenced by nutrient-rich waters but bog conditions are produced as a result of peat accumulation. Forest peat materials underlain by fen peat dominate this deposit. Thin sphagnum peat also occurs on the surface of the forest peat. The vegetation consists of black spruce-feathermoss and black spruce-feathermoss-Ledum types (see Figs. 2 and 8). The dominant soils are Terric Fibric Mesisol, Terric Mesic Fibrisol, Mesic Fibrisol and Typic Mesisol.

1.4 BOWL BOG

This bog has a concave peat surface which has developed in topographic depressions. It receives nutrient-rich water which, because of peat accumulation, is reached by plant roots only near the margins of the bog. The dominant peat material is forest peat. The vegetation consists of black spruce-feathermoss and black spruce-feathermoss-Ledum types (see Figs 3 and 9). The dominant soils are Terric Fibric Mesisol and Typic Mesisol.

1.5 BLANKET BOG

This bog occurs when peat covers the uplands, slopes and depressions alike in the landscape, up to a considerable degree of slope. Some parts of this bog are influenced by nutrient-rich ground waters. The peat materials are dominantly forest peat types with sphagnum peat being found on the slopes and upland portions of the landscape. The vegetation consists of black spruce-feathermoss-Ledum and black spruce-Sphagnum types (see Fig. 3). The dominant soils are Terric Fibric Mesisol, Typic Mesisol and Mesic Fibrisol.

2. FEN

A fen is a peat-covered or peat-filled area with a high water table which is usually at the surface. The dominant peat materials are shallow to deep, well to moderately decomposed fen peat. The vegetation consists dominantly of sedges, grasses and reeds with some shrub cover and, at times, a scanty tree layer, usually stunted larch. The waters are mainly nutrient-rich, minerotrophic waters from mineral soils. The peat materials are thus higher in both nutrients and pH than the peats from bogs. The dominant organic soil is Mesisol.

2.1 HORIZONTAL FEN

This fen occupies extensive flat, low-lying areas that show insignificant differences in the level of the peat surface. The water table is usually at or close to the surface. The dominant peat materials are shallow to very deep, well to moderately decomposed fen peat. The vegetation consists dominantly of Carex-Drepanocladus, Carex-Drepanocladus-Betula and Larix-Carex types (see Figs. 4, 7 and 10. The dominant soils are Terric Mesisol and Typic Mesisol.

2.1.1 MESIC FEN

A flat fen type common to floodplains or lowlands where the water supply is usually restricted to short periods of seasonal flooding. They are subjected to seasonal surface water loss and a drop in the water table. The vegetation is characterized by tussocks of sedges, grasses, and usually an appreciable covering of scattered willows, dward birch or a sparse tree layer. The dominant soil is Typic Mesisol.

2.1.2 HYDRIC FEN

This fen is common on flood plains and in basins where surface water is held for long intervals; thus, the peat substrate is usually perennially saturated. The surface of this fen is slightly concave with hummocks, sedge tussocks or low ridges being common. The vegetation is predominantly aquatic mosses, sedges, reeds and grasses but the low ridges often support tamarack or willows.

2.2 PATTERNED FEN

This fen occupies very gently sloping areas and its characteristic feature is a pattern of ridges and hollows. These sites are extremely wet throughout the summer. The peat is chiefly shallow to deep, well to moderately decomposed fen peat. The dominant vegetation is Carex-Drepanocladus in the hollows and stunted black spruce, tamarack, feathermosses, Sphagnum spp. and Ledum sp. on the ridges. The dominant soils are Terric Mesisol, Terric Fibric Mesisol and Typic Mesisol.

2.2.1 STRING FEN

String fens, commonly known as string bogs or ribbed fens, occupy long strips of peatland running downslope toward their outlet (Heinselman, 1963; 1970). They consist of more or less parallel low ridges, separated by water saturated hollows (flarks) oriented across the slope, at right angles to water movement. These sites are extremely wet throughout the summer. The vegetation on the ridges is stunted black spruce, tamarack, ericaceous shrubs and mosses, while on the flarks it is dominantly sedges. The dominant peat material is shallow to very deep fen peat (see Figs. 4, 11 and 13). The dominant soils are Terric Mesisol, Terric Fibric Mesisol and Typic Mesisol.

2.2.2 NET-LIKE PATTERNED FEN

These are the same as the string fens described above but, in this case, the parallel ridges are interlocked and form a net-like pattern (see Fig. 12).

2.2.3 WATER TRACK FEN

A component of patterned fen occupying a concave tract of peatland which marks the path of subsurface mineral water flow. The peat is usually well decomposed. Tamarack and shrubs may be present. Dominant soils are Terric Mesisol and Typic Mesisol.

2.3 SLOPING FEN

This fen occupies appreciably sloping areas and is often found in areas with higher water table. It is fed by seepage rather than by a distinctly localized outflow of spring water. The dominant peat materials are shallow to deep, well to moderately decomposed fen peat (see Figs. 4 and 14). The dominant soils are Terric Mesisol and Typic Mesisol.

2.4 FLOATING FEN

This fen occupies areas over a shallow water surface. The fen vegetation forms a floating or quaking peat mat encroaching on a water surface. This represents one of the stages in the filling-in of a lake basin. The dominant peat material is shallow, moderately decomposed fen peat. The vegetation consists dominantly of sedges (see Figs. 5, 11 and 15). The dominant soil is Hydric Mesisol.

2.5 COLLAPSE SCAR

These circular fen areas have developed as a result of melting of permafrost. The collapsed fen part of the peatland has a high water table and the collapsing edge forms a steep bank with leaning and dead trees being very characteristic. The peat materials vary in origin. The surface peat is usually of the fen type but the underlying, mixed peat originates from the collapsing bank. The vegetation is dominantly of the Carex-Drepanocladus type (see Figs. 5, 16 and 18). The dominant soils are Typic Mesisol and Terric Mesisol.

2.6 SPRING FEN

This fen occupies discharge areas. It may be convex or sloping and has formed directly over springs or in areas where springs abound. The dominant peat material is shallow, well to moderately decomposed fen peat (see Figs. 17 and 18). The dominant soil is Terric Mesisol.

2.7 DOMED FEN

This fen has an elevated, convex central area slightly higher than the margin. The height difference is due to ice lens formation in both the fen peat layers and the underlying mineral materials. The dominant peat material is Carex-fen peat and the soil is Mesisol. The vegetation is dominantly Carex-feathermoss-arctic willows with scattered white spruce and tamarack. The surface of many of these domed fens (palsas) consists of exposed peat and is nearly devoid of living vegetation. These peat landforms are found mainly along the Hudson Bay coast.

2.7.1 MINEROTROPHIC PALSA

Minerotrophic palsas are found in the Hudson Bay Lowlands. The peat is dominantly of fen origin and is layered with alluvial deposits. The associated soil type is Mesic Organo Cryosol. The vegetation consists dominantly of sedges, feathermosses and Arctic dwarf willows. Many palsas, however, are almost completely devoid of living vegetation.

3. SWAMP

A swamp is a peat-covered or peat-filled area. The peat surface is level or slightly concave in cross section. The water table is frequently at or above the peat surface. There is strong water movement from margins or other mineral sources. The microrelief is hummocky, with many pools present. The waters are neutral or slightly acid. The dominant peat materials are shallow to deep mesic to humic forest and fen peat and the dominant soils are Mesisols and Humisols. The vegetation is characterized by dense tree cover of cedar, spruce and tamarack.

3.1 LOWLAND SWAMP

Lowland swamps are usually found on large, very poorly drained lowlands and are often associated with glacial lacustrine basins. The dominant peat materials are shallow to deep mesic to humic forest and fen peat. The vegetation is a mixed cedar, spruce and tamarack swamp forest. The most common soils are Mesisols and Humisols.

3.1.1 HYDRIC SWAMP

Equivalent to Heinselman's (1970) "weakly minerotrophic swamp". A swamp having a concave peat surface with the water table at or above the surface most of the season. Sluggish water movement with deep pools and large hummocks of Sphagnum are common. The peat is of variable thickness, composed mainly of forest and fen peat with a thin layer of sphagnum peat sometimes also being present. The vegetation associated with this peatland is a swamp forest of tamarack birch and willow and an understory of shrubs, sedges and mosses. The dominant soils are Typic Mesisol sphagnic phase and Terric Mesisol sphagnic phase (Mills et al., 1974).

3.1.2 MESIC SWAMP

This is equivalent to Heinselman's (1970) "minerotrophic swamp". It is a swamp having a slightly concave peat surface which receives strong water movement or percolation from margins or mineral sources. The water table is frequently above the peat surface which is hummocky with many small pools. The peat material is shallow to deep, moderately decomposed woody peat. The vegetation is rich swamp forest with cedar, alder, ash, tamarack and black spruce being dominant tree species. The dominant soils are Typic Humisol and Terric Humisol (Mills et al., 1974).

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VEGETATION

Introduction

A knowledge of vegetation and vegetation succession is very important in peatland studies. The peat deposits originate from vegetation and reflect the succession of vegetation, being characterized by layers differing not only as to their degree of decomposition but also as to the botanical composition of the material.

The vegetation is also very important in interpreting remote sensing data for mapping. Landforms and vegetation are the most important components of the peatland environment appearing on remote sensing imagery. Subsurface properties, such as soils, are interpreted using this data in conjunction with the known relationship between landform, vegetation and soil.

Peatland vegetation in the boreal zone of North America has been studied by Heinselman (1970), Dansereau et al. (1952), Moss (1953) and Sjors (1961) and they defined vegetation types relating to the peatland environment. Species lists provided in these papers give the vegetation types associated with certain peatland ecosystems.

In this paper the landform approach will be taken and the most common vegetation types will be described together with the associated peat landform. The author feels that this approach is most useful not only for a better understanding of landform-vegetation relationships but also for interpreting remote sensing data for mapping and identifying peat material.

The description of vegetation types associated with peat landforms are given using the work of Sjors (1960), Heinselman (1970) and Zoltai and Tarnocai (1971 and 1974).

BOG

Bog vegetation is characterized by fewer species than are found in fen and swamp vegetation. These species are acid-living, meaning they are adapted to living in a low nutrient and low pH environment. In the boreal forest region black spruce, ericaceous shrubs and mosses form a community. In the arctic regions, on polygons, wind-trained dwarf birch, Ledum, moss and lichen species are common.

DOMED AND PLATEAU BOG

Truly an ombrotrophic environment and the vegetation is characterized by acid-living species. On palsas and peat plateaus the common vegetation types are as follows:

Black Spruce-Feathermoss Type

A dense forest of black spruce (Picea mariana) and full mat of feathermosses characterize this vegetation community. Willow (Salix bebbiana) occurs in scattered clumps with isolated occurrences of white birch (Betula papyrifera) and tamarack (Larix laricina) also being found. A full carpet of feathermosses (Ptilium cristacrastrensis, Dichranum rugosum and Pleurozium shreberi) covers the ground.

Black Spruce-Shagnum Type

Densely packed sphagnum moss, low ericaceous shrubs and stunted black spruce characterize this type (see Fig. 6). Sphagnum fuscum (Schimp.) Klinggr. is the dominant moss, growing in a tight, dense mat or in hummocks. Associated low shrubs are Ledum groenlandicum (in the south), Ledum decumbens (in the north), Chamaedaphne calyculata, Vaccinium vitis-idaea, Oxycoccos microcarpus Turcz., Rubus chamaemorus L., and

Empetrum nigrum L. Small colonies of feathermosses are sometimes also present.

Treeless-Sphagnum Type

Densely packed sphagnum moss with some low ericaceous shrubs characterize this type. Sphagnum mosses (Sphagnum fuscom, S. recurvum) form a continuous, dense carpet or hummocks and are colonized by various ericaceous shrubs (Ledum groenlandicum, Ledum decumbens, Oxycoccus microcarpus, Rubus chamaemorus, Kalmia polifolia, Andromeda polifolia). The wettest areas, where water collects in small pools, are colonized by a group of bog pioneer species; these are, in order of approximate abundance, Carex sp. Drepanocladus fluitans, Sphagnum riparium, S. teres, S. lindbergii, and Eriophorum angustifolium. The openings are occupied by Labrador tea (Ledum groenlandicum Oeder), cranberry (Vaccinium vitis-idaea L.) and lichens (Cladonia rangiferina (L) Web and C. mitis Sandst.).

Black Spruce-Feathermoss-Ledum Type

This vegetation type is somewhat similar to the black spruce-feathermoss vegetation but, here, the tree cover is more open and Ledum groenlandicum forms a well-developed shrub layer.

Black Spruce-Cladonia Type

A dense forest of black spruce and large patches of lichens characterize this type in the boreal region. In the subarctic boreal region, the tree cover is very open and the lichen layer is continuous and more fully developed (see Fig. 7). The most common lichen species are Cladonia rangiferina, C. mitis, C. alpestris (L.) Rabenh. and C. unicialis (L.) Hoffm. Scattered clumps of willow are encountered and Ledum groenlandicum (in the boreal) and L. decumbens (in the northern boreal and subarctic) are also common.

Black Spruce-Cladonia-Ledum Type

This vegetation type is somewhat similar to the black spruce-Cladonia vegetation but, here, the Ledum groenlandicum (in the boreal) and L. decumbens (in the northern boreal and subarctic) form a well-developed shrub layer.

The vegetation on bog plateaus is dominantly of the black spruce-sphagnum type (see Fig. 6), while on peat mounds it is of the treeless-sphagnum type.

The vegetation on polygonal peat plateaus is of the treeless-sphagnum type.

Treeless-Lichen Type

This vegetation type is characterized by a dense carpet of lichens. The dominant lichen species are Cladonia alpestris, C. rangiferina, Cetraria sp. and Alectonia sp. with Sphagnum mosses dominating the moist polygon trenches. Dichranum sp. are also present but in much smaller amounts than the Sphagnum moss.

Low ericaceous shrubs are scattered throughout the area or occur in the form of small clumps. These are dominantly Ledum decumbens with some Empetrum nigrum. A few scattered and windswept stunted black spruce (krummholz) are also present (see Fig. 21).

FLAT AND BOWL BOGS

These peat landforms are associated mainly with black spruce-feathermoss and black spruce-feathermoss-Ledum types of vegetation. In these vegetation types the tree layer (black spruce) is well developed, representing a merchantable forest (see Figs. 8 and 9).

BLANKET BOG

This peat landform is associated with a black spruce-feathermoss-Ledum type of vegetation cover. The tree layer is composed dominantly of merchantable black spruce. It is also associated with a black spruce-Sphagnum type but the trees in this vegetation type never reach merchantable size.

FEN

The fen vegetation is characterized by a greater number of species than occurs in the bog vegetation. This is mainly the result of the higher nutrient content and higher pH of these peatlands. The most common plant communities are formed by Carex, Drepanocladus moss, Betula glandulosa, and tamarack species.

HORIZONTAL FEN

The following vegetation types are usually associated with the horizontal fen.

Carex Type

One of the most common vegetation types on fens. It is characterized by Carex sp., Eriophorum sp., and other grass species, growing in shallow standing water (see Fig. 10). Some mosses, such as Sphagnum tallax and Drepanocladus sp. may also be found in the standing water. On somewhat drier parts Chamaedaphne calyculata and Betula glandulosa may grow. Pitcher plant (Sarracenia purpurea) and Drosera rotundifolia are also present.

Carex-Drepanocladus Type

Fen with shallow standing water characterized by Carex species and brown mosses dominantly of Drepanocladus sp., with some Calliergon sp. and Aulacumnia sp. also being present. In deeper pools floating aquatic vegetation and reeds are found.

Drepanocladus-Carex Type

This vegetation type is similar to that described above, but here, however, the Drepanocladus moss is the dominant species.

Carex-Drepanocladus-Betula Type

This vegetation type is similar to that described under the Carex-Drepanocladus type. Swamp birch (Betula glanduosa) and some willow (Salix sp.) form the shrub layer.

Larix-Carex Type

In this vegetation type tamarack (Larix laricina) dominates the tree layer and Carex sp. the herb layer (see Fig. 7). Swamp birch (Betula glandulosa), willow (Salix sp.), alder (Alnus sp.), and Chamaedaphne calyculata are also present in smaller quantities. Drepanocladus sp., Sphagnum sp. and some aquatic mosses grow in the wet pools. Some scattered low Sphagnum hummocks are also found, usually above the water level.

PATTERNED FEN

Three basic habitats can be identified in the patterned fen environment. These are the pools, the flarks and the ridges. The wet flarks are dominated by the Carex, Carex-Drepanocladus, Drepanocladus-Carex, Carex-Drepanocladus-Betula and, in some cases, Larix-Carex types of vegetation (see Figs. 11 and 12). In the shallow pools the bryophytes grow with the most common species being Drepanocladus, Calliergon and Sphagnum contortum (see Fig. 11). Along with the bryophytes, algae commonly occurs in these shallow pools. In some places iron ochre is produced by iron bacteria and algae.

On the ridges or strings, which are elevated above the water table, Larix-feathermoss or Larix-black spruce-Sphagnum types of vegetation occur (see Figs. 10, 11, 12 and 13). In both of these vegetation types Betula glandulosa and Salix species are common with some ericaceous species (Ledum, Empetrum) also being found in the Larix-black spruce-Sphagnum vegetation type. Various Carex species and bryophytes are also present.

SLOPING FEN

This landform is dominated by Carex and Carex-tamarack types of vegetation (see Fig. 14). The Carex-tamarack type is very similar to that described under the tamarack-Carex type but here, however, the tree cover is much more open and the herb layer is dominated by various Carex species.

FLOATING FEN

The floating fen is characterized by the Carex vegetation type with floating or submerged aquatic species being present mainly along the edges of the floating mat. Aquatic vegetation also dominates where pools of free water occur in the organic mat.

Some shrubs invade these floating fens, especially swamp birch and some willows and Chamaedaphne calyculata (see Fig. 15).

COLLAPSE SCAR

This peat landform has resulted from the melting of permafrost, mainly on peat plateaus and palsas. The common vegetation types are Carex and Carex-Drepanocladus (see Figs. 16 and 18). Betula glandulosa and willows also occur at times in these vegetation types. Dead trees (mainly black spruce), standing or partly submierged, are commonly seen. These trees died when the former perennially frozen landforms melted.

A ring of shallow water is usually found along the edge of the scar contact with the still remaining peat plateau or palsa. In the water pool, fast growing Sphagnum species (Sphagnum riparium and Sphagnum contortum) are found.

SPRING FEN

It is dominated by Carex and Carex-Larix types of vegetation. Areas which are most affected by seepage are normally very high in salts and if vegetation is present, it is of the salt-tolerant species (see Figs. 17 and 18).

DOMED FEN

This landform (minerotropic palsa) commonly occurs in the Coastal Plain area of Hudson Bay. The vegetation is of the Carex-feathermoss-arctic willow type either with scattered white spruce and tamarack or, more often, treeless. Many of these minerotrophic palsas are nearly devoid of living vegetation with the exception of a few willow and Carex sp. growing close to the edge, where the peat is moist, or in the moist depressions.

SWAMP

The most productive peatland vegetation in Manitoba occurs on swamps. This is basically due to two main factors: the more moderate climate (swamps are found in southeastern Manitoba) and the higher nutrient content of the peat. The characteristic vegetation cover is the swamp forest with white-cedar, tamarack and black spruce being the dominant tree species.

HYDRIC LOWLAND SWAMP

The associated vegetation is similar to that of Heinselman's (1970) poor swamp forest. The common vegetation type is tamarack-Carex-moss-swamp birch where tamarack (Larix laricina) is the dominant tree species, but cedar is also present. Swamp birch (Betula punnila), the only tall shrub present, often forms dense understories 1 to 2 meters high. Members of the Ericaceae form a fairly dense, low shrub layer, most often dominated by Andromeda glaucophylla and Chamaedaphne calyculata. Hummocks of Sphagnum sp. up to 0.5 meter high cover much of the ground.

MESIC LOWLAND SWAMP

The associated vegetation is similar to that of Heinselman's (1970) rich swamp forest. The common vegetation type is cedar-moss-tamarack where northern white-cedar (Thuja occidentalis) is the dominant tree species, but Larix, Fraxinus and Picea are also present (see Fig. 19). The shrub layer is dominanted by alder (Alnus rugosa) except where the cedar is dense. Sphagnum palustris forms hummocks and partial carpets. The vegetation on mesic lowland swamps is floristically the richest of all the peatland types. The most productive forests occur along upper margins with maximum access to minerotrophic waters.

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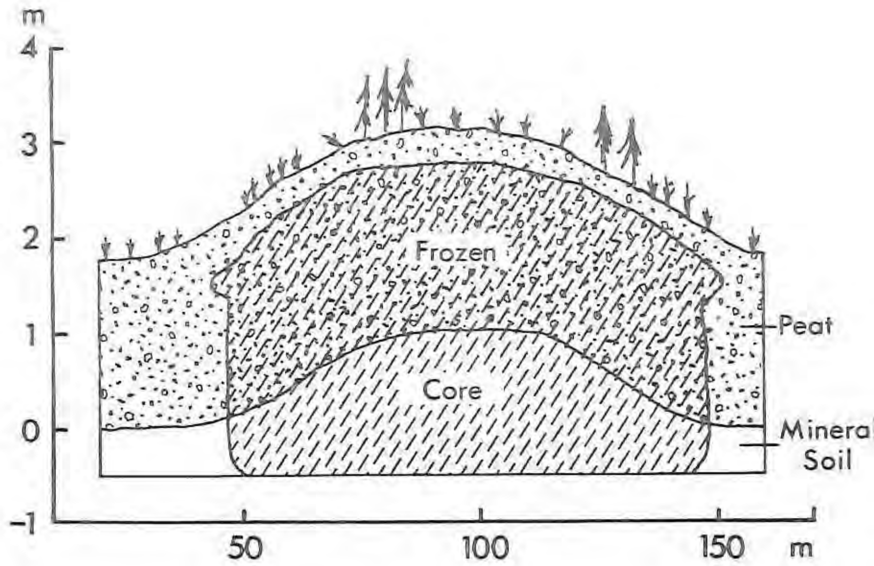
FIGURE 1



Schematic cross-section of a palsa

Schematic cross-section of a peat mound

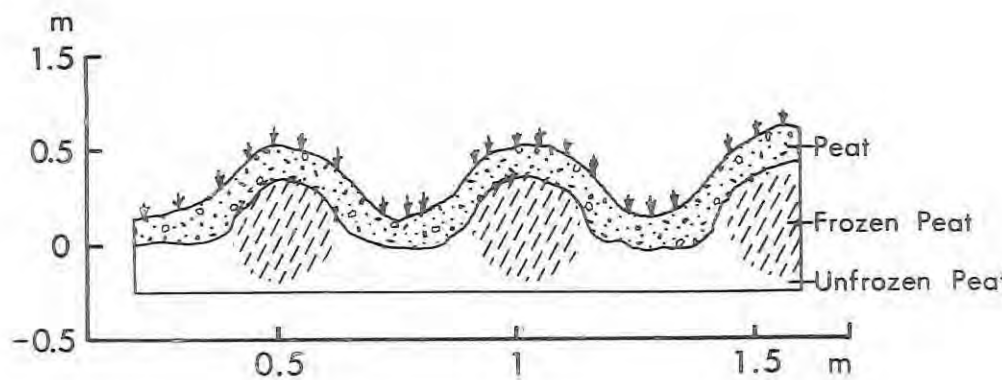
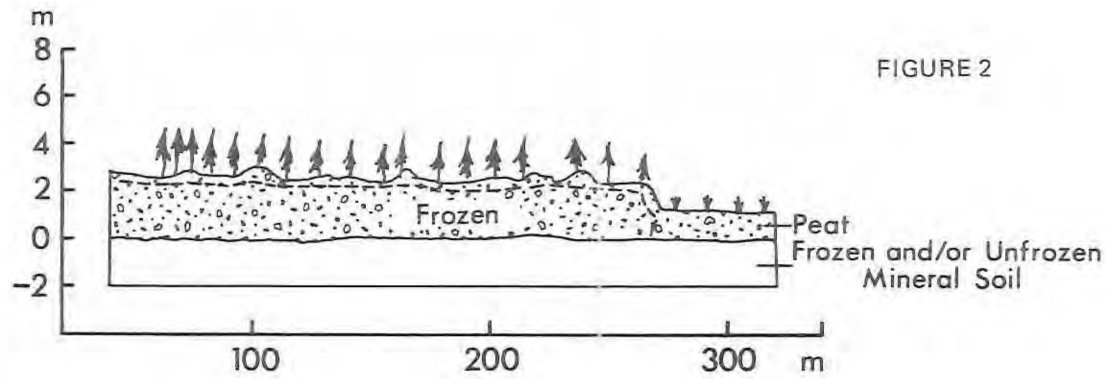
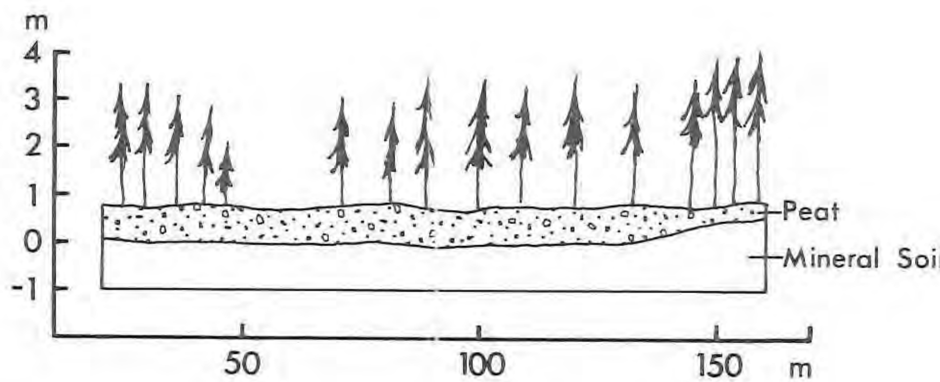


FIGURE 2

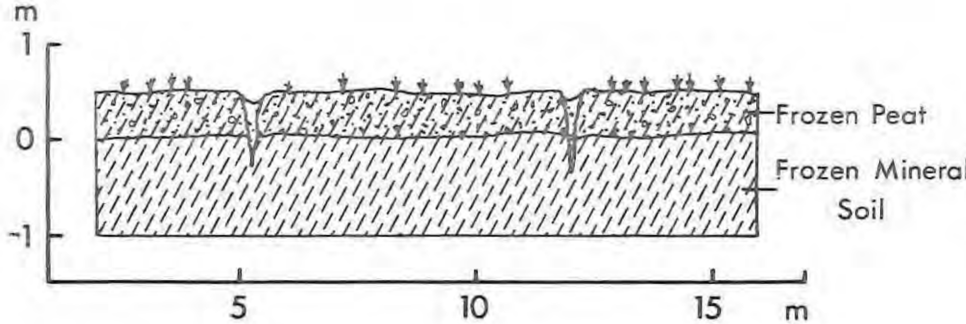


Schematic cross-section of a peat plateau



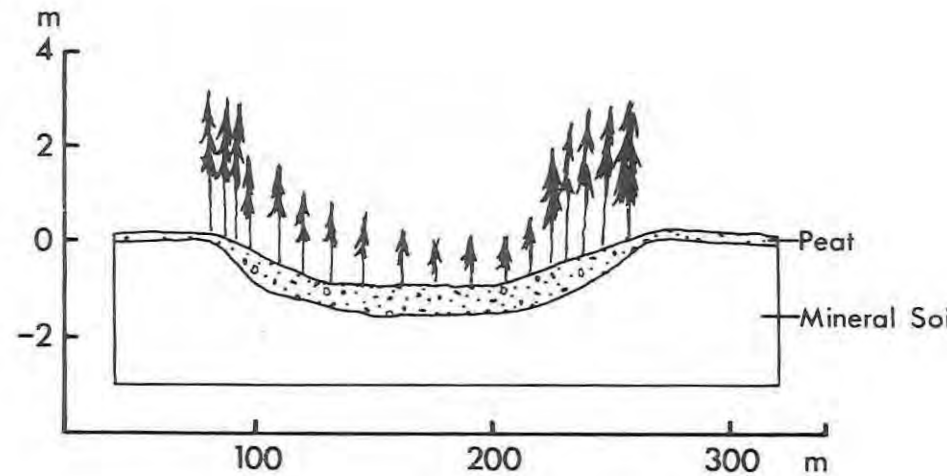
Schematic cross-section of a flat bog

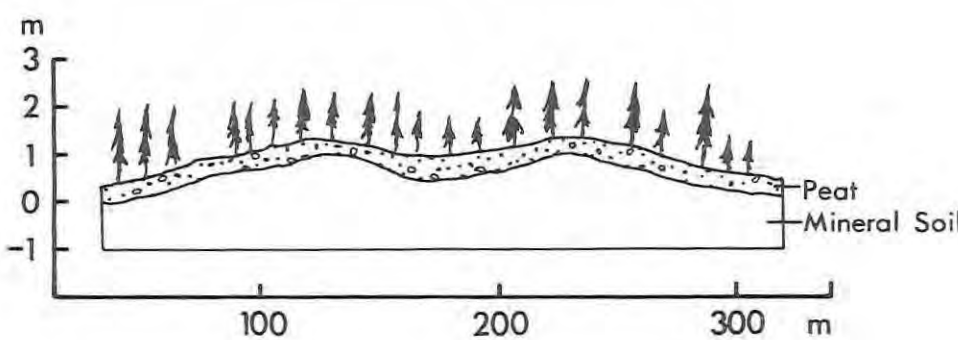
FIGURE 3



Schematic cross-section of a peat polygon

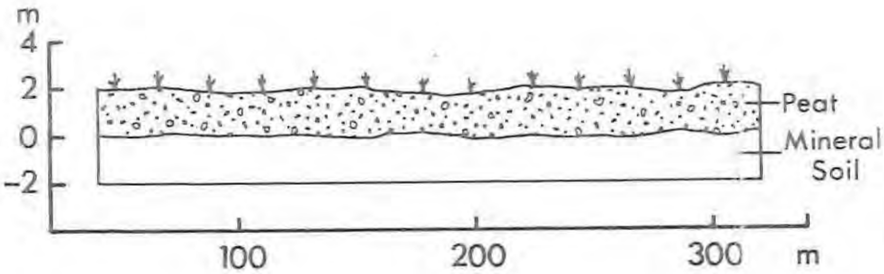
Schematic cross-section of a bowl bog





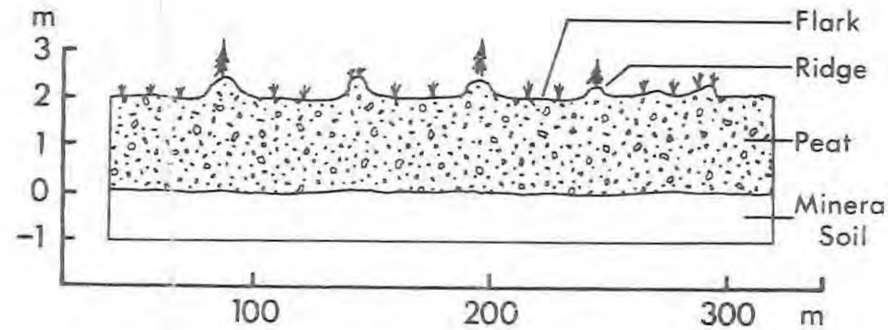
Schematic cross-section of a blanket bog

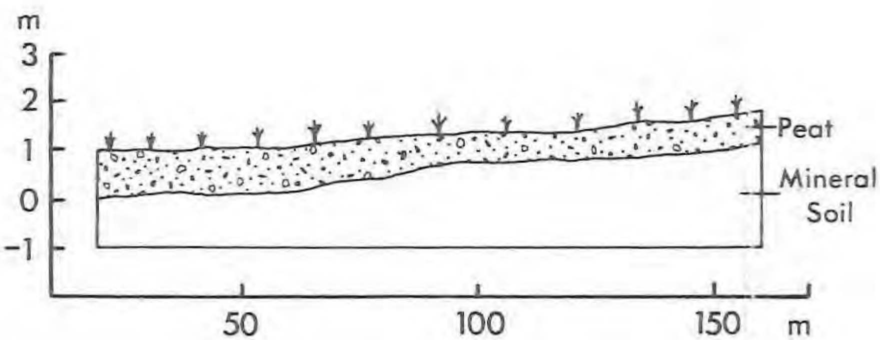
FIGURE 4



Schematic cross-section of a horizontal fen

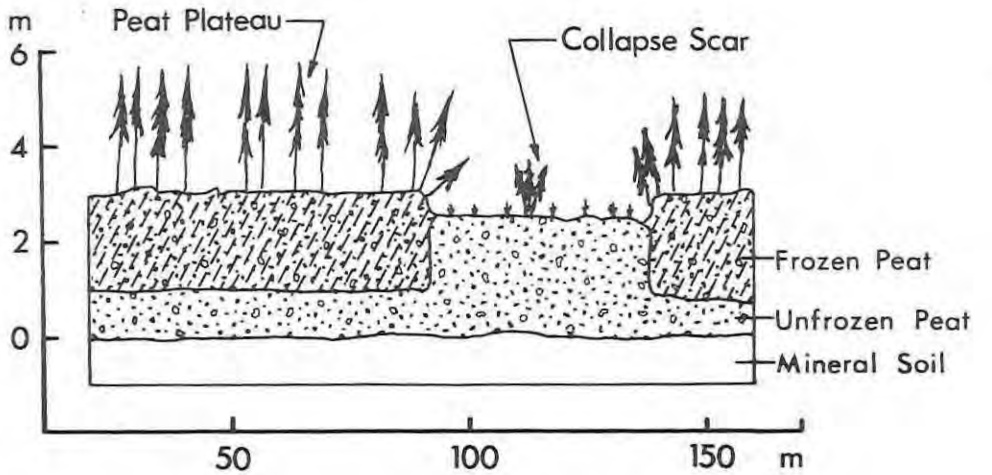
Schematic cross-section of a string fen



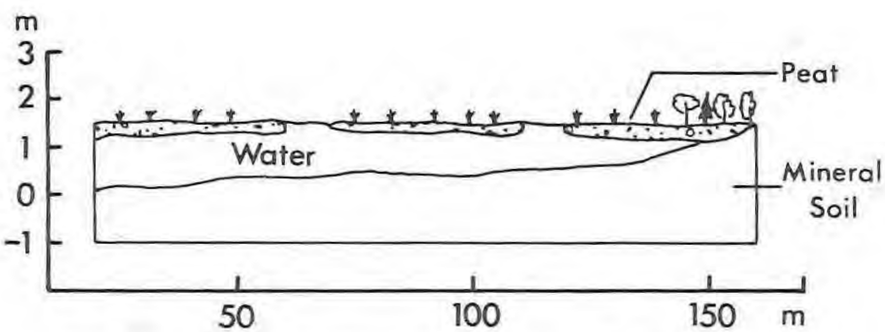


Schematic cross-section of a sloping fen

FIGURE 5



Schematic cross-section of a collapse scar



Schematic cross-section of a floating fen

Figure 6. Location: Twp. 39, Rge. 4W - Reindeer Island. Photo No: A 17186-97, 98, 99.
(A) Tear-drop shaped bog plateaus, surrounded by water-saturated fen.

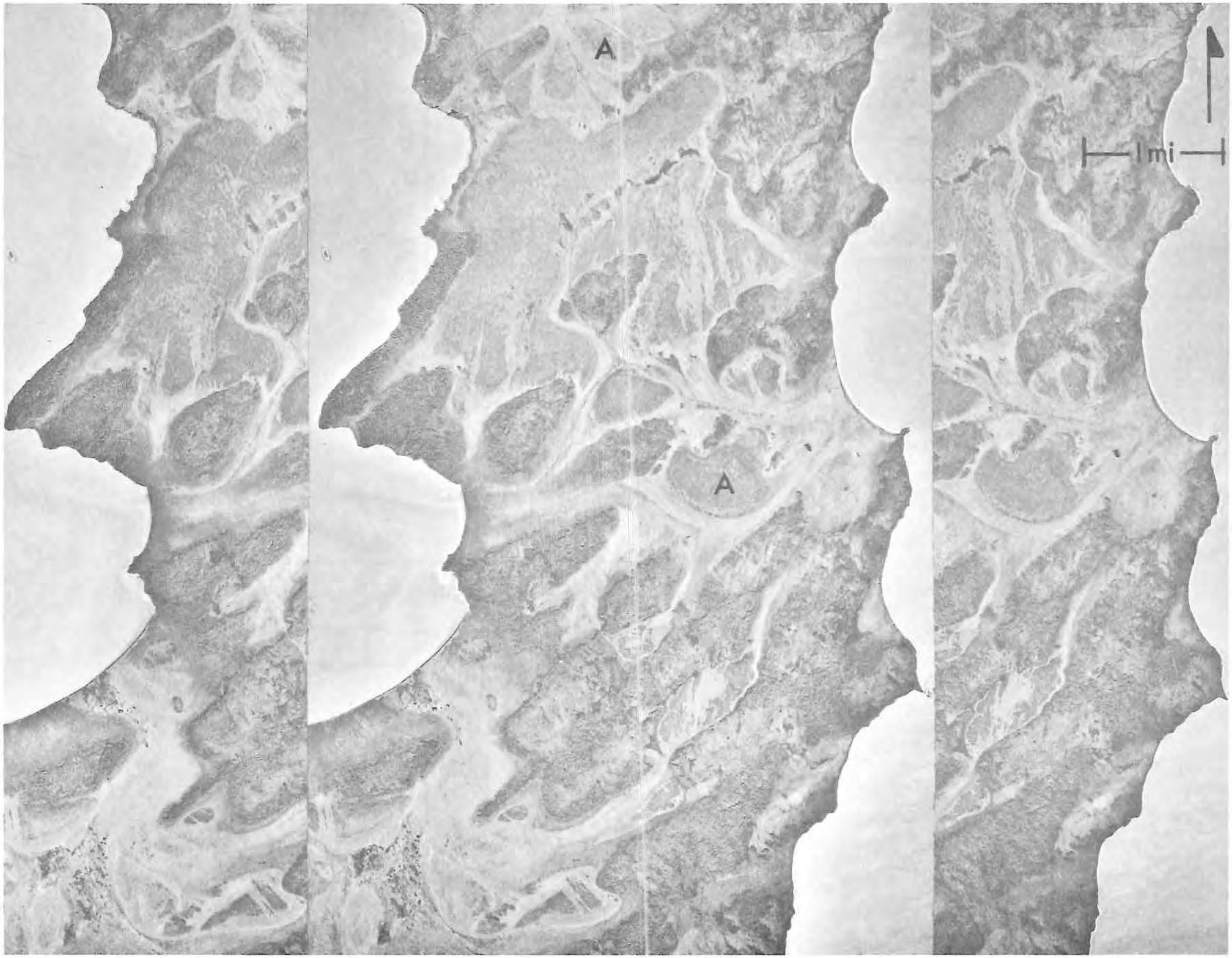


Figure 7. Location: York Factory area, Hudson Bay Lowland. Photo No: A 14219-105, 106.

(A) Round-shaped, peat plateaus formed on the abandoned Hudson Bay beaches. The light patterns in the peat plateaus are collapse scars. (B) Water-saturated horizontal fen. (C) Some of the wooded palsas are visible on this area, surrounded by fen. (D) Large thermokarst on the river-bank.

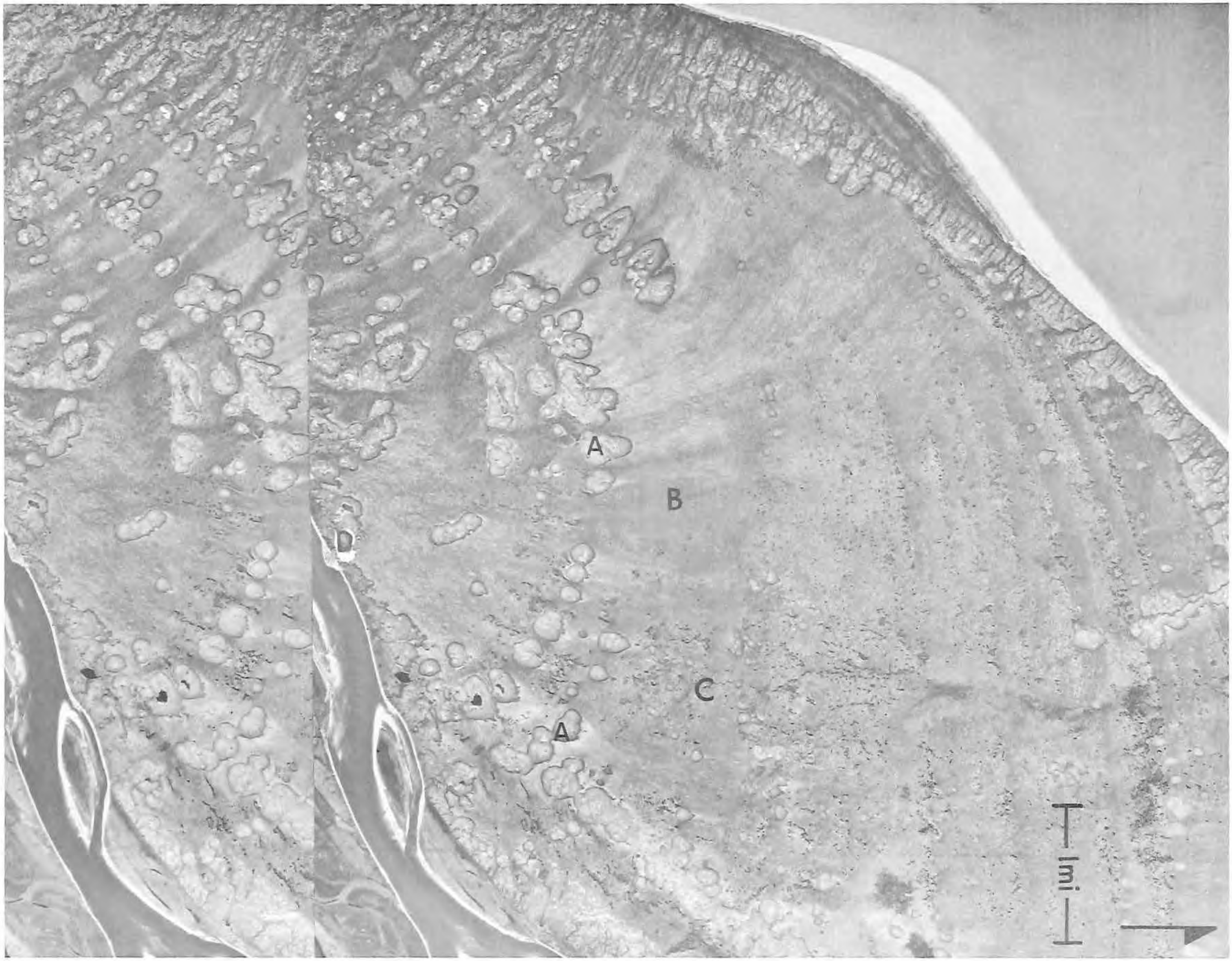


Figure 8. Location: Sec. 22, Twp. 11, Rge. 12E. Photo No: A 15541-140, 141, 142.
(A) Flat bog.

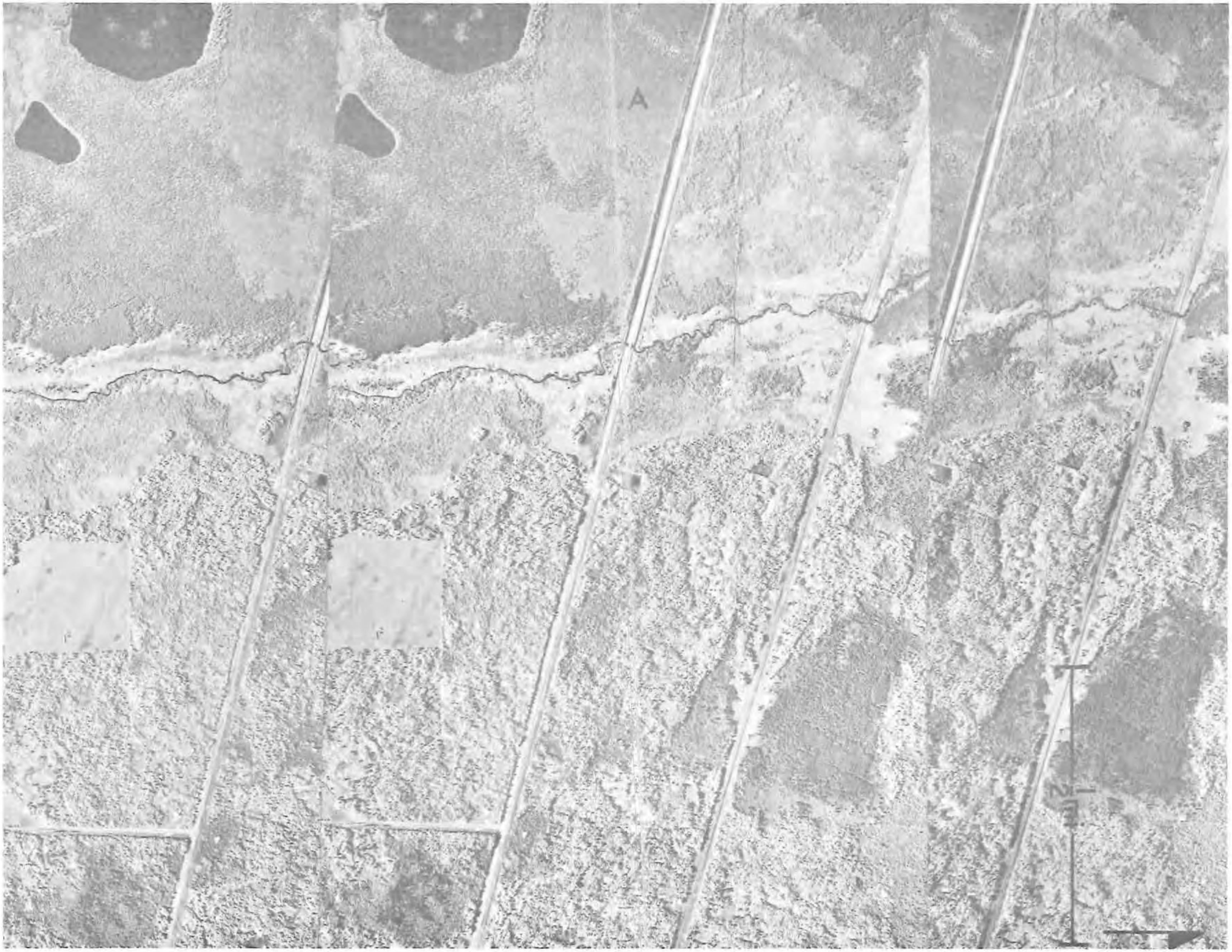


Figure 9. Location: Twp. 20, Rge. 11E. Photo No: A 15955-41, 42.
(A) Bowl bog.

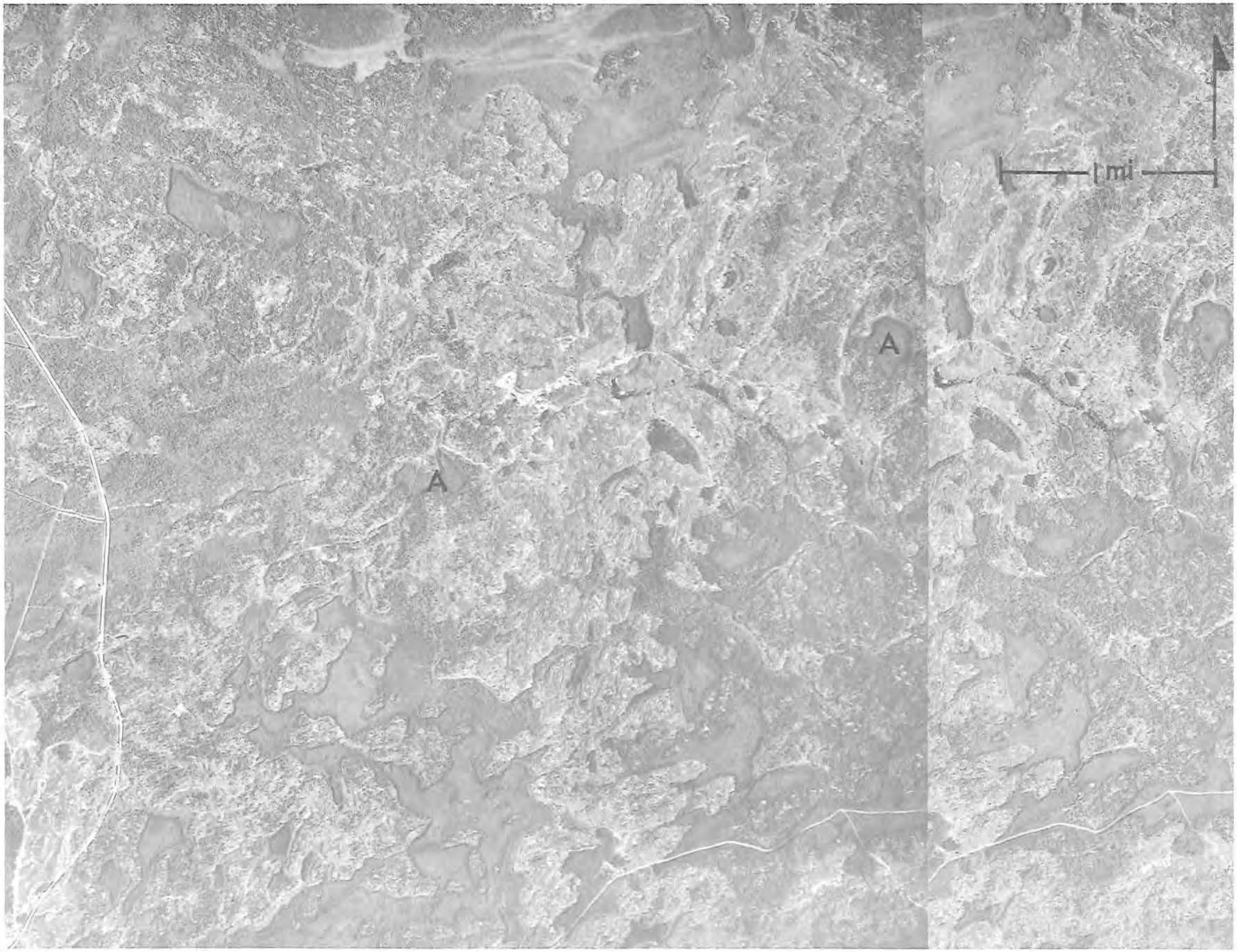


Figure 10. Location: Sec. 11, Twp. 6, Rge. 14E. Photo No: A 15542-73, 74.

(A) Horizontal fen with sedge vegetation. (B) Patterned fen. The ridges have developed parallel to the water flow. Tear-drop shaped wooded raised bogs, commonly known as black spruce islands, are typical of patterned fens.

Figure 11. Location: Sec. 5, Twp. 6, Rge. 11E. Photo No: A 14946-71, 72.

(A) Patterned fen, string fen, composed of water-saturated flarks with sedge vegetation and fen-pools. The relatively better drained low ridges are densely covered by dwarf tamarack and black spruce. (B) Floating fen developed on large-fen pools.

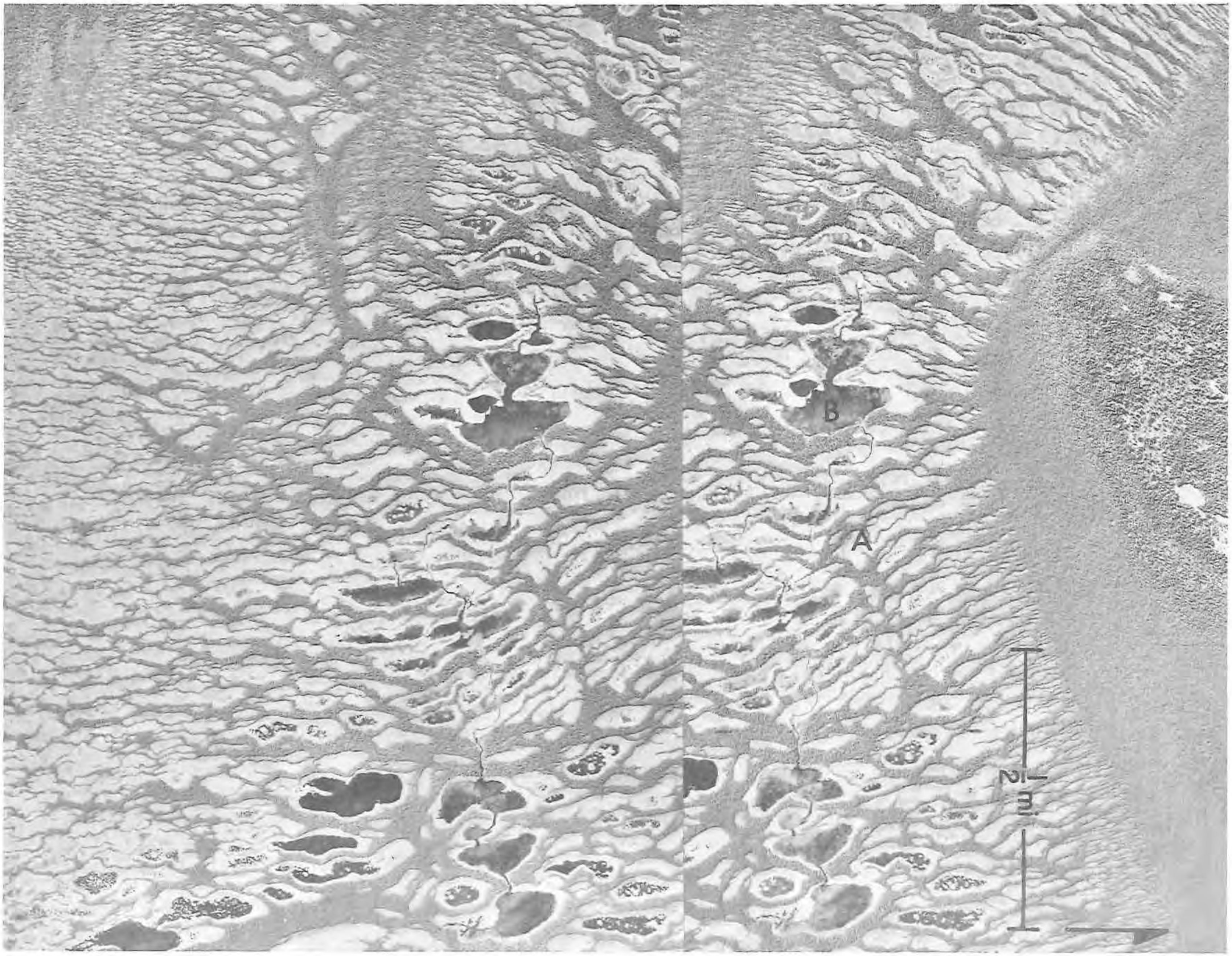


Figure 12. Location: Sec. 27, Twp. 39, Rge. 11W. Photo No: A 18043-145, 146.

(A) Patterned fen. The low ridges are interlocked and form a net-like pattern. The water-saturated flarks are covered by sedge vegetation.

Figure 13. Location: Sec. 26, Twp. 52, Rge. 27W. Photo No: A 19727-151, 152.

(A) Patterned fen, with well-developed, net-like wide ridges, covered with black spruce and tamarack. The water-saturated flarks are dominated by sedge vegetation.

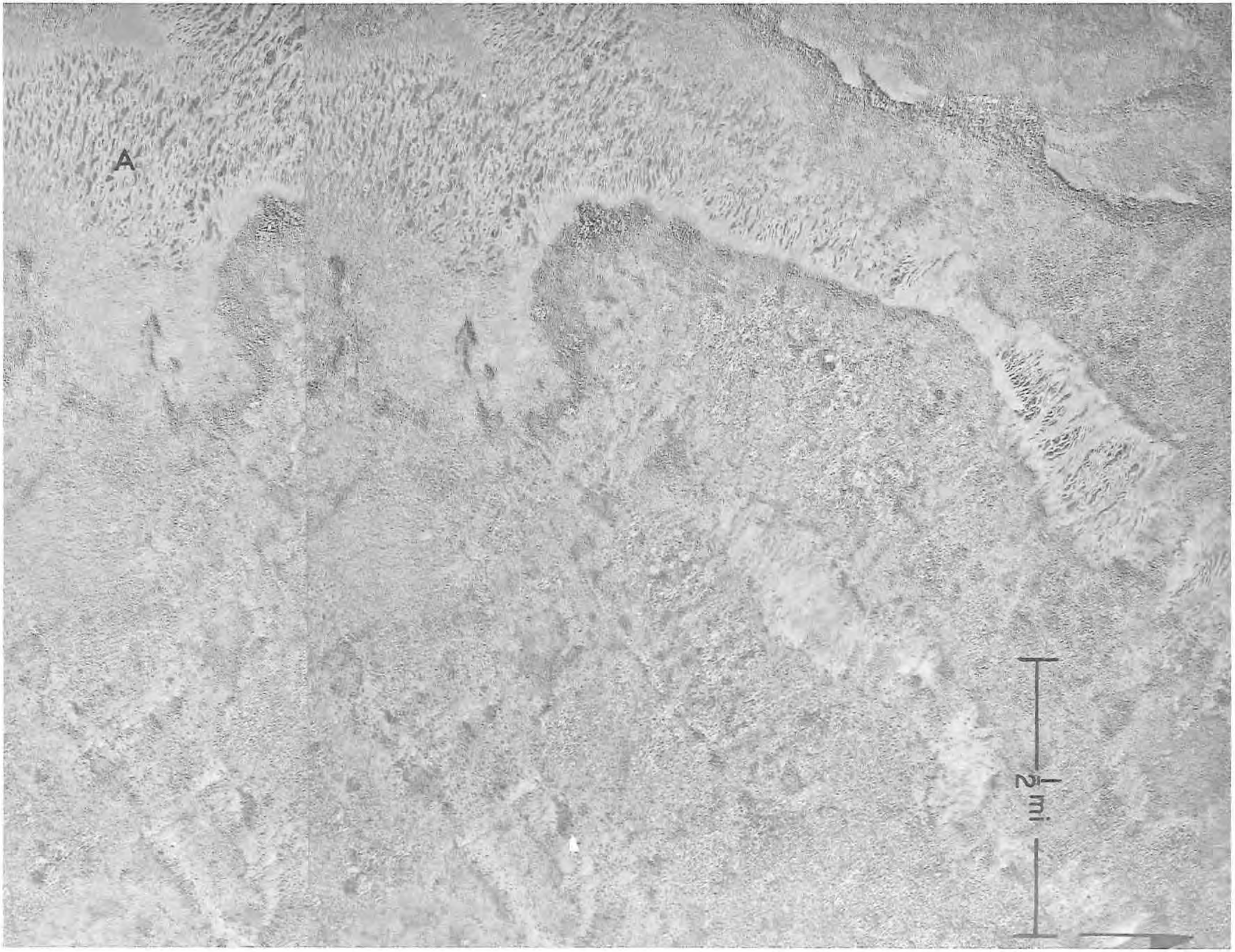


Figure 14. Location: Sec. 2, Twp. 39, Rge. 23W. Photo No: A 15607-136, 137.
(A) Sloping fen. The drainage is restricted by the beaches in this area and creates a high water table, hence the development of fens.

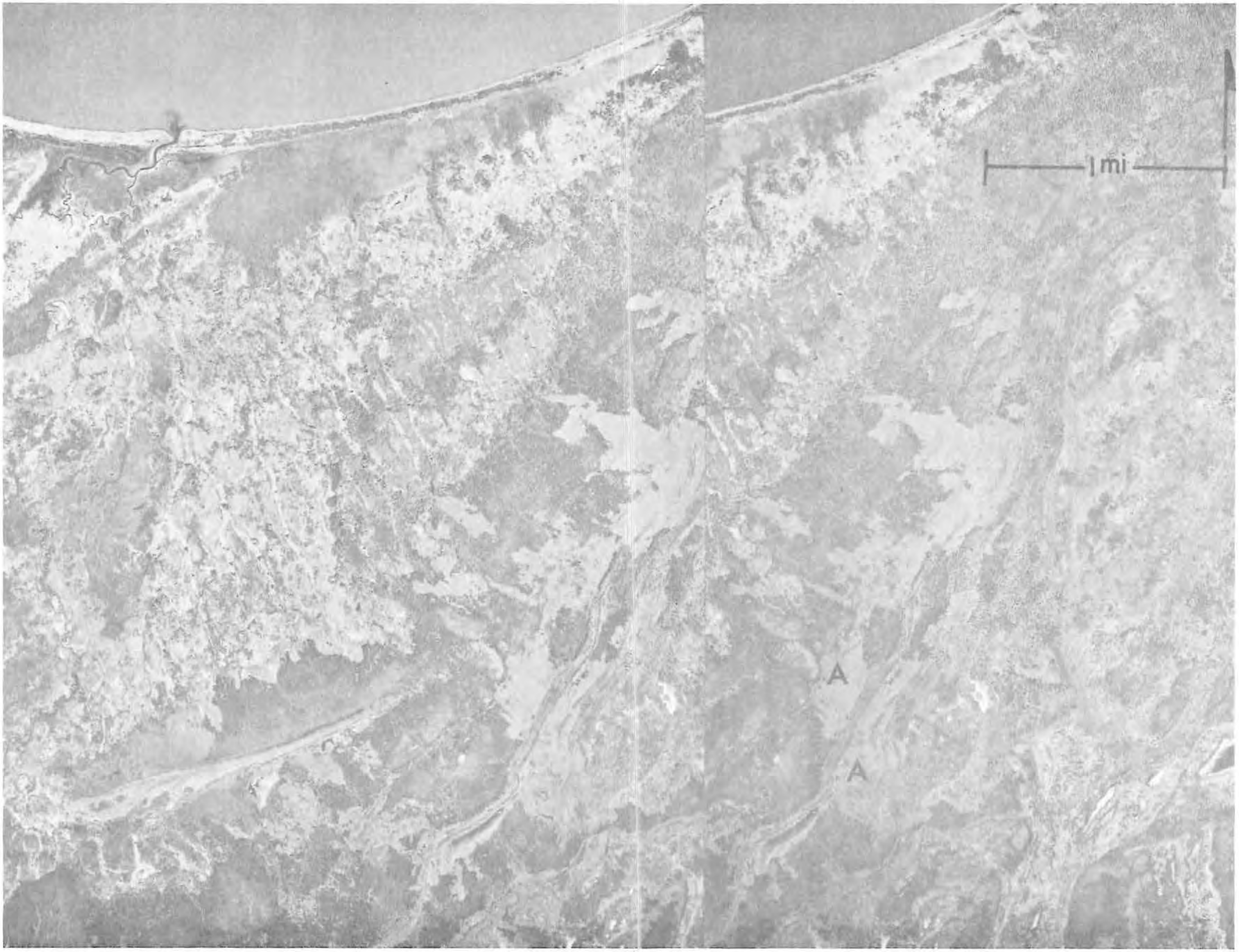


Figure 15. Location: a. Sec. 31, Twp. 56, Rge. 21. b. Sec. 6, Twp. 57, Rge. 21. Photo No: A 19737-137, 138, 139.
(A) Well-developed, anchored mat of floating fen peat. (B) Somewhat anchored, floating fen with thin fen peat. (C) Showing the development of the large round floating peat mats.

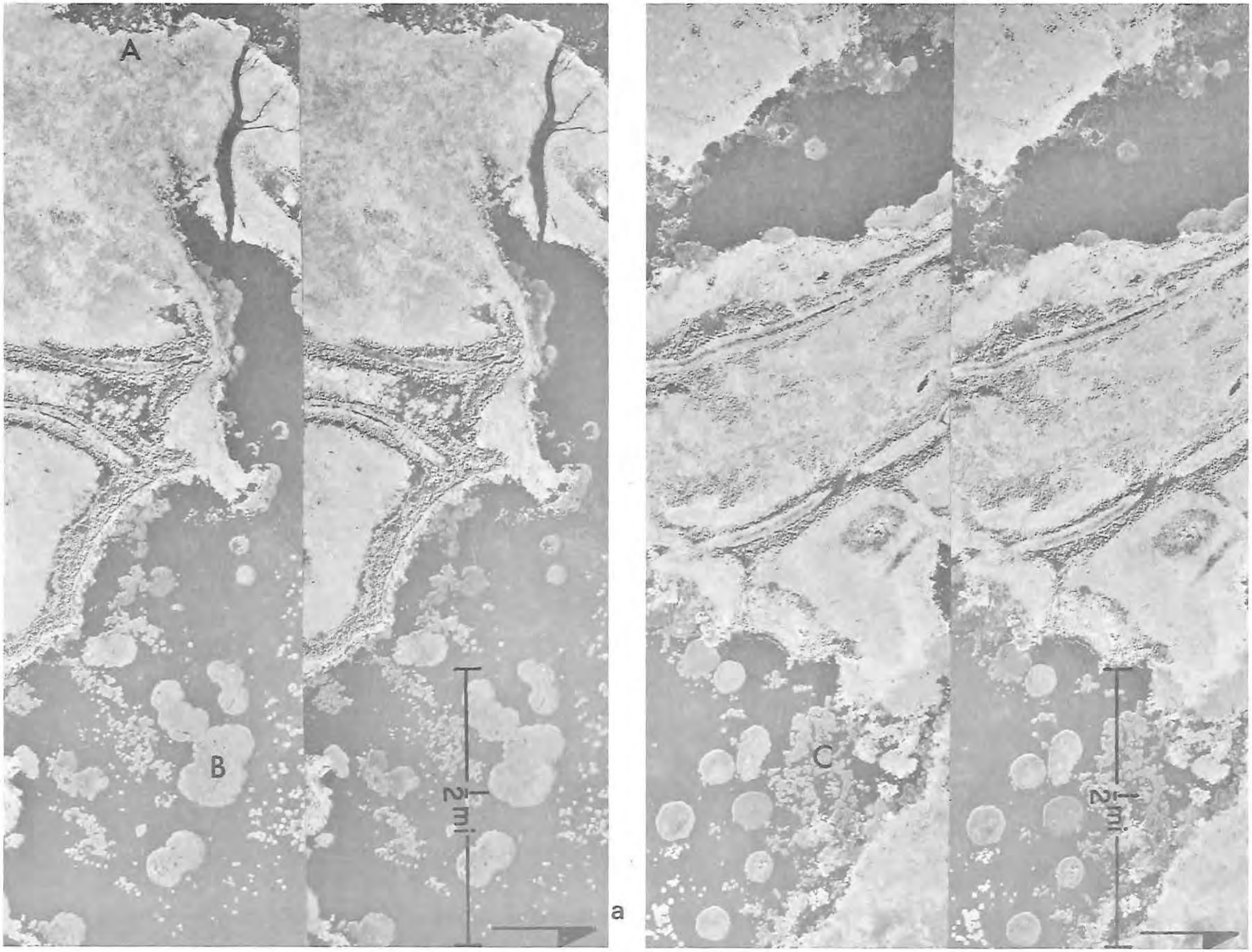


Figure 16. Location: Sec. 20, Twp. 62, Rge. 26W. Photo No: A 19735-145, 146.
(A) Light grey colored sedgy collapse scars, surrounded by treed permafrost area. Note: Enlargement of Fig. 18.

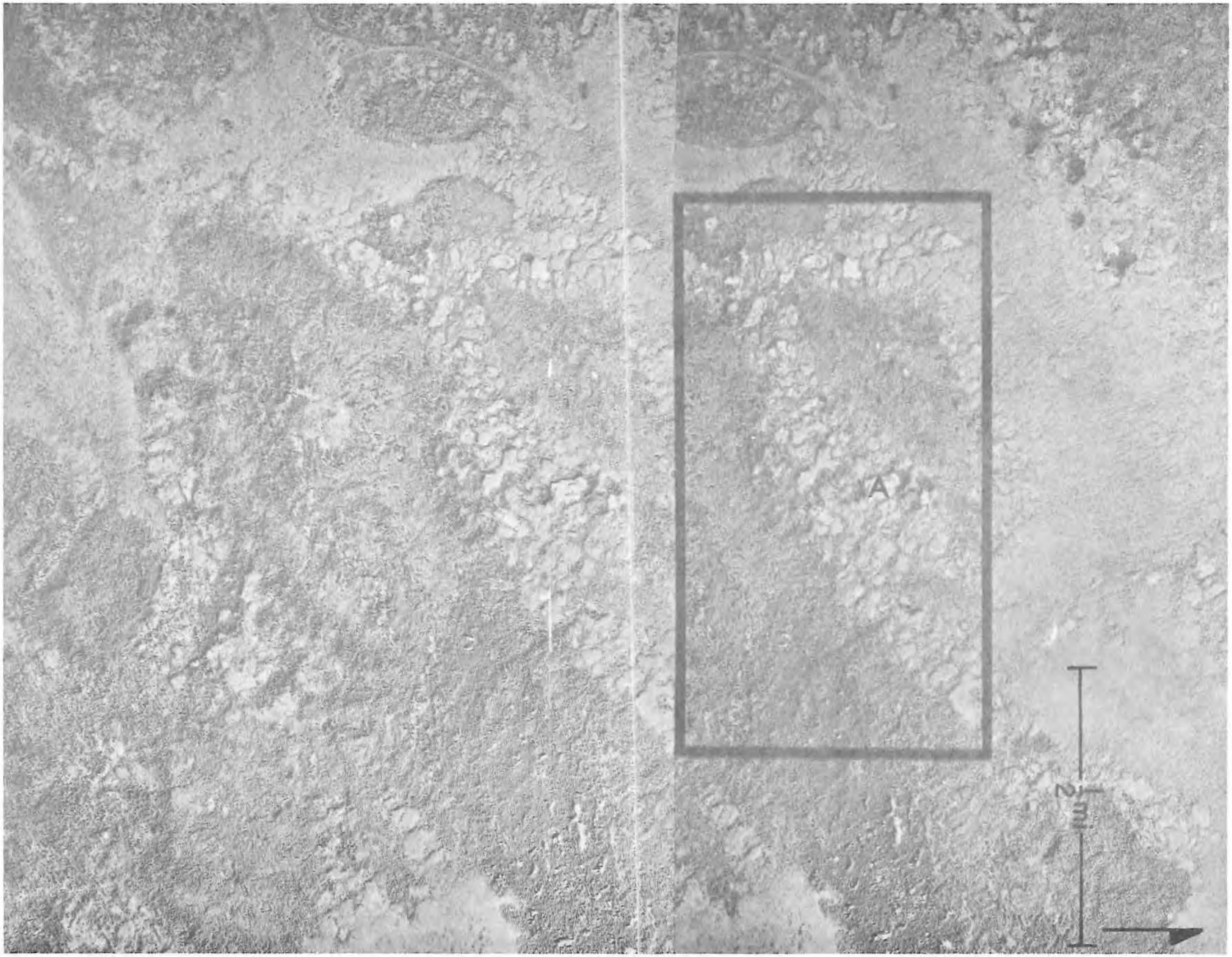


Figure 17. Location: Sec. 29, Twp. 40, Rge. 8W. Photo No: A 18200-60, 61.
(A) Spring fen.

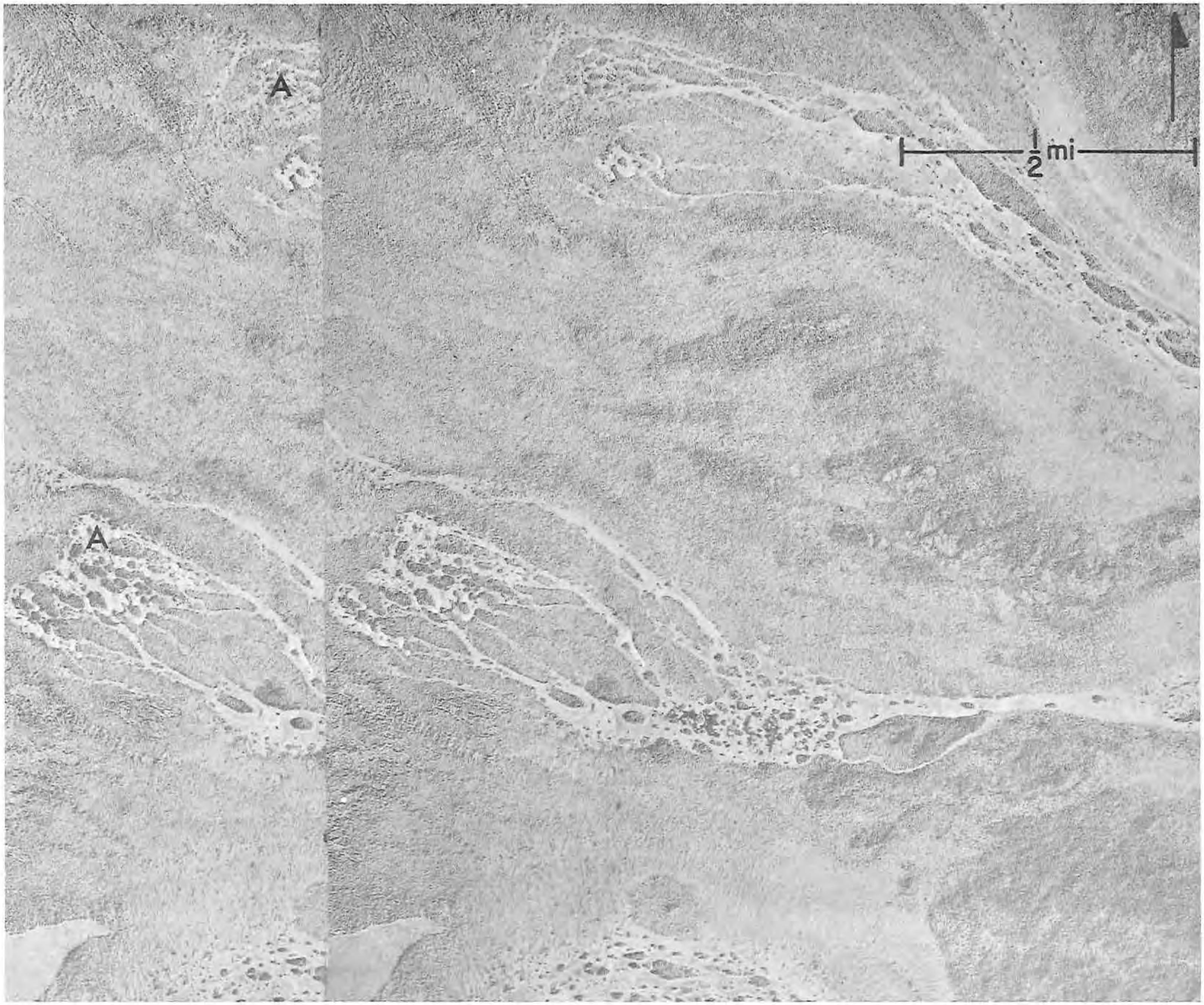


Figure 18. Location: Twp. 62, Rge. 26W. Photo No: A 13870-35, 36.
(A) Collapse scars. (B) Pattern fen. (C) Spring fen.
Note: See Fig. 16 for enlargement of area.

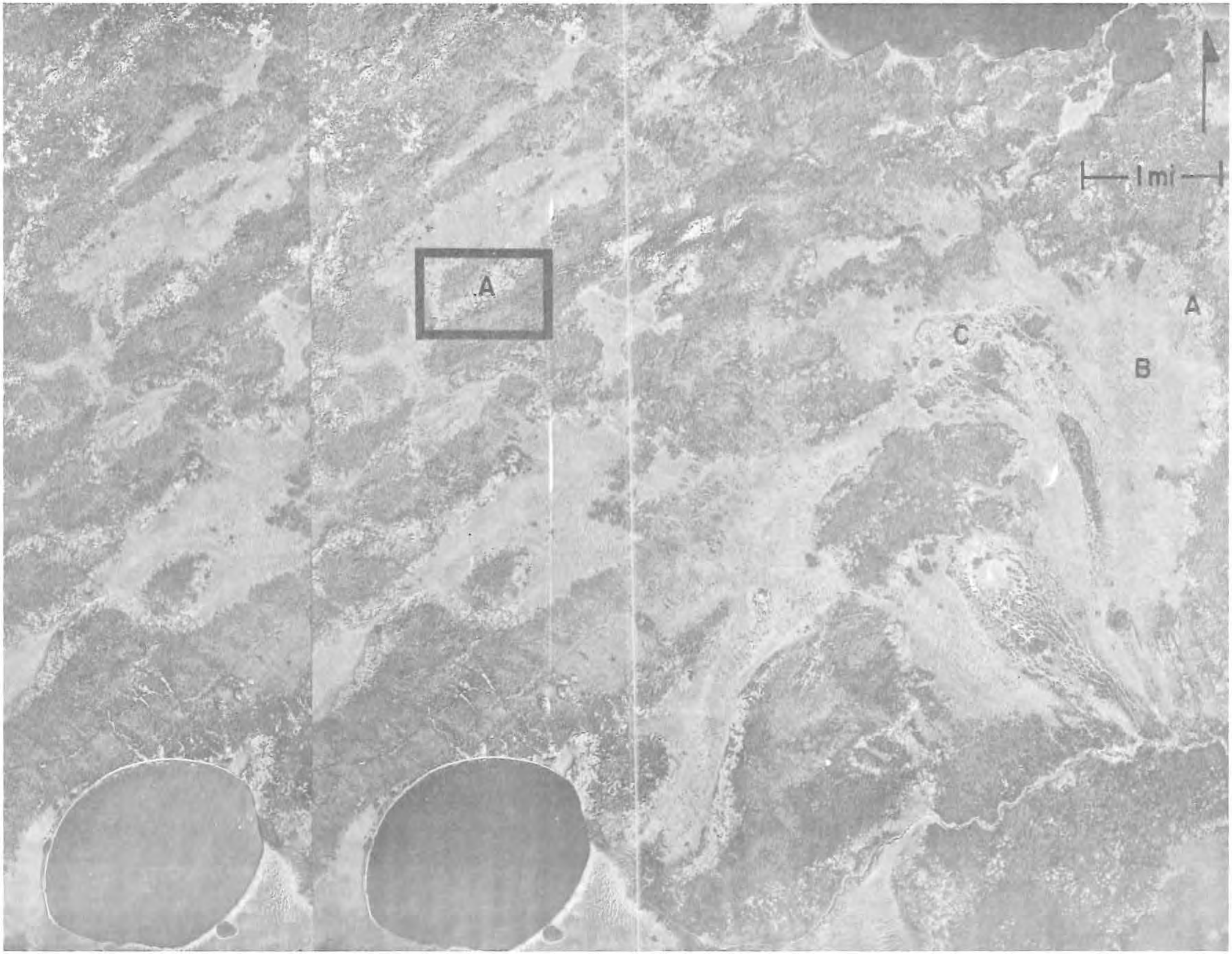


Figure 19. Location: Sec. 34, 35, Twp. 1, Rge. 13E. Photo No: A 15539-119, 120, 121.
(A) Swamp dominated by cedar and spruce vegetation. (B) Bog dominated by black spruce and Ledum vegetation.

Figure 20. Location: Sec. 16, Twp. 26, Rge. 4E. Photo No: A 16005-12, 13.

(A) Marsh area along Lake Winnipeg. Note: The marsh is a grassy wetland with a high growth of sedges and grasses and much standing water. The peat cover is very shallow and thus is not defined as peatland. These marshes are usually associated with periodically flooded alluvial soils or shore vegetation of nutrient-rich ponds and lakes.

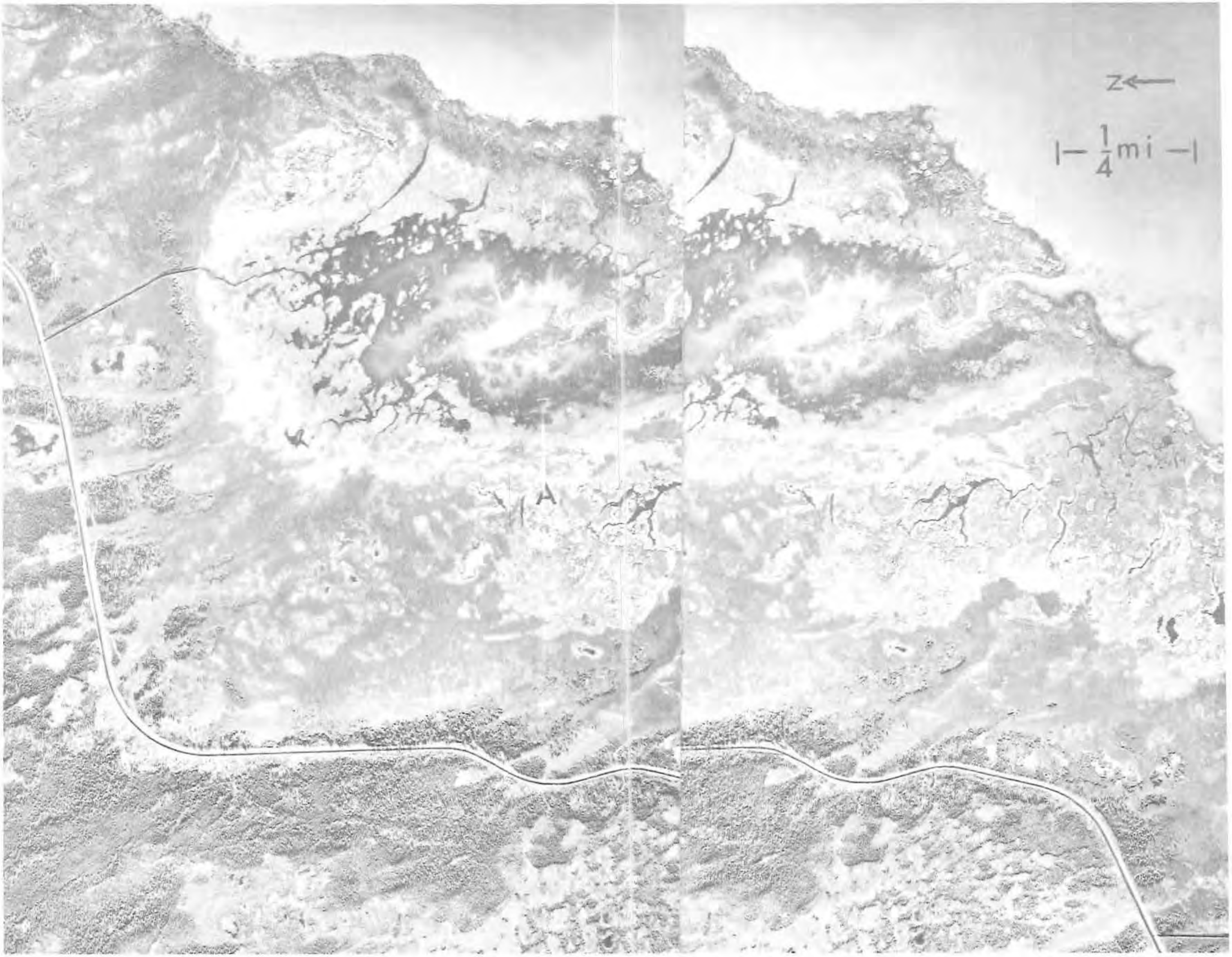
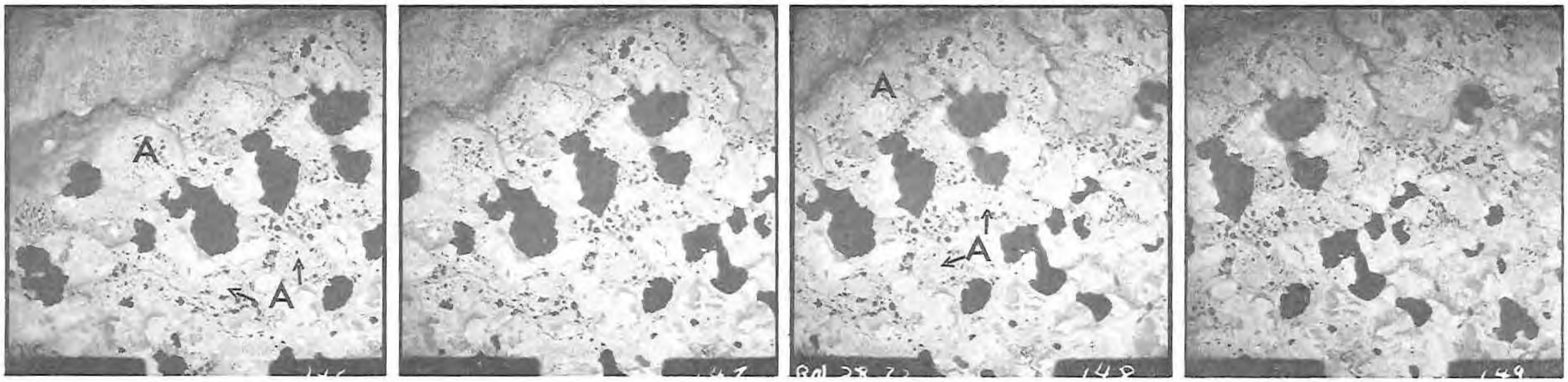


Figure 21. Location: Churchill area, Hudson Bay Lowlands. Photo No: BN 2873-146, 147, 148, 149.
(A) Large areas of polygonal peat plateaus.



Organic Soil Parent Materials

G.F. Mills

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1. Introduction

Organic soils occur under climatic conditions ranging from tropical and subtropical to subarctic and arctic. The kind of peat material which accumulates to form organic soils is strongly influenced by vegetation and the climatic conditions under which it occurs.

Organic soils consist of accumulations of organic residues resulting from the cyclical growth and decay of hydrophytic vegetation common to marshes, swamps, fens and bogs (see section on peat landforms and vegetation). The characteristics of different organic soils are closely related to the properties of the plant species which form the organic remains.

In Manitoba, both the distribution of organic soils and their properties are related to regional climate and local patterns of relief and drainage. The climate must be sufficiently humid that organic deposits accumulate at rates faster than which they decompose. A second prerequisite necessary for peat accumulation under the sub-humid to humic climatic conditions encountered in Manitoba is level to depressional areas in which a water saturated environment is maintained. Thirdly, anaerobic conditions are necessary for peat accumulation. On drainage improvement, or where the waters in the saturated environment are aerated, increased oxidation and aerobic destruction of organic matter occurs, the rate of which may exceed accumulation.

2. Peat Materials

In Manitoba four main types of several sub-types of peat materials are encountered. Their recognition is based on: (1) botanic origin as related to landform and vegetation type and (2) physical and chemical properties of the peat material. Each type of peat material has an equivalent vegetation association in the living environment, permitting some extrapolation of the environmental conditions from the peat material.

In the following definitions for the peat materials, it is noted that we are dealing with biological materials having their origin from particular kinds of vegetation. Because of variation in conditions such as climate, physiography, groundwater and drainage, this vegetation may occur as pure types as well as intergrades and transition types. Thus, the peat material itself may occur as a relatively pure substance or may be transitional in its physical and chemical properties.

2.1 SPHAGNUM PEAT

This type of peat material develops on very wet to wet sites which are isolated from mineral influenced groundwater. The dominant peat former is the Sphagnum spp. Sphagnum peat may occur under open to closed stands of stunted black spruce and tamarack (black spruce-Sphagnum-Ledum vegetation) or on near treeless heath like conditions

(Sphagnum-Ledum vegetation). The peat material consists dominantly of Sphagnum moss with minor amounts of feathermoss and stems and leaves of ericaceous shrubs. Woody intrusive material derived from roots and stems of spruce and tamarack may be present.

Sphagnum peat is usually undecomposed (fibric), light yellowish brown to very pale brown in colour and loose and spongy in consistence with entire Sphagnum plants being readily identified. At lower depths in the profile, Sphagnum peat occurs as reddish yellow to dark brown, compacted somewhat layered fibric material. The unrubbed fiber content of Sphagnum peat is approximately 85 percent decreasing to about 50 percent on rubbing. The material is extremely acid ($pH < 4.5$) and has bulk density values usually less than 0.1 gm/cc.

Selected physical and chemical properties of Sphagnum peat materials from the Roseau River Watershed, Southeastern Manitoba are presented in Table 1 and from the Mackenzie River Valley, North West Territories in Table 2.

Two sub-types of Sphagnum peat are recognized based on the dominant species and the peat environment (Tarnocai, 1973; Zoltai et al. 1974).

2.11 SPHAGNUM (RECURVUM) PEAT

Sphagnum species growing submerged or at the surface of acid waters. These Sphagnum mosses are rapid growing and often occur as the initial Sphagnum species in saturated fen environments. In bog environments, with hummocky microrelief, these species are dominant in the bog pools. Organic landforms containing permafrost are characterized by varying amounts of collapsing of the permafrost both within the landform and around the edges. Sphagnum recurvum is often the pioneer Sphagnum species found in the acidic waters associated with the collapse of the permafrost.

2.12 SPHAGNUM (FUSCUM) PEAT

These species of Sphagnum grow in somewhat better drained moist to wet acid peat. Sphagnum fuscum has a cushion forming growth habit and thus occurs on bogs with a nummocky microrelief. The early stafes of the Sphagnum growth cycle consist of a complex association of S. recurvum in low, wet hollows separated by cushions or pillows of S. fuscum. The bog builds up in this way until the surface becomes too dry for any of the Sphagnums except S. fuscum (Moss, 1953).

2.2 FOREST PEAT

This type of peat material develops on slightly better drained sites on the slopes of bogs or near mineral soil margins throughout central portions of the Boreal Forest Region and adjacent to mineral soil margins (Mesic Swamps) in southeastern Manitoba. In northern portions of the Boreal Forest affected by discontinuous and widespread permafrost distribution, forest peat materials are associated with perennially frozen peatlands (peat plateaus and palsas). Although the dominant peat formers vary with climatic change, much of the forest peat material is derived from black spruce, ericaceous shrubs and feathermosses.

Table 1. Selected Physical and Chemical Properties of Sphagnum Peat Materials from the Roseau River Watershed, Southeastern Manitoba.

Profile No.	Horizon	Sampling Depth (cm)	Fiber Content % Unrubbed	Fiber Content % Rubbed	C/N Ratio	C.E.C. m.e./100 gm	Pyrophos. %	Ash %	Bulk Density g/cc
S55	Of_1	0- 20	98	58	60.1	91.9	12.4	9.9	
	Of_2	20- 80	74	36	97.3	133.1	4.8	5.6	0.07
	Of_3	80-160	98	66	87.2	112.2	5.4	3.9	
SJ21	Of_1	0- 10	100	70	82.7	118.2	3.9	5.0	
	Of_2	10- 35	84	30	71.7	120.0	13.4	9.5	
	Of_3	35-115	84	48	99.9	129.8	8.4	3.0	0.09
	Of_4	115-155	58	22	53.2	136.7	9.6	4.7	
	Om_1	155-195	62	20	40.7	140.7	5.4	5.4	
SJ6	Of_1	0- 20	92	68	83.6	107.9	3.2	4.9	
	Of_2	20-100	64	18	55.2	119.0	7.3	4.9	0.10
S106	Of_1	0- 15	100	88	61.6	112.5	5.3	5.8	
	Of_2	15- 70	88	60	66.2	101.6	9.7	18.8	0.05
	Om_1	70- 90	62	32	47.1	111.0	9.6	4.0	
P25	Of_1	0- 25	100	62	50.3	157.9	4.7	20.0	0.06
S105	Of_1	0- 30	100	92	65.0	93.4	5.4	3.9	
	RANGE		58-100	18-92	50.3-99.9	91.9-157.9	3.2-13.4	3.0-20.0	0.05-0.10
	MEAN		84.267	51.33	68.12	119.06	7.23	7.29	.074
	S.D.		16.12	24.05	18.35	18.09	3.13	5.31	

Table 2. Selected Physical and Chemical Analysis of Sphagnum Peat Materials, Mackenzie River Valley, N.W.T.

Profile No.	Horizon	Sampling Depth (cm)	Fiber Content % Unrubbed	Fiber Content % Rubbed	C/N Ratio	C.E.C. m.e./100 gm	Pyrophos. %	Ash %	Bulk Density g/cc
T35A	Of	0- 23	76	18	43	83	67	5.4	
	Ofz$_1$	23- 79	67	10	53	106	40	4.1	
	Ofz$_2$	79-140	65	14	57	97	28	4.6	
T15A	Of	0- 35	84	32			6		
T5A	Of	22- 45	92	62	87	95	5	3.9	
T27C	Of	0- 25	88	26	38	99	12	2.6	
	Ofz$_1$	25-119	80	42	68	109	18	2.9	
	Ofz$_2$	119-212	78	20	80	105	20	4.4	
T28A	Of	0- 31	98	58	90	95	7	0.9	
	Ofz$_1$	31- 83	76	22	66	113	25	7.1	
T28B	Of	0- 50	98	70			2		
T36C	Of	0- 56	92	34	90	103	7	1.3	
T36D	Of	0- 60	72	58	64	81	2	1.5	
T40	Of	0- 27	72	32			19		
T35B	Of	0- 18	88	60	45	99	14	2.3	
AJC-72 -92	Of$_1$	0- 41	64	16	69	96	93	4.7	
	Ofz$_1$	41-137	74	6	127	125	23	3.3	
	Ofz$_2$	137-244	70	4	121	148	15	6.8	
	Ofz$_3$	244-320	70	26	55	162	41	12.1	
	RANGE		64-98	4-62	38-127	81-162	5-93	0.9-12.1	
	MEAN		79.16	32.11	72.1	107.3	23.37	4.24	
	S.D.		10.84	20.58			23.33		

Forest peat is usually moderately well to well decomposed (mesic to humic) and has a very dark brown to dark reddish brown matrix. More decomposed materials are black in colour. The peat material commonly has an amorphous to very fine-fibered structure and may have a somewhat layered macro-structure. The material is non-sticky to slightly sticky and contains a random distribution of coarse- to medium-sized woody fragments (roots, stems and needles derived from the forest cover). There are often intrusive layers of larger woody particles of stems, roots and trunks of coniferous tree species deposited as a result of fire history.

The unrubbed fiber content of the matrix material (particles less than 0.15 mm) is about 55 percent but reduces to about 10 percent on rubbing. Forest peats associated with cedar vegetation, or which are influenced by minerotrophic aerated water are usually more decomposed. Forest peat materials are usually base saturated and medium acid to neutral (pH 5.9 to 7.3). The matrix material is fairly dense throughout (bulk density is usually greater than 0.1 gm/cc and becomes greater with increasing depth). Selected analysis of forest peat materials are presented from the Roseau River Watershed (Tables 3 and 4) and from the Mackenzie River Valley (Table 5).

The sub-types of forest peat have been separated based on dominance of the plant material and associated properties of the peat material.

2.21 WOODY-FOREST PEAT

The dominant peat formers are Picea mariana, ericaceous shrubs (Ledum spp., Vaccinium vitis-idae L) and Larix laricina. In northern areas, the present environment occurs on raised perennially frozen peatlands (Tarnocai, 1973). In the south this sub-type occurs as layers in Flat Bogs.

2.22 FEATHERMOSS-FOREST PEAT

The dominant peat formers are the feathermosses (Hypnum spp., Dicranum spp., Pleurozium spp., and Hylocomium spp.) associated with dense black spruce cover. The present peatland environment in northern areas is perennially frozen and raised (Tarnocai, 1973). In southern areas, this peat material occurs in layers, often in association with woody forest peat in Flat Bogs.

2.23 CEDAR-BLACK SPRUCE-FEATHERMOSS-FOREST PEAT

This forest peat sub-type occurs in southeastern Manitoba and is associated with organic landforms which are strongly influenced by slowly moving mineral-rich groundwaters (Mesic Swamp). The vegetation on such sites reflects the minerotrophy of the groundwaters and in addition to many of the bog species contsins various herbaceous species characteristic of upland sites (Alnus spp., Cornus spp., Abies balsamifera, Betula spp., Salix spp.) (Mills et al., 1974).

Table 3. Selected Physical and Chemical Properties of Forest Peat Materials (Black Spruce-Ledum-Feathermoss) from the Roseau River Watershed, Southeastern Manitoba.

Profile No.	Horizon	Sampling Depth (cm)	Fiber Content % Unrubbed	Fiber Content % Rubbed	C/N Ratio	C.E.C. m.e./100 gm	Pyrophos. %	Ash %	Bulk Density g/cc
P21	Of_1	0- 15	84	32	47.5	76.2	11.6	15.5	
	Om_1	15- 22			20.5	163.9			0.16
	Om_2	22- 70	64	4	29.2	224.2	53.9	22.2	0.17
	Om	70-140	50	6	36.8	231.0	35.0	17.6	0.16
P25	Om_1	25-100	58	14	35.2	200.7	57.4	24.0	0.17
	Om_2	100-160	46	2	26.4	173.9	77.2	27.7	0.17
SJ80(b)	Of_2	10- 20	62	14	33.9	132.1	14.1	21.4	
	Om_1	20-140	58	8	32.7	172.6	18.3	13.1	0.08
	Oh_1	140-310	54	2	29.5	209.6	23.2	17.5	0.13
Su40	Of_1	0- 20	58	12	34.9	155.1	24.3	24.3	0.14
	Om_1	20- 67	64	16	49.2	184.6	20.0	15.6	0.13
	Om_2	67-140	66	16	34.2	197.3	36.9	16.1	0.10
S107	Of_2	10- 40	84	44	35.6	151.7	5.8	8.1	
	Om_1	40- 90	64	12	34.5	162.5	9.4	7.0	0.12
P1	Om_1	15- 40	44	0	38.5	255.5	82.4	23.8	0.18
	Om_2	40-67	54	2	34.2	240.8	75.0	23.7	0.17
	Oh_1	67- 98	34	4	23.5	206.5	91.0	31.9	0.52
S24	Of_2	10- 45	58	8	24.4	198.8	49.0	13.4	0.18
	Om_1	45- 60	58	6	27.3	200.2	45.5	10.0	0.17
	Om_2	60-110	42	4	20.4	201.6	46.9	11.7	0.20
M17	Of_2	5- 20	88	22	35.9	143.9	14.4	20.9	0.16
	Om_1	20- 82	56	6	40.4	197.6	38.0	18.1	0.07
	RANGE	Om	42-66	10-16	20.4-49.2	[illegible]-255.5	9.4-82.4	7.0-27.7	0.07-0.20
		Total	34-88	0-44	20.4-49.2	76.2-255.5	5.8-91.0	7.0-31.9	0.07-0.52
	MEAN	Om	55.7	7.54	32.82	200.46	45.8	17.4	.158
		Total	59.33	12.57	34.96	186.50	39.49	18.27	.167
	S.D.		13.55	16.05	11.65	40.70	25.82	6.52	

Table 4. Selected Physical and Chemical Properties of Forest Peat Materials (Cedar-Feathermoss-Black Spruce) from the Roseau River Watershed, Southeastern Manitoba.

Profile No.	Horizon	Sampling Depth (cm)	Fiber Content % Unrubbed	Rubbed	C/N Ratio	C.E.C. m.e./100 gm	Pyrophos. %	Ash %	Bulk Density g/cc
Su79	Oh_1	25- 75	46	8	27.3	255.6	46.2	16.6	0.15
	Oh_2	75-160	58	8	24.0	196.3	20.1	13.3	0.16
SJ77	Oh_1	25- 50	58	6	28.5	234.4	40.6	13.5	
Su44	Om_1	0- 80	24	12	39.1	211.2	25.3	21.1	0.14
	Om_2	80-230	54	6	15.6	209.4	12.5	22.6	0.12
	Oh_1	280-300	38	6	26.6	190.9	33.0	33.1	0.21
P58	Of_1	0- 8	72	32	45.6	146.4	18.6	14.8	
	Om_1	8- 20	78	24	41.6	161.7	42.0	13.1	
	Oh_1	20- 75	62	12	41.1	250.5	33.0	10.8	0.11
	Oh_2	75-120	58	10	49.9	203.2	38.1	10.1	0.15
Su132	Oh_1	3- 20	44	4	27.6	183.3	36.3	20.6	
	Oh_2	20- 40	44	4	28.2	186.7	59.1	18.2	
	RANGE	Oh	24-58	4-12	24.0-49.9	190.9-255.6	20.1-59.1	10.1-33.0	0.11-0.16
		Total	24-78	4-32	15.6-49.9	161.7-255.6	12.5-59.1	10.1-33.0	0.11-0.16
	MEAN	Oh	51.00	7.25	31.65	212.61	38.3	17.03	.156
		Total	53.00	11.00	32.93	202.47	33.73	17.32	.149
	S.D.		14.83	8.55	10.23	32.85	13.07	6.42	

Table 5. Selected Physical and Chemical Analysis of Forest Peat Materials, Mackenzie River Valley, N.W.T.

Profile No.	Horizon	Sampling Depth (cm)	Fiber Content % Unrubbed	Fiber Content % Rubbed	C/N Ratio	C.E.C. m.e./100 gm	Pyrophos. %	Ash %	Bulk Density g/cc
T14	Of	0- 13	64	12			19		
T5	Om	0- 22	56	8	32	106	27	4.6	
T40	Om	27- 84	46	6			68		
T36B	Om	40-220	50	8	25	102	21	7.8	
	RANGE		46-64	6-12	25-32	102-106	19-68	4.6-7.8	
	MEAN		54.00	8.50	28.5	104	33.75	6.2	
	S.D.		7.83	2.52			23.09		

2.24 LICHEN-FOREST PEAT

The dominant peat formers are lichens (Cladonia spp., Cetraria nivalis (L) Ach.), feathermosses and ericaceous shrubs. This peat material occurs in northern areas where the peatland is affected by permafrost. It is commonly deposited on the relatively dry surface of mature peat plateaus and palsas. This peat is more decomposed than the woody and feathermoss sub-types because of its high content of lichens (Tarnocai, 1973; Zoltai et al., 1974).

2.3 FEN PEAT

This type of peat material develops on very wet fens influenced by minerotrophic groundwaters. The peat material is derived primarily from Carex spp. and Drepanocladus spp. Sub-types of this peat contain woody inclusions of partially decayed stems of Betula, Salix and Larix.

Fen peat is usually moderately well to well decomposed (mesic to humic), dark brown to very dark brown material in which the fibers are fine to medium sized with a horizontally matted or layered structure. More highly decomposed fen peat is very dark brown to black, compacted, fine-fibered to amorphous material. In many soils the upper 8 to 12 inches is fibrous and well preserved; decomposition becomes greater at lower depths. Moderately well decomposed fen peat is non-sticky to slightly sticky; well decomposed materials (humic) are slightly sticky to sticky. Unrubbed fiber content is approximately 20 to 80 percent, decreasing to 2 to 25 percent on rubbing. The peat is usually medium acid to neutral (pH 5.6 to 7.3). The moderately well decomposed material is fairly dense (bulk density greater than 0.1 gm/cc) with the more decomposed material becoming more dense and compacted (bulk density approximately 0.2 gm/cc).

Selected physical and chemical properties of fen peat materials are presented in Tables 6 and 8 (Roseau River Watershed) and Tables 7 and 9 (Mackenzie River Valley).

Sub-types of fen peat are separated on the dominance of the plant material making up the peat.

2.31 BROWN MOSS-FEN PEAT

Vegetation grows submerged in peaty ponds of slightly acid to mildly alkaline reaction. Material is composed of dark coloured mosses of the Genera Drepanocladus, Calliergon and Aulacomnium (Tarnocai, 1973). This peat sub-type occurs in the hollows or flarks of Patterned Fen Landforms and in Hydric Fens where former open ponds and pools have recently closed in by floating mats of vegetation.

2.32 SEDGE-FEN PEAT

Vegetation grows in water saturated peat where there is some influx of mineralized water, the pH being neutral. Vegetation consists of Carex and some Eriophorum species (Tarnocai, 1973; Zoltai et al., 1974). This peat sub-type is the major component of peat material underlying Horizontal Fens throughout a wide range of climatic conditions.

Table 6. Selected Physical and Chemical Analysis of Fen Peat Materials (Carex-Drepanocladus) from the Roseau River Watershed, Southeastern Manitoba.

Profile No.	Horizon	Sampling Depth (cm)	Fiber Content %		C/N Ratio	C.E.C. m.e./100 gm	Pyrophos. %	Ash %	Bulk Density g/cc
			Unrubbed	Rubbed					
Su11	Of_1	0- 50	56	14	29.3	147.6	7.8	7.1	0.10
	Om_1	50- 95	48	14	30.6	150.4	7.0	10.9	0.13
	Om_2	95-125	46	10	28.0	126.3	21.3	25.8	0.14
	Om_3	125-185	60	12	25.7	163.2	31.0	39.7	0.12
SJB46	Om_1	0-100	46	18	20.5	97.7	6.0	8.6	0.11
	Om_2	100-175	44	6	21.1	132.2	15.8	9.6	0.11
	Om_3	175-200	44	4	20.1	154.0	40.0	14.3	0.13
S14	Om_1	15- 80	46	16	26.9	99.3	5.2	9.5	0.11
	Om_2	80-144	42	6	26.8	110.1	5.5	6.2	0.09
	Om_3	144-190	44	8	21.5	114.3	11.0	21.9	0.11
Su155	Om_2	45- 95	44	6	22.5	139.7	11.6	7.8	0.09
	Om_3	95-165	48	8	26.2	109.1	14.5	8.2	0.10
	Oh_1	165-260	66	4	23.9	119.8	23.5	15.7	0.11
Su33	Of_1	0- 30	50	14	22.4	86.4	14.1	12.2	0.11
	Om_1	30- 80			25.5	127.3	13.6	8.8	0.11
	Om_2	80-140	46	6	20.6	138.5	55.3	24.1	0.16
Su206	Om_1	0- 30	48	8	22.6	201.0	23.3	14.3	
	Oh_1	30-75	46	2	23.5	200.1	15.2	11.4	
	Oh_2	75- 90	38	2	21.2	191.9	29.8	10.6	
Su195	Om_1	0- 30	58	22	24.0	156.3	20.5	15.0	
	Om_2	30-60	54	6	22.8	172.3	20.6	12.9	0.16
	Oh_1	60- 90	42	2	21.9	186.4	35.0	12.5	
	Oh_2	90-110	38	0	20.2	184.1	28.7	10.9	0.20
S105	Om_2	100-185	84	24	26.3	141.5	14.4	6.0	0.09
S69(a)	Om_4	100-174	50	4	23.3	160.9	17.2	12.1	0.12
Su144	Oh_1	125-160	58	4	34.9	239.4	38.0	8.9	0.19
SJ21	Om_2	195-235	40	2	22.6	151.4	20.4	11.6	0.17
SJ6	Om_2	165-220	66	8	23.5	138.3	9.6	9.2	0.16
S106	Om_2	90-150	48	12	48.8	141.6	8.3	5.5	0.08
	Om_4	190-220	42	4	23.0	142.2	30.6	19.3	

Table 6 (cont'd)

Profile No.	Horizon	Sampling Depth (cm)	Fiber Content % Unrubbed	Rubbed	C/N Ratio	C.E.C. m.e./100 gm	Pyrophos. %	Ash %	Bulk Density g/cc
S107	Om_2	90-140	44	12	30.1	180.0	13.0	10.6	0.13
S24	Om_3	110-133	42	2	18.9	161.8	48.0	12.7	0.19
Su79	Oh_3	160-210	38	4	19.3	150.0	50.2	24.1	0.17
SJ77	Oh_3	90-220	46	2	22.1	176.6	32.6	10.1	0.17
Su44	Om_3	230-280	24	4	18.7	175.1	60.4	32.7	0.13
	Oh_2	300-370	40	10	39.6	141.1	10.2	34.4	
	RANGE	Om	24-84	2-24	18.7-48.8	86.4-239.4	5.2-60.4	5.5-39.7	0.08-0.20
	MEAN	Om	48.67	9.25	24.82	143.38	20.96	14.29	.125
		Total	47.89	8.00	26.39	150.87	22.72	14.47	.131
	S.D.	Total	10.36	5.92	10.62	32.94	14.84	8.35	

Table 7. Selected Physical and Chemical Analysis of Fen Peat Materials, Mackenzie River Valley, N.W.T.

Profile No.	Horizon	Sampling Depth (cm)	Fiber Content % Unrubbed	Fiber Content % Rubbed	C/N Ratio	C.E.C. m.e./100 gm	Pyrophos. %	Ash %	Bulk Density g/cc
T35A	Ofz_3	140-200	68	6	47	111	32	7.2	
T14	Om	13- 47	60	6			32		
	Omz	47-170	60	24			5		
T15A	Omz_1	35- 79	54	8			24		
	Omz_2	79-115	52	8			15		
T15B	Om	0-130	60	12	26	109	68	14.1	
T5A	Omz_1	45-256	56	8	43	106	12	6.3	
	Omz_2	256-320	54	2	30	97	35	17.4	
T27C	Ofz_3	212-260	72	6	53	131	64	12.3	
T28A	Ofz_2	83-112	64	16	39	128	100	14.8	
T44	Om	0- 22	34	8	16	125	57	9.2	
	Oh	22- 42	28	4	18	125	72	20.0	
T36C	Omz	56-225	34	10	23	115	50	8.0	
T35B	Omz	18- 57	48	16	51	92	24	3.5	
T36A	Of	0- 65	92	60			8		
	Of	65-235	70	26			43		
T36B	Of	0- 40	92	56	27	85	14	5.1	
	RANGE Om		34-60	2-26	16-51	92-125	5-57	3.5-17.4	
	Total		28-92	2-60	16-51	85-131	5-100	3.5-20.0	
	MEAN Om		51.8	10.4	29.8	107.3	32.2	9.75	
	Total		59.06	16.24	33.9	111.3	33.23	10.7	
	S.D.		17.79	17.04			22.22		

Table 8. Selected Physical and Chemical Properties of Woody Sedge-Brown Moss-Fen Peat Materials (Forest-Fen Transition) in the Roseau River Watershed, Southeastern Manitoba.

Profile No.	Horizon	Sampling Depth (cm)	Fiber Content % Unrubbed	Fiber Content % Rubbed	C/N Ratio	C.E.C. m.e./100 gm	Pyrophos. %	Ash %	Bulk Density g/cc
S105	Om$_1$	30-100	62	10	33.1	107.9	5.4	4.9	0.09
S69(a)	Om$_1$	30- 50	78	20	34.2	122.5	10.6	22.7	0.11
	Om$_2$	50- 70	72	10	31.3	135.2	9.0	8.5	0.11
	Om$_3$	70-100	42	4	23.8	145.7	9.1	8.3	0.12
Su144	Om$_2$	25- 90	54	10	34.9	189.7	13.9	59.9	0.15
	Om$_3$	90-125	50	8	24.9	217.5	22.2	9.4	
S55	Om$_1$	160-240	50	10	30.0	132.8	6.7	6.2	0.12
S106	Om$_3$	150-190	30	6	32.8	140.2	7.1	5.0	0.12
SJ80(b)	Oh$_1$	140-310	54	2	29.5	209.6	23.2	17.5	0.13
SJ77	Oh$_2$	50- 90	54	4	27.2	151.8	11.8	8.2	0.12
	RANGE Om (8)		30-78	4-20	23.8-34.9	107.9-217.5	5.4-22.2	4.9-59.9	0.09-0.15
	Total (10)			2-20			5.4-23.2		
	MEAN Om (8)		54.75	9.75	30.63	148.94	10.5	15.62	.117
	Total (10)		54.60	8.40	30.17	155.29	11.90	15.06	.119
	S.D.		13.79	5.06	3.84	37.37	6.23	16.75	

Table 9. Selected Physical and Chemical Analysis of Woody Sedge-Brown Moss Fen Peat Materials (Forest-Fen Transition), Mackenzie River Valley, N.W.T.

T28B	Om	50-110	60	18			40		
T36D	Om	60-185	48	4	27	131	80	9.4	
	MEAN		54.00	11.00	27	131	60.00	9.4	
	S.D.		8.49	9.90			28.28		

2.33 SEDGE-BROWN MOSS-FEN PEAT

Vegetation grows in water saturated peat and in shallow ponds of slightly acid to mildly alkaline reaction under the influence of some mineralized water. Vegetation is composed of Carex sp. in association with the brown mosses described in sub-type 2.31 (Zoltai et al., 1974).

2.34 WOODY SEDGE-BROWN MOSS-FEN PEAT (FOREST-FEN TRANSITION)

Vegetation grows in water saturated peat which is slightly acid. Vegetation consists of brown mosses (sub-type 2.31), Carex spp., ericaceous shrubs (Andromeda polifolia L., Chamaedaphne calycaluta (L.) Moench, Kalmia polifolia Wang., Betula glandulosa, B. pumila, Salix spp., Larix laricina (Du Roi, K. Koch) and some Picea mariana (Mill.) B.S.P.).

The matrix of this material is usually moderately well decomposed and exhibits a fine-fibered felt-like appearance. Wood content is usually intermediate between that of forest peat and fen peat. Analysis of this sub-type are presented in Table 8 (Roseau River Watershed) and Table 9 (Mackenzie River Valley). The Woody Fen sub-type of peat occurs under Horizontal Fen landforms supporting tamarack forest cover in the Mackenzie River area (Tarnocai, 1973; Zoltai et al., 1974) and throughout large areas of the Boreal Forest Region. In southeastern Manitoba (the northern limit of swamp landforms), this peat material occurs under Hydric Lowland Swamps (Mills et al., 1974).

2.4 AQUATIC PEAT

Aquatic peat materials occur as basal layers of any organic soils which have developed through processes of pond filling. This type of peat material usually forms in shallow lakes and ponds and includes all of the aquatic oozes and peats such as gyttja, sedimentary peat, sapropel copropel and marl. Various aquatic mosses and algae and plants such as pond weed, water plantain and water lily make up a major part of these materials. The material is well decomposed, amorphous, black in colour and fairly dense and compacted (Davis, 1959). In the organic soils examined to date in Manitoba and in the Mackenzie River Valley, aquatic peats, when found, usually occur as the basal peat deposit.

2.5 DISCUSSION

Selected physical and chemical data characteristic of organic peat materials from the Roseau River Watershed, Southeastern Manitoba and from the Mackenzie River Valley, N.W.T., are summarized in Tables 10 and 11. A comparison of unrubbed and rubbed fiber contents and the distribution of these values among the samples analyzed for each peat material is shown in Figures 22 to 25.

Table 10. Range and Means for Selected Physical and Chemical Analysis of Peat Materials from the Roseau River Watershed, Southeastern Manitoba

Peat Material	No. of Samples		Fiber Content, % Unrubbed	Fiber Content, % Rubbed	C/N Ratio	C.E.C. m.e./100 gm	Pyrophos. %	Ash %	Bulk Density g/cc
Sphagnum Peat	15	Range	58-100	18-92	50.3-99.9	91.9-157.9	3.2-13.4	3.0-20.0	0.05-0.10
		Mean	84.27	51.33	68.12	119.06	7.23	7.29	0.074
		S.D.	16.12	24.05	18.35	18.09	3.13	5.31	
Forest Peat (bS-feathermoss-Ledum)	22	Range	34-88	0-44	20.4-49.2	76.2-255.5	5.9-91.0	7.0-31.9	0.07-0.52
		Mean	59.33	12.57	34.96	186.50	39.49	18.27	.167
		S.D.	13.55	16.05	11.65	40.70	25.82	6.52	
Forest Peat (eC-feathermoss-bS)	12	Range	24-78	4-32	15.6-49.9	161.7-255.6	12.5-59.1	10.1-33.0	0.11-0.16
		Mean	53.00	11.00	32.93	202.47	33.73	17.32	0.149
		S.D.	14.83	8.55	10.23	32.85	13.07	6.42	
Fen Peat (Brown moss-Carex)	36	Range	24-84	2-24	18.7-48.8	86.4-239.4	5.2-60.4	5.5-39.7	0.08-0.20
		Mean	47.89	8.00	26.39	150.87	22.72	14.47	.131
		S.D.	10.36	5.92	10.62	32.94	14.84	8.35	
Woody-Fen Peat (Forest-Fen Transition)	10	Range	30-78	2-20	23.8-34.9	107.9-217.5	5.4-23.2	4.9-59.9	0.09-0.15
		Mean	54.60	8.40	30.17	155.29	11.90	15.06	0.119
		S.D.	13.79	5.06	3.84	37.37	6.22	16.75	

Table 11. Ranges and Mean for Selected Physical and Chemical Analysis of Peat Materials from the Mackenzie River Valley, N.W.T.

Peat Material	No of Samples		Fiber Content, %		C/N Ratio	C.E.C. m.e./100 gm	Pyrophos. %	Ash %
			Unrubbed	Rubbed				
Sphagnum Peat	19	Range	64-98	4-62	38-127	81-162	5-93	0.9-12.1
		Mean	79.16	32.11	72.1	107.3	23.37	4.24
		S.D.	10.84	20.58			23.33	
Forest Peat	4	Range	46-64	6-12	25-32	102-106	19-68	4.6-7.8
		Mean	54.00	8.50	28.5	104	33.75	6.2
		S.D.	7.83	2.52			23.09	
Fen Peat (Brown moss-Sedge)	17	Range	28-92	2-60	16-51	85-131	5-100	3.5-20.0
		Mean	59.06	16.24	33.9	111.3	33.23	10.7
		S.D.	17.79	17.04			22.22	
Woody Fen Peat (Forest-Fen Transition)	2	Range	48-60	4-18			40-80	
		Mean	54.00	11.00	27	131	60.00	9.4
		S.D.	8.49	9.90			28.28	

The data show a wide range in physical and chemical properties between different peat materials as well as considerable variation in these properties within peat materials. However, a comparison of the average data for individual peat materials from the Roseau River Watershed (Table 10) with those from the Mackenzie River Valley (Table 11) indicate reasonably similar values of ranges and means for similar materials between the two areas.

The classification of organic soils as carried out in the field is partly dependent on an assessment of the fiber content of the peat materials. Problems have been encountered in the assignment of a range of unrubbed and/or rubbed fiber content to the three broad classes of fiber: Fibric, Mesic and Humic. It has been difficult to tie fiber limits into field concepts of the peat materials. The assignment of a range of fiber content to peat materials will hopefully encompass the range of properties that occur in these materials in nature. One approach is to establish the range in fiber content encountered in the commonly occurring peat materials over a range of climatic and environmental conditions and use these as a guide in dividing up the continuum of fiber content.

The fiber content of the peat materials is shown in graphs in Figures 1 to 4. Mean fiber contents for similar peat material, when grouped together from both the Roseau River and the Mackenzie River area, are given in Table 12. Several observations can be made by examination of these data.

1. The graphs indicate in all cases that there is greater variability in rubbed fiber content than what occur in the unrubbed analysis. It would seem from this that the definition of the fiber content classes should be based on both the rubbed and unrubbed data.

2. Sphagnum peat, usually considered to be a fibric peat, appears to be defined best by unrubbed fiber content limits set at >60 percent and rubbed fiber >40 percent (Figure 1 and Table 12).

3. Forest peats which were classified Mesic in the field have mean unrubbed and rubbed fiber contents which fit this concept (Figure 23 and Table 12). However, the range of fiber content in this peat material is such that, for the rubbed values the majority of samples analyzed as being humic. The fiber content of humic forest peats (materials from the Mesic Swamp Landforms under the Cedar-Feathermoss-black spruce vegetation) do not appear to significantly differ from the mesic forest peat found in the Flat Bogs under black spruce-feathermoss-Ledum vegetation.

4. The fen peat materials (Figure 24) are characterized by a fairly narrow range in unrubbed fiber content. The rubbed values are much more variable with approximately two-thirds analyzing as humic. These peat materials are quite similar in fiber content to the forest peats and are differentiated at present mainly on wood content and various chemical and physical properties.

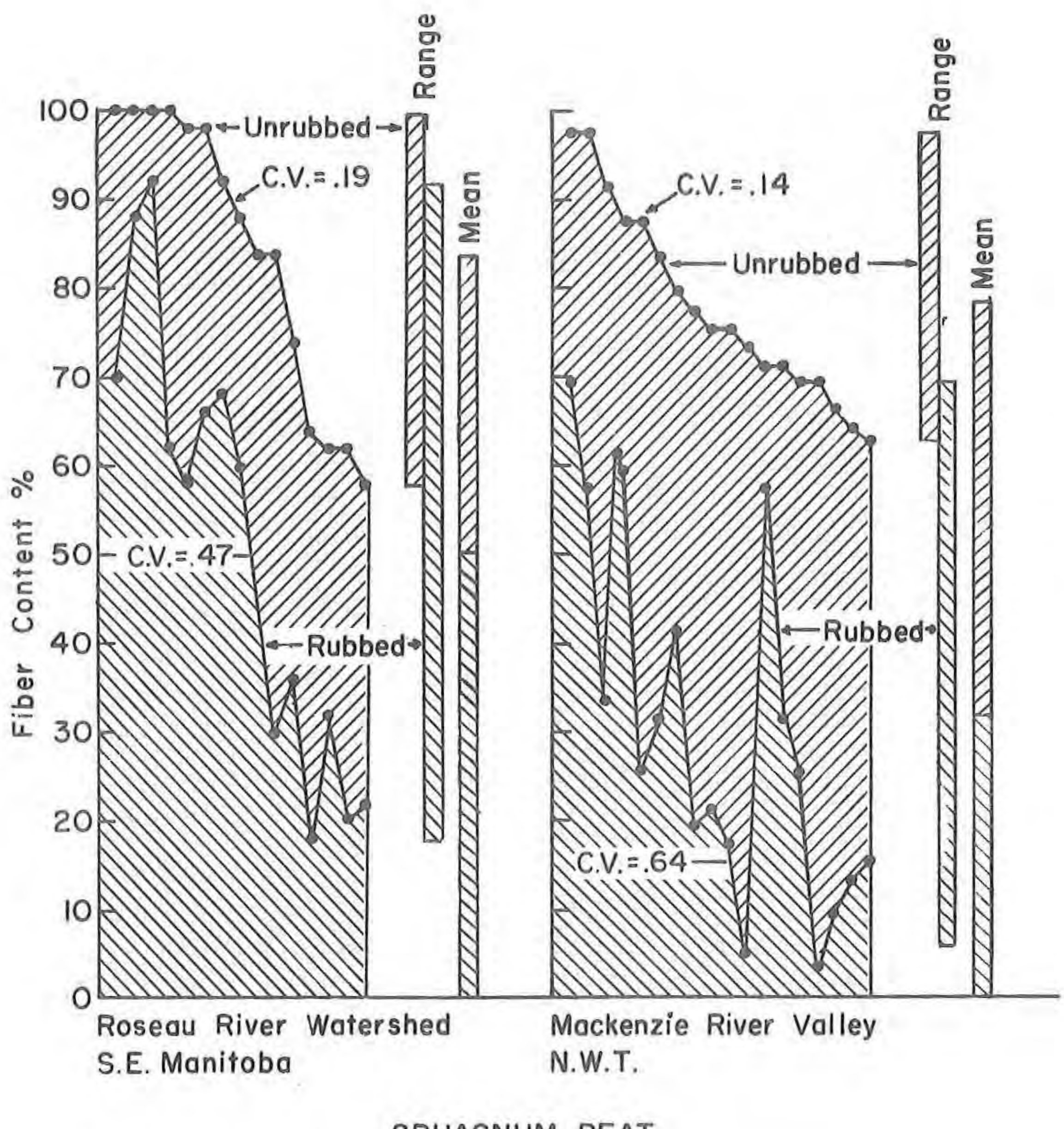

Figure 22. Distribution of Unrubbed and Rubbed Fiber Content of Sphagnum Peat Materials from the Roseau River Watershed and the Mackenzie River Valley.

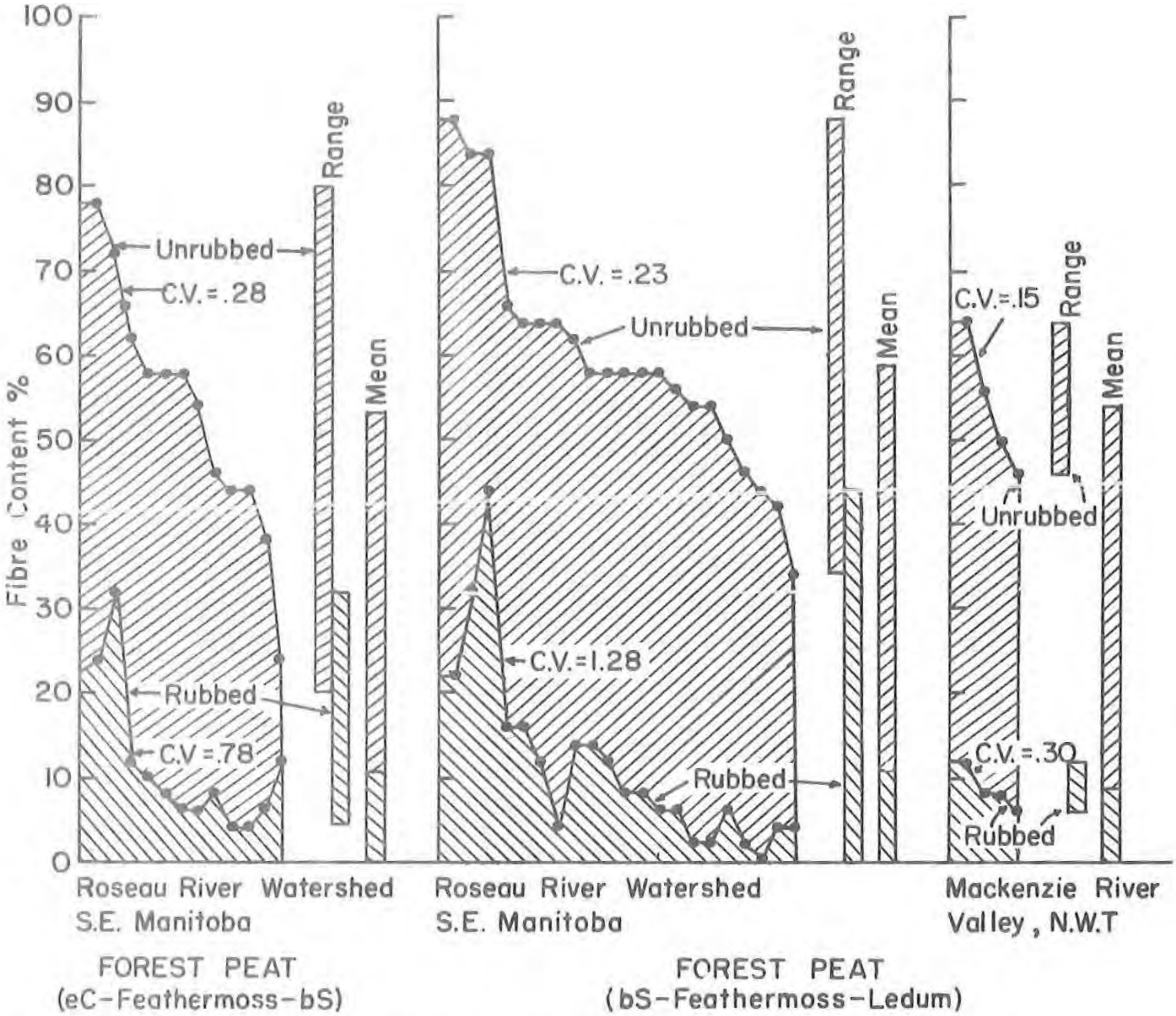

Figure 23. Distribution of Unrubbed and Rubbed Fiber Content of Forest Peat Materials from the Roseau River Watershed and the Mackenzie River Valley.

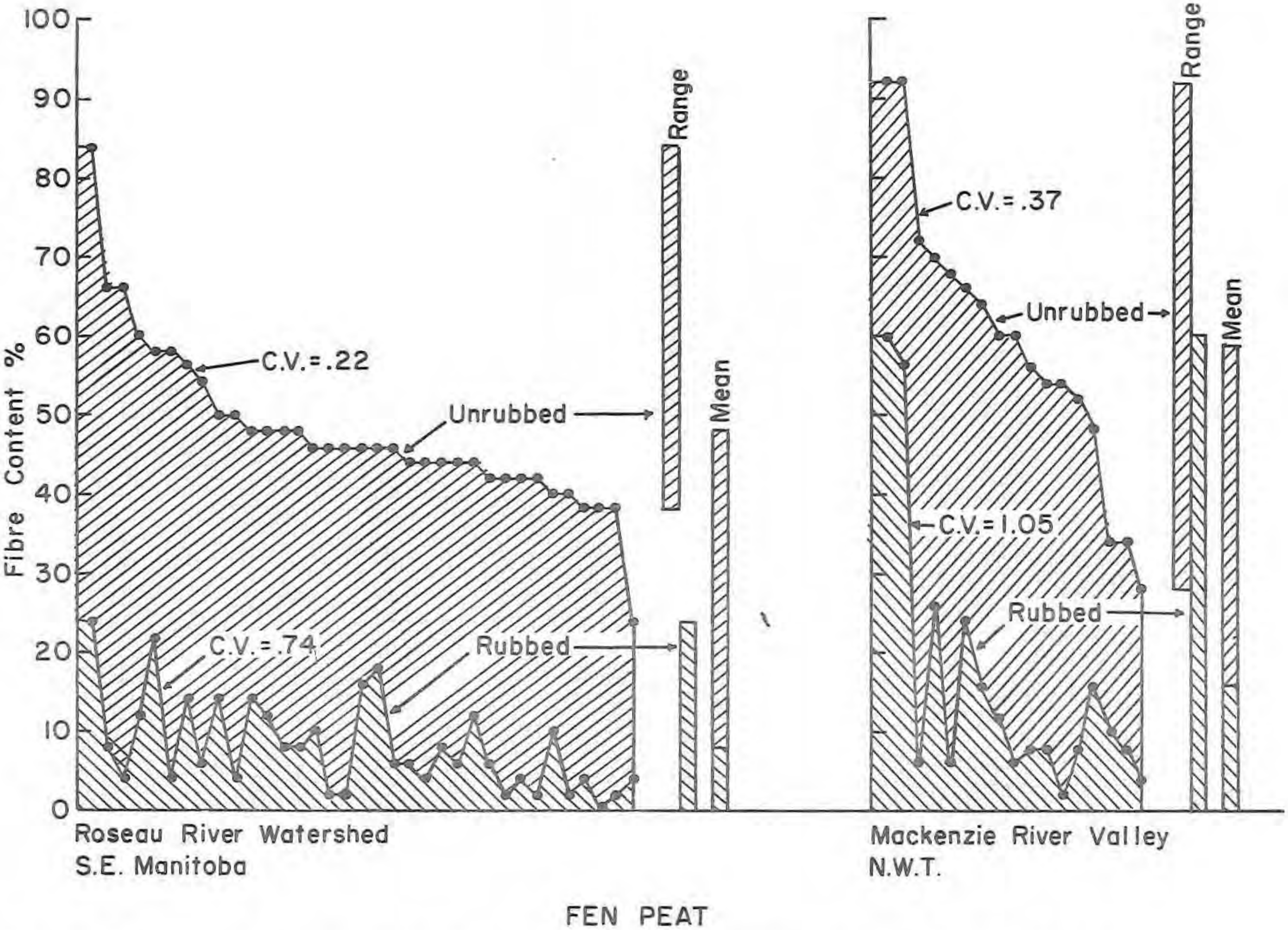

Figure 24. Distribution of Unrubbed and Rubbed Fiber Content of Fen Peat Materials from the Roseau River Watershed and the Mackenzie River Valley.

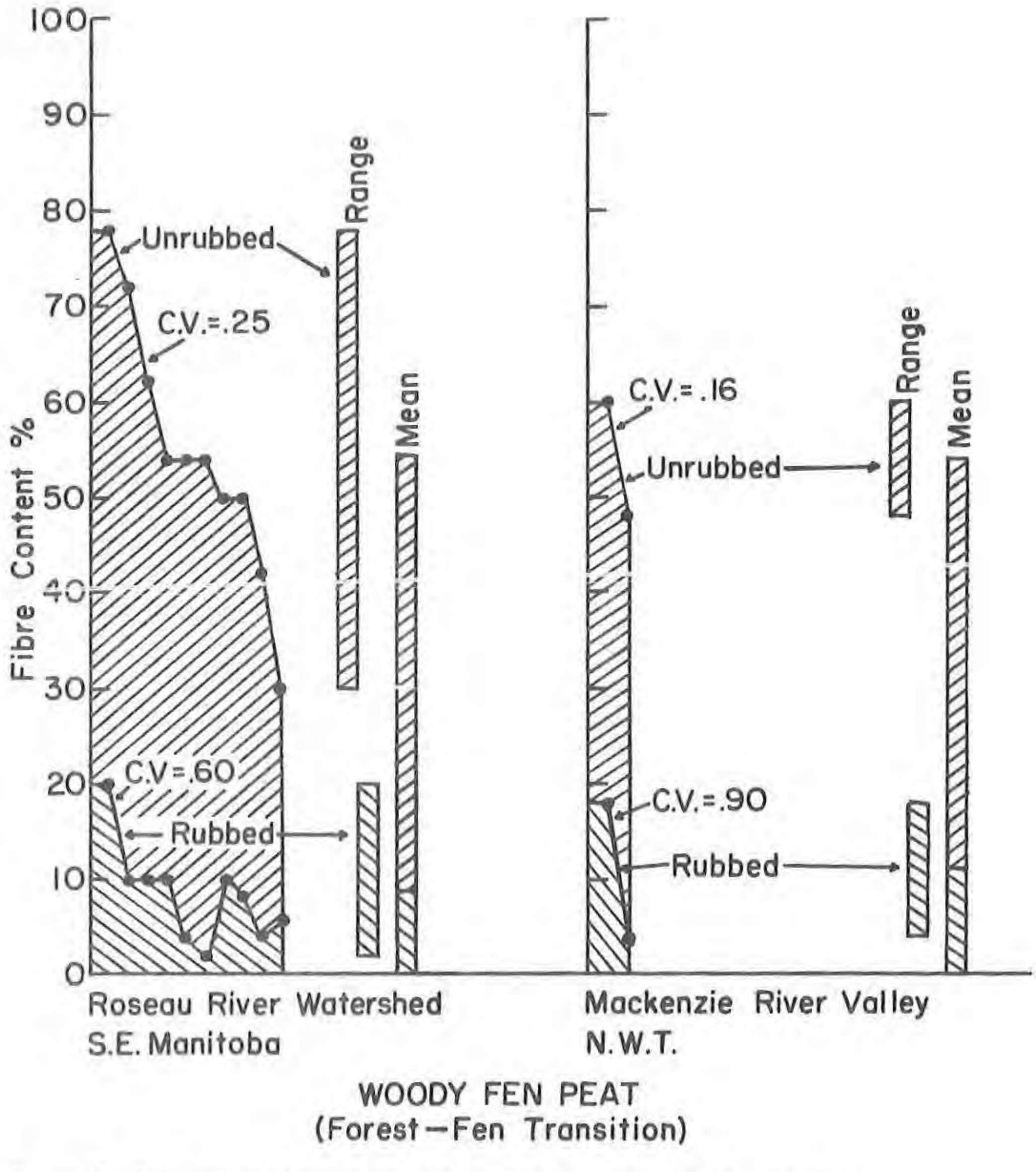

Figure 25. Distribution of Unrubbed and Rubbed Fiber Content of Woody Fen Peat Materials (Forest-Fen Transition) from the Roseau River Watershed and the Mackenzie River Valley.

Table 12. Mean Unrubbed and Rubbed Fiber Content: All Types and Sub-types of Peat Materials, Roseau River Watershed and Mackenzie River Valley.

Peat Material	No. of Samples	Fiber Content, %	
		Unrubbed	Rubbed
Sphagnum	34		
Mean		81.41	40.59
S.D.		13.46	23.88
Forest (total)	38		
Mean		56.70	11.62
S.D.		13.56	12.95
Fen (total)	65		
Mean		52.09	10.34
S.D.		13.81	10.53
Moss and Sedge Fen	53		
Mean		51.53	10.69
S.D.		14.10	11.39
Woody Fen	12		
Mean		54.50	8.83
S.D.		12.74	5.55
Forest (eC-Feathermoss-bS)	12		
Mean		53.00	11.00
S.D.		14.83	8.55

5. The woody fen peat materials (Forest-Fen Transition) are most similar in unrubbed and rubbed fiber contents (Figure 25 and Table 12) to the fen peats. Separation of the two materials is based mainly on assessment of wood contents intermediate between that of the forest peats and the fen peats.

6. The differentiation of mesic from humic materials (both forest and fen) according to present fiber limits and methods of analysis is perhaps the most difficult part of organic soil classification.

This problem should be considered from the point of view of the following alternatives:

a) adjustment in concept;

b) adjustment in limits, or

c) alternate methods of fiber analysis to achieve consistent values which fall closer to our concepts of the peat materials.

3. Summary and Conclusions

The definition of peat materials as the parent material of organic soils involves a morphological description as well as the characterization of their physical and chemical properties. This morphological description is given in general terms of colour, fibrosity, structure, consistence, wood content, etc.

The classification of peat materials relies heavily on the botanic origin of the material as inferred from the present day environment. To date, four main types of peat materials are recognized. Several sub-types, based on differences in botanic origin are described, but more work is needed to define these materials in terms of meaningful differences in physical and chemical properties. The definition of peat materials according to their botanic composition is evolving and should become more specific as work progresses.

A major difficulty in organic soil classification is with respect to setting fiber content limits which define concepts of mesic and humic peat. The trend with respect to rubbed fiber content as determined by present techniques is to a very narrow range to define humic materials. Such a narrow range on the low end of the fiber scale seems necessary to avoid a split down the middle of otherwise uniform concepts of mesic peat.

In conclusion, organic peat materials are useful for establishing organic soil series. In general, the peat material types and sub-types reflect differences in physical and chemical properties as well as differences in ecology. Peat materials, if considered as the parent material of organic soils, are also of value in soil mapping. As described under the Landform and Vegetation Section, most mapping of organic terrain relies on air photo interpretation and the recognition of organic landforms and vegetation type. The correlation of these two components of the peatland environment with underlying peat materials enables us to better relate the peat landform and its characteristic vegetation to particular organic soils.

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The Techniques of Mapping Organic Soils in Manitoba

G.F. Mills and C. Tarnocai

The techniques of mapping organic soils in Manitoba reflect the concern of pedologists for potential users of general or pedological surveys. These concerns basically, are no different for organic soils than they are for mineral soils. That is, the techniques employed convey, as fully as scale of mapping will permit, the maximum amount of information respecting the morphological, chemical and physical properties, and the ecological relationships that exist among these soils. This comprehensive approach, dependent upon the three elements of landform, vegetation and soils (in the pedological sense) derived from recent attempts at developing biophysical land surveys. It is not very different from the approach taken in standard surveys of mineral soils in many provinces today where, for example, soils and landform are recognized in the mapping process. Some standard surveys provide landform and vegetation information in map legends.

What is unique about the mapping of organic soils in Manitoba is the recognition of organic landforms as described by Tarnocai (see handout). Because this system of organic landform classification is hierarchical in its structure, it permits the recognition of local landform units for most scales of mapping in use at the present time. Local organic landforms at the class level (bogs, fens, swamps) provide a useful basis for mapping at small scales usually less than 1:250,000, while subclasses (domed bogs) are most useful for medium scale mapping, i.e., between 1:250,000 and 1:50,000, and organic landform types (palsa) at scales greater than 1:50,000.

Local landforms provide a natural basis for establishing mapping units. They reflect uniform ecological conditions in peatlands, particularly at the subclass and type level. This uniformity in ecologic condition is reflected in the vegetative community it supports and the compositional nature of the peat deposit itself. This uniformity permits a much higher degree of confidence in the mapping of relatively inaccessible peatlands; requires less dependence upon ground truthing; lends itself to air photo and other remotely sensed imagery interpretation and finally, reduces the cost and time required to conduct such surveys.

The incorporation of vegetation and landform, in addition to soils data in mapping unit descriptions, enhances greatly the possibilities and usefulness for interpretations for biologically orientated uses as forestry and wildlife habitat characterization. Landforms themselves are very useful for engineering interpretations. Trafficability and building site evaluations are dependent on the confident prediction of uniform physical condition to considerable depth. The close association of landform and peat material enhances such interpretation.

Examples of the Manitoba approach is best exemplified in the Roseau River Basin study, where all three elements of landform, vegetation and soils are shown in the map symbols. The text accompanying the map integrates and explains the ecological relationships that exists between the three elements. Examples of how organic landform classes, subclasses and types can be used at different scales of mapping is shown in the handout material on the Cranberry Peatland by Tarnocai.

The recently published Soil Survey Report No. 16 of the Grahamdale Map Area by G.F. Mills provides an example of the partial application of this approach. In this example, only soil data appears on the map. Some information related to peat material composition and associated vegetation appears in the legend. This partial approach is, however, consistent with the approach employed for mapping mineral soils in this study.

An additional feature of the mapping technique in Manitoba is the criteria employed in the differentiation of soil series on the basis of significant compositional differences in peat materials (see section on peat materials by G.F. Mills). Major kinds of peat materials of significance in Manitoba are Sphagnum moss peat, fen peat, forest peat, forest-fen peat and limnic sediments (coprogenous earth and marl).

Differentiation of soil series in forested peatlands where Sphagnum moss is actively growing is especially important. Vast areas of peatlands in the southern and central section of the Boreal Forest Region are being paludified with rapidly growing Sphagnum moss. In many instances, it exceeds the growth rate of the forest cover. The ecological significance of this in terms of soil series differentiation is recognized in Manitoba. Organic soils having little or no Sphagnum moss peat (usually less than 6 inches and discontinuous) are differentiated from those having a 6 to 24 inch continuous surface layer of Sphagnum and are in turn differentiated from those having continuous surface layers more than 24 inches in thickness. Forest site quality in the Boreal Forest Region peatlands is very significantly reduced where Sphagnum moss development exceeds several feet in thickness.

Differentiation of series having a combination of peat materials, apart from surface growth of Sphagnum, depends on the degree of contrast in the criteria universally established for soil series differentiation. That is, soil series are differentiated if woody content, pH, bulk density, inorganic fraction of peat layers, depth and texture of cumulo layers are significantly different and are related to recognized contrasting peat materials in the organic section.

Associated features of organic soils such as the compositional nature and form of underlying mineral deposits are also used to differentiate soil series, regardless of the thickness of the organic section. Soil series having thick or thin organic sections are differentiated if they are underlain by (a) smooth, medium to fine lacustrine sediments, (b) smooth, coarse to moderately coarse lacustrine sediments, (c) very stony, extremely calcareous glacial till, (d) stone-free to moderately stony, moderately to strongly calcareous glacial till, (e) very stony, acidic, coarse textured glacial till, (f) limestone or dolostone bedrock, or (g) granitoid bedrock.

Last but not least, in terms of criteria important to establishment of, or differentiation of soil series are climatic parameters. Climatic classes established by the Canadian Soil Climatic Classification System, with some modifications reflecting floristic and soil response to sub-region or local climate have been used for this purpose.

The proposed introduction of the Cryosolic Order into C.S.S.C. will necessitate the establishment of additional soil series in the Cryoboreal Climate. Depth to permafrost in the organic section will dictate the recognition of some organic soils as Cryosols if permafrost occurs at less than one meter from the surface after August 21 and others as Cryic Organics if it is found at greater depths.

Soil Capability Classification

R.E. Smith

It appears that the time has come to begin some dialogue on the suitability of soils for various uses. The approach being used in Manitoba draws very heavily on the system developed in Ontario by Leeson and Hoffman. We think that the capability of organic soils has to be related to the capability of associated mineral soils because it is assumed that the best organic soils are no better than poorly drained Gleysolic soils in the Red River Valley. We are concerned with the problems of development of these soils; in their native state they have little value for agriculture but are becoming important for the potential production of forage crops and grazing. We are not too concerned to use them for vegetable production.

Dr. D.W. Hoffman discussed the major provisions of the capability classification system by pointing out that it is not related to the CLI system for mineral soils which are rated for common field crops. The "Ontario" system was constructed for rating soils for production of vegetables (onions and carrots) on Ontario organics. There also are systems developed for rating tree crops and tobacco.

A Guide for Capability Classification of Organic Soils

Physical Features used to Determine Organic Soil Capability Class

DECOMPOSITION	WOOD CONTENT*
	0 None
35 Fibric	5 1-25%
0 Mesic	10 26-50%
20 Humic	20 >-50%
REACTION	**DEPTH**
	0 Deep (>72")
20 pH under 5.0	20 Mod deep (52"-72")
0 pH 5.0 to 7.0	35 Shallow (36"-52")
20 pH over 7.0	50 Very Shallow (<36")
SUBTRATUM TEXTURE	**CLIMATE**
0 Fine	0 Climatic category i
20 Medium or Coarse	20 Climatic category ii
	35 Climatic category iii

* Wood Content - expressed as percentage of total material present within the control section (volume)

B. Organic Soil Classes

The six characteristics under A above have numbers to the left of each description. As a guide to the proper land class, add up the numbers which are opposite the descriptions you selected and subtract this figure from 100 (circle the land class below that approximates the value which you have now obtained).

1	2	3	4	5	6	7
100 - 85	80 - 70	65 - 55	50 - 40	35 - 25	20 - 10	less than 10

ORGANIC SOIL CLASSES

Class 1 (100-85) - Organic soils of this class have no water, topographical of pH limitations and are deep and level. They are located in climate category 1 and are at an intermediate stage of decomposition.

CLASS 2 (80-70) - Organic soils in class 2 have one limitation which restricts their use in a minor way. The limitation may be woodyness, reaction, flooding, topography, depth or climate.

CLASS 3 (65-55) - Organic soils in this class have moderately severe limitations that restrict the range of crops or that require special management practices.

CLASS 4 (50-40) - Soils in this class have limitations which severely restrict the range of crops or which require special development and management practices. Reclamation and management costs will be high.

CLASS 5 (30-20) - Soils of this class have such severe limitations that they are restricted to the production of perennial forage or other specially adapted crops. Large scale reclamation is not feasible.

CLASS 6 (20-10) - Class 6 organic soils are capable of producing only indigenous crops and improvement practices are not feasible.

CLASS 7 (less than 10) - Organic soils of this class have no capability for agriculture.

C. How to Rate Organic Soils

The rating of organic soils is a relatively simple procedure when the guide is closely followed. First, identify the stage of decomposition, reaction, climate, substratum texture, wood content and depth in the appropriate classes as defined. Next classify the capability as outlined previously. Brief definitions of the soil characteristics follow.

DECOMPOSITION - refers to the stage of decomposition of the organic materials.

Fibric - the least decomposed of all organic soil materials. There are large amounts of well-preserved fiber that are readily identifiable as to botanical origin. A rubbed fiber content of more than 40% of the organic volume.

Mesic - the intermediate stage of decomposition. Has a rubbed fiber content between 10% and 40% of the organic volume.

Humic - the most highly decomposed. Has a rubbed fiber content less than 10% of the organic volume.

CLIMATE - refers to climatic zones defined in

Climatic category i - includes the following climatic types 1G, 2G, 2H, 2F, 3F, 3G, 3H, 3K

Climatic category ii - includes the following climatic types 2F, 3F, 4G, 4H, 4K

Climatic category iii - includes the following climatic types 5G, 5H, 5K, 5L, 1C, 2C, 3L, 3M, 4F, 6G, 6H

WOODY CONTENT - wood located within 20 inches of the surface will probably interfere with cultivation practices and wood in the profile affects the moisture regime.

DEPTH - refers to the depth of organic material over sand, silt, loam, clay, marl or bedrock. Limitations occur when any of these materials occur within 6 feet of the surface.

REACTION - refers to the acidity or alkalinity of the soil.

C. Development Difficulty Classification

It is possible that two separate soils may have similar capability for agriculture but one may be more difficult to reclaim than the other A development difficulty rating from 1 to 7 is proposed for all organic soils in an unreclaimed state. Brief definitions of the development difficulty classes follow.

Classes 1, 2 and 3 - only minor reclamation is required. Minor reclamation is considered to be those operations which can be carried out by a single operator.

Class 4 - major reclamation is required but is warranted when soil capability is high. Major reclamation is that requiring cooperation between adjoining operators and/or outside financial asistance.

Classes 5 and 6 - major reclamation is required and seldom warranted.

Class 7 - hazards to development are so serious that they can be overcome only by major scale projects. Such development is unwarranted.

Hazards which are considered in arriving at the degree of development difficulty are those shown on page 1 and vegetative cover, excess water and flooding, and surface roughness.

To determine development difficulty class follow the features on page one as for capability class and add the appropriate amounts of following.

	Vegetative Cover	Excess Water and Flooding	Surface Roughness
0	Light (grasses, reeds, etc.)	0 None	0 None
20	Moderate (brush, small trees)	35 Frequent	35 Holes & Mounds 1 - 2 ft.
35	Heavy (numerous large trees)	65 Extreme	50 Holes & Mounds 2 ft.

Subtract total from 100 as before (p.2).

The guide for classifying the capability of organic soils for agriculture was prepared for Ontario conditions and was not developed for application to larger more diversified regions. The technique, however, can be used on a continental basis by increasing or otherwise changing the number of physical features and their penalty points. For example, penalty points could be added for salinity, and type of underlying material. Modifications will be made to the guide as it is field tested and more information becomes available.

Mr. Smith indicated that the procedure of interpreting organic soils differed from the Ontario method in a number of respects.

1. In Manitoba an attempt was made to integrate the evaluation of organic soils with the associated mineral soils.

2. The basis for evaluating organic soils was that these soils would be used for regionally adopted crops such as forage and cereal grains rather than for vegetable crops.

3. The definitions of depth of organic section, climatic classes, peat types, vegetative cover, and excess water are different than those used in Ontario. Shallow organic soils smooth lacustrine sediments are not discounted so severely in Manitoba.

The following pages taken from the manuscript of the "Soils of the Roseau River" project are included to supply the reader with additional information regarding the current status of organic soil evaluation for agriculture in Manitoba.

Table 13

Soil Properties Utilized to Determine the Capability Classification of Organic Soils

Symbol	Soil Property and Guidelines to Use	Penalty Value
C	THERMAL REGIME - soil temperature classes as defined in the Revised System of Soil Classification for Canada (1973)	
	Mild — MAST 8-15^{o}C, MSST 15-22^{o}C	0
	Cool — " 5-8^{o}C , " 15-18^{o}C	0
	Cold — " 2-8^{o}C , " 8-15^{o}C	35
	Very Cold — " -7-2^{o}C , " 5-8^{o}C	60
	Extremely Cold — " $<$-7^{o}C , " $<$ 5^{o}C	90
W	EXCESS WATER - refers to groundwater level and flooding	
	Adequate: drainage provided for optimum crop yields and a water table sufficiently high to prolong the life of the soil (18 to 36 inches).	0
	Marginal: less than adequate; yields reduced and choice of crops reduced (water table 12 to 18 inches or 36 to 48 inches).	35
	None: no control measures (water table $<$12 inches or $>$48 inches)	55
L	COARSE WOOD FRAGMENTS (Wood $>$ 4" dia., volume % within depths of 51").	
	None — Fen peat, $<$1%	0
	Moderate — Forest-Fen and Sphagnum peats, 1-5%	10
	High — Forest peat, $>$5%	25
H	DEGREE OF DECOMPOSITION - as related to permeability	
	Mesic forest-fen and forest peat	0
	Mesic to humic forest peat	10
	Fibric sphagnum peat and humic aquatic peat	20
F	NATURE OF SURFACE MATERIALS - fertility as related to soil reaction	
	Forest, forest-fen and fen peats, pH 4.5 to 7.5	0
	Sphagnum peats, pH $<$4.5	20
	Fen peats with pH $>$7.5	10

Table 13 (cont'd)

Symbol	Soil Property and Guidelines to Use	Penalty Value
N	SALINITY	
	None - conductivity 0-4 mmhos/cm	0
	Slight - conductivity 4-8 mmhos/cm	20
	Moderate - conductivity 8-12 mmhos/cm	50
	High - conductivity 12-16 mmhos/cm	75
	Excessive - conductivity 16 mmhos/cm	80
D	DEPTH OF ORGANIC MATERIALS AND NATURE OF UNDERLYING SUBSTRATE*	
	Deep to very deep deposits underlain by sandy, loamy or clayey stone-free lacustrine sediments	0
	Shallow deposits underlain by loamy lacustrine sediments	0
	Shallow deposits underlain by clayey lacustrine sediments	10
	Shallow deposits underlain by sandy lacustrine sediments	20
	Shallow to very deep deposits underlain by skeletal loamy till, marl or diatomaceous earth	30
	Shallow to very deep deposits underlain by bedrock	50

* Penalty values for shallow depth of organic materials relates to the eventual loss of the land resource through subsidence. Shallow organic soils underlain by clays, sands, stony till, marl or bedrock have limited capability for agriculture when the organic layer has disappeared. These soils are therefore downgraded for shallow depth as well as for the underlying materials.

1. Minor Development Difficulty

Only minor reclamation is required to overcome limitations to use. Minor reclamation is considered to be those operations which can be carried out by a single operator and which do not require cooperation between adjoining operators. Such operations would include leveling rough surfaces, removal of surface woody layers and land clearing.

2. Major Development Difficulty - Reclamation Warranted

Major reclamation is required but is warranted when soil potential is high. Major reclamation is that requiring cooperation between adjoining operators or outside financial assistance or both. Major reclamation operations include drainage, construction of water control works or correction of very low pH or very high pH.

3. Major Development Difficulty - Reclamation Seldom Warranted

These organic soils can be developed only by very large reclamation projects. Major reclamation is seldom warranted here because the hazards are so serious that they constitute some continuing limitation which reduces the agricultural capability.

Many features of organic soils which affect their agricultural capability also affect the degree of development difficulty experienced in reclaiming organic soils and the relative costs associated with maintaining their productive capacity. The relative importance of these soil properties may be adjusted when considering development difficulty. In addition, factors such as vegetative cover, inundation and surface roughness must be evaluated. The features of organic soils important to the evaluation of degree of development difficulty ratings are listed in Table 14. The relative limitation of each feature to reclamation is often related to organic materials and soil types; in other cases, the relationship is with the physiographic position of the soil area relative to other organic and mineral soils. In all cases, the applicable feature is ranked by means of penalty values as to its relative effects on development difficulty.

To determine the relative degree of development difficulty the penalty values for the features applicable to each soil are added together and subtracted from 100. This figure is used as a guide by comparing with the following ranges for each degree of development difficulty group. The following ranges for each group were used in the Roseau River Basin:

1. >70

2. 25 - 69

3. 0 - 24

2.4 Subclass Limitations

The intrinsic physical and chemical properties of organic soils which are important for evaluation of agricultural capability and for estimating the degree of difficulty for development have been described

Table 14

Physical Features Utilized to Determine Development Difficulty Rating of Organic Soils

Symbol	Physical Features and Guidelines to Use		Penalty Value
V	Vegetative Cover - Light, grasses, reeds	- Fens	0
	Moderate, brush, small trees	- Hydric Swamps	10
		- Raised Bogs	10
	Heavy, numerous large trees	- Transitional Bogs	20
		- Mesic Swamps	20
W	Excess water - Underground seepage and surface runoff from surrounding highlands into undrained depressional organic soil areas	- Raised Bogs	10
		- Transitional Bogs	10
		- Mesic Swamps	10
		- Hydric swamps	15
		- Mesic Fens	20
		- Hydric Fens	40
I	Inundation - Overflow from nearby large bodies of water or poorly defined rivers		
	None		0
	Slight		10
	Severe		20
T	Surface Roughness - Mounds, hummocks, ridges and holes		
	None		0
	Holes & mounds 1-2 feet microrelief		10
	Holes and mounts > 2 feet microrelief		20
L	Coarse Wood Fragments: Wood >10 cm diameter, percent by volume within depths of 130 cm		
	<1% Fen peat		0
	1-5% Forest-Fen peat, Sphagnum peat		10
	>5% Forest peat		20
H	Degree of Decomposition - permeability and hydraulic conductivity		
	Mesic Fen peat, Forest-Fen Peat		0
	Mesic to Humic Forest peat		10
	Fibric Sphagnum Peat		20
	Humic Aquatic Peat		20
D	Depth of Organic Materials - Shallow to deep 30 to 130 cm		0
	- Very deep >130 cm		20

by Leeson (1969). A discussion of these factors as they apply to the organic soils of the Roseau River watershed is presented in the following sections. The effects of each factor on agricultural capability have been weighted by means of relative penalty values in Table 13. Similarly, the effects of the various soil features on the degree of difficulty in reclaiming organic soils are ranked by means of penalty values in Table 14.

2.41 Thermal Regime. Organic soils are generally cooler than adjacent mineral soils. This limitation to agricultural use is expressed in varying degrees, depending on regional climate, moisture regime of the organic soils, and their physiographic position in the landscape. Although there is daily and seasonal temperature variation in the surface layers of organic soils, the mean annual soil temperature (M.A.S.T.) is lower and the amplitude of temperature fluctuation is less than in adjacent mineral soils. The result of these differences in thermal regime is that crops on organic soils are damaged by cold more often than are similar crops grown on nearby mineral soils. Organic soils have a shorter season than adjacent mineral soils, during which active growth may take place. Drainage of cool air into the depressional areas where organic soils occur, in combination with the insulating effects of the organic materials contribute to this shortened forstfree period.

The thermal regime of non-frozen organic soils does not cause problems in their development for agriculture, but will result in varying degrees of hazard to crop production. Organic soils with mild thermal regimes present no limitation to agricultural use. Cool thermal regimes may cause a slight hazard to crop production on organic soils through lower crop yields but do not pose a threat of crop loss. Organic soils with cold thermal regimes are so adversely affected that the best possible organic soil of the area will have a continuing moderately severe to severe climatic limitation restricting the range of crops. Increasing probability of crop loss may be expected as the climate becomes colder.

2.42 Excess Water. Reclamation and management of organic soils for agricultural use always involves varying degrees of water table control. The moisture regime of organic soils in their unreclaimed state usually restricts plant growth to indigenous species. Most organic soil areas, because they are low lying relative to surrounding areas, are characterized by excess water for at least part of the year. Improper manipulation of the water regime of an organic soil could result in increased subsidence, potential, irreversible physical damage to the soil and increased hazards of wind erosion and fire damage. Excess water levels associated with organic soils affect both the degree of difficulty for development as well as posing a continuing limitation to agricultural use after reclamation.

The relative degree of difficulty with which effective drainage can be implemented in organic soil areas depends on the following:

1. The source of excess water and location of the organic soil area with respect to surrounding physiographic features.

2. The degree of water control necessary for the crops to be grown.

3. The kind of organic soil

4. Nature of the underlying substrates

Organic soil areas adjacent to mineral soil margins usually do not have the serious limitation of excess water that is found in the central portions of a peatland. Organic soils near the peatland margin often have very gently sloping topography away from the mineral soil areas. Runoff waters, therefore, pass through or over such areas to collect in the more depressional parts of the peatland. In addition, the organic soils on the edge of the peatland are usually shallower than the organic soils found in the central portions of a peatland. For any drainage scheme, the volume of water to be removed will be less from the shallow soils than is the case for the deeper organic deposits.

The water table levels and related conditions of aeration necessary for plant growth vary with the kind of vegetation or crop to be grown. For example, most pasture, forage and grassland crops can withstand a higher water table than can vegetable crops. Various studies have shown that a water table of 24 to 36 inches is desirable for many field and vegetable crops although common grain crops require water levels deeper than 36 inches (Stephens, 1955).

The kind of organic materials affects the permeability of the soil and, therefore, the success of any drainage scheme. In general, the moderately well decomposed peats have the most ideal transmission rates for water. The more decomposed peats have lower permeabilities restricting water movement so that response to drainage control is slow. Fibric, undecomposed organic materials have rapid permeabilities which can lead to overdraining and possible conditions of droughtiness.

The nature of the underlying substrates, especially where they occur close to the soil surface, influences the drainability of organic soils. If the underlying materials are permeable, difficulties can arise through uncontrolled inflow of artesian water into the area to be developed. Under these conditions, it is difficult to apply different levels of water control to individual adjoining fields in the same peatland. If permeable substrates are close to the surface, drains are very effective and drainage spacing may be increased. Organic soils underlain by impermeable subsoils permit relatively little seepage into or out of the peatland, but closer spacing of field drains will be necessary.

For purposes of evaluating the effects of excess water on agricultural capability, three levels of water control are proposed (Table 13). Adequate water control is defined as a water table maintained between 18 to 36 inches. This level of water control imposes little or no limitation to agricultural production. Marginal water control, either through a continuing limitation of excess wetness (water table maintained at

12 to 18 inches) or excess droughtiness (water table always between 36 to 48 inches) may cause minor crop losses which become more serious with increasing frequency of occurrence. No water control from the natural conditions (water table less than 12 inches) or excessive water control involving overdrainage are downgraded more severely in their effect on agricultural potential.

The degree of difficulty of providing adequate water control is related to particular organic landforms with characteristic water regimes attributed to their position in the peatland or to proximity to adjacent mineral soil areas (Table 14). Raised Bogs, because the surface organic layers are above the groundwater table, usually present only minor problems of water table control. Transitional Bogs and Mesic Swamps may have a very gently sloping surface allowing for good runoff conditions, but they are often in the position of receiving additional runoff from adjoining areas. Hydric Swamps have high average water table levels for longer time periods because of their position near the central depressed portions of a peatland. The water table conditions associated with Mesic and Hydric Fens usually present the most severe limitation to attempts to control excess water.

2.43 Coarse Wood Fragments. Woody inclusions in the form of trunks, stumps and branches occur in varying quantities in most forested organic soils. Such coarse wood fragments can interfere with ditching or tile drain installation and cultivation practices. The difficulty experienced in the reclamation of organic soils is related to the amount and size of woody inclusions. The degree of limitation to the agricultural use of organic soils is related as well to the hardness and resistence to decomposition of the wood. The wood inclusions in organic soils formed under hard wood forest have a more serious limitation than do soils containing wood mainly from softwood species.

The degree of limitation imposed by wood content on agricultural capability is best evaluated in terms of peat materials as they relate to broad ranges of wood content. The wood content of fen peats is commonly very low or absent, so presents no problems for development and no limitations for agricultural use. Forest-fen peat and sphagnum peats have increasing amounts of woody inclusions and so are downgraded in terms of ease of development relative to the fen peats. The intermediate wood contents of these peats presents a moderate limitation to agricultural use. Organic soils developed on forest peats may have very high concentrations of wood in the profile. The wood content of these soils is a serious problem to be overcome in their development and also presents a continuing limitation to agricultural use.

2.44 Degree of Decomposition. The degree of decomposition of organic materials in the soil profile affects permeability, capillary rise of water and rate of subsidence. Undecomposed (fibric) materials have greater permeability than do moderately well decomposed (mesic) and well decomposed (humic) peat materials. Similarly, the height of capillary rise of water in the soil profile increases with the degree of decomposition. The degree of decomposition of organic materials is of greater importance in lower portions of the profile as the properties of the surface layers (upper 12 inches) will alter very rapidly after initial drainage improvement takes place (Leeson, 1969).

The degree of decomposition and the associated permeability of organic soils is related to the dominant kinds of organic materials forming that soil. Soils developed from fibric sphagnum peat may be so permeable that overdraining may result. This in turn can cause excessive rates of subsidence and droughty conditions for crop growth. Well decomposed (humic) forest peats or aquatic peats are much less permeable and more difficult to drain. The permeability of humic organic materials is similar to that of fine-textured mineral soils with the result that they are slow to respond to water control. Although humic peats are characterized by a high capillary rise, crops growing on them may suffer from physiological drought as they retain their water so tightly. Moderately well decomposed (mesic) fen, forest-fen and some forest peats are most desirable for agricultural development as they do not have the extremes of permeability which cause water control problems in fibric and humic peat materials.

Because the rate of decomposition of undecomposed peat materials proceeds faster than for humic peats, the amount of subsidence and shrinkage will be more pronounced on fibric organic soils. For this reason, adequate water level control becomes more important on the fibric soils to minimize subsidence loss.

The effect of degree of decomposition of organic soils on their agricultural capability is evaluated in relation to the major kinds of organic materials. Moderately well decomposed fen and forest-fen peats have least limitations to use with respect to this feature. The low hydraulic conductivity of moderately well to well decomposed (mesic grading into humic) forest peats imposes a moderate limitation to drainability. However, these limitations are not so severe as the rapid permeability and excessive subsidence potential of fibric sphagnum peat. A severe limitation to use for agriculture is also imposed by very well decomposed aquatic peat materials which are virtually impermeable and very difficult to drain. Fibric sphagnum peats and humic aquatic peats present the two extremes in permeability and drainability and the greatest problems to reclamation for agriculture.

2.45 Nature of Surface Materials. Organic soils are generally infertile with respect to phosphorus and potassium and some minor elements such as boron and copper. As most organic soils will require fertilization for the successful production of agricultural crops, any differences in level of plant nutrients between organic soil types is probably not significant. However, organic soils, through differences in soil reaction, cause relative differences in availability of plant nutrients. Organic soils with reaction of the surface materials ranging from pH 4.5 to 7.5 are most desirable for crop production. Such soils include most of the forest and forest-fen peats and many of the fen peats. Any tendency to acidic soil reaction can be corrected with minimal amounts of lime. Most of the plant nutrients required for crop production are available in this pH range.

The conditions of low pH commonly found on organic soils developed from deep sphagnum peats may lead to toxic levels of some trace elements and deficiencies of others. Soil reaction values of pH less than 4.5 severely restrict the range of crops capable of being produced and high inputs of lime are needed to correct the condition. These soils are downgraded in capability because of the difficulties in overcoming nutrient limitations imposed by the low pH.

Some organic soils developed from fen peats in a strongly calcareous environment have a high soil reaction (pH greater than 7.5). Such alkaline soil conditions may occur where marl is present in the soil profile and there is Ca or Mg saturated groundwater flowing from areas of limestone bedrock or high lime till. Nutrient deficiencies of phosphorus, manganese and boron may be accentuated on this kind of organic soil.

2.46 Salinity. Certain areas of organic soils, because of their physiographic position, may possess, or are likely to develop salt concentrations of sufficient magnitude to affect crop growth or limit the range of crops which might be grown. Organic soils with none or only slight accumulations of soluble salts which are not restrictive to plant growth have no limitation due to salinity. These soils may have conductivities ranging from 0 to 4 mmhos/cm. Slight accumulations of salts (4 to 8 mmhos/cm) and moderate accumulations (8 to 12 mmhos/cm) present an increasingly severe limitation to plant growth and are downgraded accordingly. Lower capability classes are applied to soils with high concentrations of soluble salts (12 to 16 mmhos/cm) and excessive amounts of salts (16 mmhos/cm) as the growth of introduced species becomes impossible and the native vegetation is not useful.

2.47 Depth of Organic Materials and Nature of Underlying Substrates. An evaluation of the agricultural potential of organic soils after reclamation must take into account that such soils are subject to subsidence. As mentioned previously, decreases in elevation of the organic soil surface through subsidence are caused by shrinkage due to drying, compaction, oxidation, erosion and burning. The effects of each of these factors on the rate of subsidence is accentuated after drainage takes place. After the initial rapid subsidence occurs, studies have indicated that organic soils continue to subside at rates of three-quarters to two inches annually. Minimal subsidence rates are achieved by controlled drainage. The degree of difficulty experienced in maintaining the water table at optimum levels for both crop production and for minimizing subsidence varies with the factors described in the section on "Excess Water".

The importance of the depth of organic materials to their agricultural potential is related to the continuous use of such land areas for agricultural production. Organic soils underlain by bedrock or extremely stony till materials unsuitable for sustaining arable culture should not be reclaimed for agricultural use. These soils are downgraded as the depth of organic materials decreases as well as because of the untillable nature of the underlying substrates. Because such organic soils, even with optimum water control, will ultimately disappear, the land base is eventually lost from production.

The situation is quite different for organic soils underlain by stone-free mineral materials. In evaluating such soils, the limitation imposed by the shallow depth of organic material is not so important. As the shallow organic materials disappear, the underlying substrates are still capable of sustaining arable culture. In many instances, these more shallow organic soils are the most desirable on which to initiate agricultural production because the surface organic layers disappear relatively quickly, exposing the more fertile mineral substrates.

2.48 Inundation. Some of the limitations to the agricultural use of organic soils attributable to excess water may in fact, arise from inundation or overflow from nearby large bodies of water or poorly defined rivers. The degree of difficulty experienced in reclamation and the expense of maintenance imposed by this factor are usually related to the proximity which an organic soil area is to a lake or river and to the hydrologic characteristics of these water bodies.

2.49 Surface Roughness. Increasing development difficulty is imposed by increasing amounts of surface roughness and greater amounts of microtopographic change over short distances. Surface roughness in organic soils may be caused by fire, water, wind, erosion and frost action. Fen peats in their natural state usually have no problems associated with microtopography. Partially drained fen areas which have been subject to fires causing burnouts are more difficult to develop. The surface roughness of most soils associated with forested organic landforms is severe enough to retard the movement of land clearing machines.

2.50 Vegetative Cover. The light vegetative cover associated with treeless fens imposes no difficulty for development of the underlying organic soil. A forest cover consisting of open stands of large trees or relatively dense stands of stunted tamarack or spruce associated with Hydric Swamps and Raised Bogs presents a moderate degree of development difficulty. A much more serious degree of development difficulty is encountered by the closed stands of heavy black spruce forest associated with Mesic Swamps and Transitional Bogs.

3.0 The Agricultural Capability of the Organic Soils of the Roseau River Watershed

The organic soils in the Roseau River Watershed have been rated for both potential agricultural capability and the degree of development difficulty involved in achieving this potential. Both evaluations have been made according to the system and criteria outlined in the previous section.

The development difficulty rating for each organic soil in the watershed is presented in Table 15. Minor development difficulty is expected for soils developed from shallow fen peat. All other organic soils in the watershed are affected by varying degrees of major development difficulty. Organic soils formed on shallow forest peat, shallow to very deep forest-fen peat and very deep fen peat have a major degree of development difficulty, but reclamation is warranted. Organic soils with a major degree of development difficulty, such that reclamation is seldom warranted, have formed on deep forest peat, deep sphagnum peat and deep hydric fen peats.

The features of each organic soil affecting agricultural capability are evaluated in Table 16. Ratings are given for each soil reflecting an unreclaimed capability as well as the potential capability after reclamation. All of the organic soils in the watershed have a climatic limitation for agricultural use imposed by coolness, length of frost-free period and growing season. Each soil is downgraded for this factor so that the best organic soil of the area after reclamation is rated in Capability Class 03. The single most limiting factor to the agricultural use of most organic soils is excess water. The rating for potential capability is arrived at after the limitations caused by excess water have been overcome or removed. These ratings, therefore, reflect the severity of the remaining limitations after reclamation.

Most development of organic soils for agriculture will involve large scale drainage control projects. The peatland is the unit which must be considered in the evaluation of drainage projects of this size. Following is a general description of the degree of development difficulty associated with the reclamation of the various organic soils in each peatland and a summary of the potential capability for agriculture after reclamation. Detailed assessments of the potential capability for agriculture can be made by utilizing the ratings in Tables 15 and 16 in conjunction with the soil maps (not here included).

3.1 Moodie Peatland

Although drainage throughout much of the Moodie Peatland is moderately good, major difficulty in development for agriculture would be encountered. Because the soils consist of shallow forest peat overlying extremely stony water-worked till, reclamation for the major portion of the peatland is not recommended. The soils of this peatland are rated in Capability Class 07 after reclamation.

3.2 South Junction Peatland

Large areas of this peatland are characterized by very deep organic deposits overlying sandy to clayey textured sediments; loamy and clayey textured materials are dominant. Although the Sprague River and its tributaries contribute to drainage of the western half of the peatland, large areas to the east and north of this river are very poorly drained.

Large-scale water control systems are required in order to reclaim this peatland. The degree of difficulty encountered in achieving this water control is warranted on the organic soils developed on the deep forest and forest-fen peats (potential agricultural capability Class 05); it would be seldom warranted on the deep sphagnum organic soils as continuing problems of fertility and water control are severe (Capability Class 06).

Table 15. Development Difficulty Ratings for the Organic Soils of the Roseau River Watershed, Manitoba.

Soil		Soil Properties			Physical Features Used to Determine Development Difficulty Rating									
Symbol	Name	Depth (cm)	Organic Parent Material	Underlying Substrate	V Vegetative Cover	T Surface Roughness	W Excess Water	I Inundation	L Coarse Wood Fragments	H Permeability	D Depth of Organic Materials	GUIDE NUMBER (100-Factor Total)	Development Difficulty Rating	Major Subclass Limitations
Bb	Buffalo Bay	>130	Humic Forest	Clayey	20	10	10	0	20	10	20	10	3	LW
Bb*		>130	Humic Forest	loamy	20	10	10	0	20	10	20	10	3	LW
Bm	Baynham	>130	Mesic Forest	clayey	20	10	10	0	20	10	20	10	3	LW
Bm*		>130	Mesic Forest	loamy	20	10	10	0	20	10	20	10	3	LW
Ca	Cayer	40-130	Mesic Fen	clayey	0	0	20	0	0	0	0	80	1	W
Ca*		40-130	Mesic Fen	loamy	0	0	20	0	0	0	0	80	1	W
Ca*(b)	Cayer, burnt-out				0	20	20	0	0	0	0	60	2	TW
Cr	Crane	40-130	Mesic Fen	till (loamy)	0	0	20	0	0	0	0	80	1	WD
Er	Erskine	>160	Sphag/For-Fen & Fen	sandy	10	10	10	0	10	20	20	20	3	WF
Gd	Grindstone	40-130	Mesic Forest	till(loamy)	20	10	10	0	20	10	0	30	2	LD
Gd sp		40-90	Mesic Forest	till(loamy)	20	10	10	0	20	10	0	30	2	LD
Ha	Haute	>130	Humic Forest	sandy	20	10	10	0	20	10	20	10	3	LW
Hc	Halcrow	40-130	Sphag/For-Fen & Fen	till(loamy)	10	10	15	0	10	0	0	55	2	WD
Hw	Howell	40-130	Sphag/For-Fen & Fen	clayey	10	10	15	0	10	0	0	55	2	W
Hw*		40-130	Sphag/For-Fen & Fen	loamy	10	10	15	0	10	0	0	55	2	W
J	Julius	>160	Fibric Sphagnum	clayey	10	10	10	0	10	20	20	20	3	WF
Kc	Kircro	40-130	Mesic Fen	Sandy	0	0	20	0	0	0	0	80	1	W
Kt	Katimik	>130	Sphag/For-Fen & Fen	clayey	10	10	15	0	10	0	20	35	2	W
Kt*		>130	Sphag/For-Fen & Fen	loamy	10	10	15	0	10	0	20	35	2	W
Kt(d)	Katimik, drained	>130	Sphag/For-Fen & Fen		10	10	0	0	10	0	20	50	2	W
Lb	Lamb Lake	40-130	Mesic Forest	till(loamy)	20	10	10	0	20	10	0	30	2	WD
Mc	Macawber	>130	Mesic Fen	till(loamy)	0	0	20	0	0	0	20	60	2	WD
Mh	Murray Hill	>130	Mesic Fen	Sandy	0	0	20	0	0	0	20	60	2	W
Mu	Mud Lake	40-130	Humic Forest	till(loamy)	20	10	10	0	20	10	0	30	2	LD
Ok	Okno	40-130	Mesic Forest	clayey	20	10	10	0	20	10	0	30	2	L
Ok*		40-130	Mesic Forest	loamy	20	10	10	0	20	10	0	30	2	L
Or	Orok	40-130	Mesic Forest	clayey	20	10	10	0	20	10	0	30	2	LW
Ov	Overflowing	>130	Mesic Fen	clayey	0	0	40	20	0	0	20	20	3	W
Ov*		>130	Mesic Fen	loamy	0	0	40	20	0	0	20	20	3	W

Table 15 (cont'd)

Soil		Soil Properties			Physical Features Used to Determine Development Difficulty Rating									
					V	T	W	I	L	H	D			
Symbol	Name	Depth (cm)	Organic Parent Material	Underlying Substrate	Vegetative Cover	Surface Roughness	Excess Water	Inundation	Coarse Wood Fragments	Permeability	Depth of Organic Materials	GUIDE NUMBER (100-Factor Total)	Development Difficulty Rating	Major Subclass Limitations
Re	Reed River	40-130	Humic Forest	Sandy	20	10	10	20	20	10	0	10	3	LW
Rr	Rat River	40-130	Mesic Forest	sandy	20	10	10	0	20	10	0	30	2	L
Sd	Stead	>130	Mesic Fen	clayey	0	0	20	0	0	0	20	60	2	W
Sd*		>130	Mesic Fen	loamy	0	0	20	0	0	0	20	60	2	W
Sh	Shelley	>130	Mesic Forest	sandy	20	10	10	0	20	10	20	10	3	L
Sj	South Junction	40-130	Humic Forest	clayey	20	10	10	0	20	10	0	30	2	L
Sj*		40-130	Humic Forest	loamy	20	10	10	0	20	10	0	30	2	L
Sm	Summerberry	40-130	Mesic Fen	loamy	10	20	10	10	0	10	0	40	2	W
Sn	Santon	>160	Sphag/For-Fen & Fen	clayey	10	10	10	0	10	20	20	20	3	WF
Sn*	Santon	>160	Sphag/For-Fen & Fen	loamy	10	10	10	0	10	20	20	20	3	WF
St	Sturgeon Gill	40-130	Sphag/For-Fen & Fen	sandy	10	10	15	0	10	0	0	55	2	W
Wh	Whithorn	>160	Sphag/For-Fen & Fen	clayey	10	10	10	0	10	20	20	20	3	WF
Wh*		>160	Sphag/For-Fen & Fen	loamy	10	10	10	0	10	20	20	20	3	WF
Wk	Waskwei	>130	Sphagnum/Forest	clayey	20	10	10	0	20	10	20	10	3	LW
Wk*		>130	Sphagnum/Forest	loamy	20	10	10	0	20	10	20	10	3	LW

Table 16. Agriculture Capability Classification and Development Difficulty Ratings for the Organic Soils of the Roseau River Watershed, Manitoba.

Soil		Soil Properties			Factors Affecting Use (Penalty Points)							Suitability Class			
					C	W	L	H	F S	D					
Symbol	Name	Depth (cm)	Organic Parent Material	Underlying Substrate	Thermal Regime	Water Table	Coarse Wood Fragments	Degree of Decomp. - Permeability	Nature of Surface Materials - Reaction Subsidence	Thickness of Org. Materials and Nature of Underlying Substrate	GUIDE NUMBER (100-Factor Total)	Natural	Reclaimed	Development Difficulty Rating	Major Subclass Limitations
Bb	Buffalo Bay	>130	Humic Forest	clayey	35	55	25	10	0	0	-25	7	5	3	LW
Bb*		>130	Humic Forest	loamy	35	55	25	10	0	0	-25	7	5	3	LW
Bm	Baynham	>130	Mesic Forest	clayey	35	55	25	10	0	0	-25	7	5	3	LW
Bm*		>130	Mesic Forest	loamy	35	55	25	10	0	0	-25	7	5	3	LW
Ca	Cayer	40-130	Mesic Fen	clayey	35	35	0	0	0	0	30	5	3	1	W
Ca*		40-130	Mesic Fen	loamy	35	35	0	0	0	0	30	5	3	1	W
Ca*(b)	Cayer, burnt-out				35	35	0	0	0	0	30	5	3	2	TW
Cr	Crane	40-130	Mesic Fen	till (loamy)	35	35	0	0	0	30	0	7	5	1	WD
Er	Erskine	>160	Sphag/For-Fen & Fen	sandy	35	55	10	20	20	0	-40	7	6	3	WF
Gd	Grindstone	40-130	Mesic Forest	till (loamy)	35	35	25	10	0	30	-35	7	7	2	LD
Gd sp		40- 90	Mesic Forest	till (loamy)	35	35	25	10	0	30	35	7	7	2	LD
Ha	Haute	>130	Humic Forest	sandy	35	55	25	10	0	0	-25	7	5	3	LW
Hc	Halcrow	40-130	Sphag/For-Fen & Fen	till (loamy)	35	35	10	0	0	30	-10	7	5	2	WD
Hw	Howell	40-130	Sphag/For Fen & Fen	clayey	35	35	10	0	0	0	20	7	3	2	W
Hw*		40-130	Sphag/For-Fen & Fen	loamy	35	35	10	0	0	0	20	6	3	2	W
J	Julius	>160	Fibric Sphagnum	clayey	35	55	10	20	20	0	-40	7	6	3	WF
Kc	Kircro	40-130	Mesic Fen	sandy	35	35	0	0	0	0	30	5	3	1	W
Kt	Katimik	>130	Sphag/For-Fen & Fen	clayey	35	55	10	0	0	0	0	7	5	2	W
Kt*		>130	Sphag/Form-Fen & Fen	loamy	35	55	10	0	0	0	0	7	5	2	W
Kt(d)	Katimik, drained	>130	Sphag/For-Fen & Fen		35	35	10	0	0	0	20	6	3	2	W
Lb	Lamb Lake	40-130	Mesic Forest	till (loamy)	35	35	25	10	20	30	-55	7	7	2	WD

Table 16. (Cont'd)

Soil		Soil Properties			Factors Affecting Use (Penalty Points)										
					C	W	L	H	F S	D		Suitability Class			
Symbol	Name	Depth (cm)	Organic Parent Material	Underlying Substrate	Thermal Regime	Water Table	Coarse Wood Fragments	Degree of Decomp. - Permeability	Nature of Surface Materials - Reaction Subsidence	Thickness of Org. Materials and Nature of Underlying Substrate	GUIDE NUMBER (100-Factor Total)	Natural	Reclaimed	Development Difficulty Rating	Major Subclass Limitations
Mc	Macawber	>130	Mesic Fen	till (loamy)	35	55	0	0	0	30	-20	7	5	2	WD
Mh	Murray Hill	>130	Mesic Fen	sandy	35	55	0	0	0	0	10	6	4	2	W
Mu	Mud Lake	40-130	Humic Forest	till (loamy)	35	35	25	10	0	30	-35	7	7	2	LD
Ok	Okno	40-130	Mesic Forest	clayey	35	35	25	10	0	0	- 5	7	5	2	L
Ok*		40-130	Mesic Forest	loamy	35	35	25	10	0	0	- 5	7	5	2	L
Or	Orok	40-130	Mesic Forest	clayey	35	35	25	10	20	0	-25	7	6	2	LW
Ov	Overflowing	>130	Mesic Fen	clayey	35	55	0	0	20	0	-10	7	5	3	W
Ov*		>130	Mesic Fen	loamy	35	55	0	0	20	0	-10	7	5	3	W
Re	Reed River	40-130	Humic Forest	sandy	35	35	25	10	0	0	- 5	7	5	2	LW
Rr	Rat River	40-130	Mesic Forest	sandy	35	35	25	10	0	0	- 5	7	5	2	L
Sd	Stead	>130	Mesic Fen	clayey	35	55	0	0	0	0	10	6	4	2	W
Sd*		>130	Mesic Fen	loamy	35	55	0	0	0	0	10	6	4	2	W
Sh	Shelley	>130	Mesic Forest	sandy	35	55	25	10	0	0	-25	7	5	3	L
Sj	South Junction	40-130	Humic Forest	clayey	35	35	25	10	0	0	- 5	7	5	2	L
Sj*		40-130	Humic Forest	loamy	35	35	25	10	0	0	- 5	7	5	2	L
Sm	Summerberry	40-130	Mesic Fen	loamy	35	35	0	0	0	0	30	5	3	2	W
Sn	Santon	>160	Sphag/For-Fen & Fen	clayey	35	55	10	20	20	0	-40	7	6	3	WF
Sn*	Santon	>160	Sphag/For-Fen & Fen	loamy	35	55	10	20	20	0	-40	7	6	3	WF
St	Sturgeon Gill	40-130	Sphag/For-Fen & Fen	sandy	35	35	10	0	0	0	20	6	3	2	W
Wh	Whithorn	>160	Sphag/For-Fen & Fen	clayey	35	55	10	20	20	0	-40	7	6	3	WF
Wh*		>160	Sphag/Form-Fen & Fen	loamy	35	55	10	20	20	0	-40	7	6	3	WF
Wk	Waskwei	>130	Sphagnum/Forest	clayey	35	55	25	10	20	0	-45	7	6	3	LW
Wk*		>130	Sphagnum/Forest	loamy	35	55	25	10	20	0	-45	7	6	3	LW

3.3 Sprague Peatland

The Sprague Peatland is comprised mainly of deep and very deep organic soils underlain by clayey textured lacustrine sediments. Large areas in the central portion of the peatland are very poorly drained. Ditches associated with highway and railroad construction have improved the drainage across the southern portion of the peatland. The organic soils of the peatland, in their present day condition, have virtually no capability for agriculture (Class 07). Some limited forage and grazing capacity is found in the southern part of the peatland.

Development on all soils in the peatland is expected to be of major difficulty, although if large-scale water control systems were installed, the organic soils would have potential agricultural capability of Class 05 and 06 with a few small areas of Class 03 and 04. The main limitation to use would be continuing problems associated with water control on all soils, and in addition, the high wood content of the peat material on the forested soils.

3.4 Pine Creek Peatland

The Pine Creek Peatland is a narrow, elongate area of organic soils bordered on the east by a steeply sloping escarpment and on the west by the Pine Creek. The northern sections of the peatland consist of shallow to deep forest peat deposits underlain by clayey textured lacustrine deposits and local areas of sandy textured substrates. A thin band of shallow stratified organic and mineral alluvial materials occurs along the Pine Creek. The organic soils throughout the remainder of the peatland are very deep to deep and are underlain by loamy to clayey textured lacustrine deposits.

Drainage from this peatland is via Pine Creek and the Pine Creek drain. Although this drain and ditch construction on adjacent lands developed for agriculture have helped to improve drainage over portions of the peatland, the central and southern sections remain very poorly drained. Groundwater discharge from the escarpment areas bordering the peatland to the north and east serves to maintain water flow into and through the area all year.

Central portions of the peatland and peripheral areas of very deep forest peat present major difficulty for development. Continuing problems of water control in the central depressional areas indicate a potential capability of Class 06; excess water and the high wood content of the heavily forested soils limit these areas in capability to Class 05. Areas of potential Capability Class 03 occur along Pine Creek and its tributaries. The main limitation to use of these soils is a flooding hazard associated with the creek.

3.5 Sundown Peatland

This large peatland is characterized by a wide range in drainage conditions and soil type. In the western part of the peatland, the problems associated with reclamation are minor on the shallow fen peats, major on the deep fen peats and major with severe continuing limitation of excess water on the deep hydric fen peats. The potential capability of the shallow fen peat soils is Class 03. Other shallow fen peat soils underlain by stony water-worked till are noted in Capability Class 05 after reclamation. These soils are downgraded because of the stony nature of the underlying till. The deeper fen peat soils occurring in the central areas of the peatland are rated in Capability Class 04 because of serious continuing problems of excess water. The deep hydric fen soils have excess water so difficult to control that they are rated in Class 06.

Although the organic soils formed on forest and forest-fen peats in the eastern half of the peatland have a major degree of development difficulty, reclamation is warranted. The potential capability of these soils is Class 05. A few organic soils formed on deep sphagnum peat have a major degree of difficulty in development and reclamation is seldom warranted. These soils after reclamation have continuing limitations to use of fertility and water control.

3.6 Caliento Peatland

The Caliento Peatland consists of organic soils developed on deep to very deep fen peat deposits overlying stony water-worked till and thin sandy deposits over till. Drainage over much of this peatland has been improved by ditches constructed in conjunction with roads and the railroad.

Minor development difficulty would be encountered in reclaiming the areas of shallow to deep fen peat; major difficulty would be associated with those soils found on very deep fen peat. The potential agricultural capability of the shallow organic soils is rated in Class 05, where the mineral substrates are stony, water-worked till and Class 03 if they are underlain by sandy deposits. The organic soils consisting of very deep fen peat deposits are rated in Capability Class 05 if adequate water control is provided.

3.7 Vita Peatland

The Vita Peatland is a relatively small area of shallow fen peat overlying thin sand and gravelly textured deposits and water-worked glacial till. Drainage has been much improved in this peatland so that some agricultural use is presently being made of the area. The shallow organic soils present only a minor degree of development difficulty, but the potential of the soil after reclamation is limited (Capability Class 05). The narrow land area bordering the Roseau River channel through the peatland is rated in Capability Class 03. The main limitation to use of this area is hazards imposed by flooding of the Roseau River.

4.0 Summary

Approximately 19 percent (112,850 acres) of the Roseau River Watershed is comprised of organic soils which in their native sate have no capability for agriculture. Most of the organic soils are very poorly drained and experience flooding and inundation in the spring and during times of excess precipitation. These organic soil areas collect excess runoff from surrounding upland areas and flooded creeks.

Because the organic soils constitute a very significant portion of the resource base of the watershed, their capability for agriculture is assessed according to their potential value. The classification of these soils was based on those characteristics which are considered to affect their agricultural capability and development difficulty. In general, of the 112,850 acres of organic soils, about 10 percent have good agricultural potential (Capability Class 03), about 80 percent have fair potential (Capability Class 04, 05 and 06), and the remaining 10 percent have little or no potential (Capability Class 07); their major continuing limitation being drainage.

The assessment of development difficulty is based on the probable amount of reclamation required to effect adequate water control. It indicates the relative degree of difficulty which may be encountered in developing the organic soil areas for agriculture. This evaluation shows that most organic soil areas will require major reclamation beyond the capability of individual farmers.

As agricultural development increases in the Roseau River Watershed, it is expected that most of the developmental inputs in the near future will be placed on the mineral soil areas. In the longer term, development will proceed on to organic soils with higher potential. Intensification of agriculture in any portion of the watershed will involve major drainage improvement and very significantly affect flowage in the Roseau River system.

Soil Correlation

John H. Day

The discussion on correlation problems was focused by the speaker on various subjects listed below with summary statements on opinions expressed or discisions taken.

1. Soil taxonomy. One of the principal changes proposed for trial concerns the control section, depth and thickness of tiers. It was decided that new soil series established during the trial period had been established on the basis of the proposal:

   surface tier 40 cm
   middle tier 80 cm
   bottom tier 40 cm
   with 160 cm thick control section.

2. Number of subgroups. There are more subgroups in the taxonomy than are required by mapping programs. The CanSIS 1973 (revised) list includes 267 series, 133 of which have been established in Ontario and 94 in Manitoba. The subgroups in which no series are assigned are 8.1-1b, -3, -4, -5, -10, 8.2-10, 8.3-2, -5, -7, -9, -10, 8.4-1. The most populous subgroups are 8.2-1, -4, -11, 8.3-1, -4, -6, -8. Steps were taken in 1970 to limit the number of subgroup combinations. It was decided not to further decrease the number of subgroups, at least until there has been a much larger area of soils mapped.

3. Discussion of the number of series established in Manitoba and Canada (94 and 267) as compared to Minnesota and U.S.A. (29 and 136 in 1973) focused attention on the possibility that in Canada we need to establish areal minimum limit for a new series.

It was also suggested that we should consider the ramifications to correlation procedures of broadening the subgroup definitions of certain taxons to include minor soils of very limited areal extent. For such soils, series would be established and defined to recognize the characteristic that was divergent from the central concept of the defined taxon.

Finney commented that in the U.S. system the 90 defined subgroups should reduce to about 35. Closely similar taxa could be combined, e.g., Hemic Terric Borosaprist would be combined with Terric Borosaprist.

The standard for extent of soil series is as follows:

Extensive > 100,000 acres
Moderately extensive 10,000 - 100,000 acres
Low extent 2,000 - 10,000 acres
Unnamed soil < 2,000 acres.

F I E L D   T O U R

June 5-7, 1974

Held in Conjunction With

The National Organic Soil Mapping Workshop

June 3-7, 1974

Winnipeg, Manitoba

Prepared by the Canada-Manitoba Soil Survey

FIELD TOUR ITINERARY

June 5-7, 1974

June 5 - Winnipeg to Dauphin

STOP 1: Visit several sites in the Riverton Peatland

June 6 - Dauphin to The Pas

STOP 2: two sites in organic terrain near Dawson Bay on Lake Winnipegosis

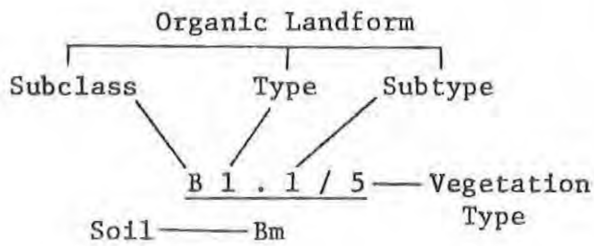
STOP 3: The Big Bog Peatland

STOP 4: Organic terrain on The Pas Moraine

June 7 - The Pas to Cranberry Portage

STOP 5: Frozen and non-frozen organic terrain in the Cranberry Peatland

Explanation of Map Symbol



Organic Landform

	Subclass		Type		Subtype		Family Moisture Regime
A.	Bog	1.	Raised	.1	Domed	.1	subaquic
				.2	Plateau		
B.	Transitional Bog	1.	Flat	.1	Hummocky	.1	aquic
		2.	Sloping	.2	Sinkhole	.2	peraquic
				.3	Conglomerate		
C.	Fen	1.	Lowland	.1	Mesic	.1	aquic
		2.	Horizontal	.2	Hydric	.2	peraquic
		2.	Patterned	.1	Water track	.1	peraquic
				.2	String	.2	peraquic
				.3	Wooded Island & Fen Complex		
		3.	Flood Plain	.1	Mesic	.1	aquic
D.	Swamp	1.	Lowland	.1	Hydric	.1	peraquic
				.2	Mesic	.2	aquic
E.	Marsh	1.	Catchment				

Vegetation Type

1. Black spruce-Sphagnum-Ledum
2. Black spruce-Sphagnum-Cladonia-Ledum
3. Sphagnum-Ledum
4. Black spruce-Ledum-Mixed Moss
5. Black spruce-feathermoss
6. Carex-Drepanocladus
7. Tamarack-Carex-Mixed Moss-Swamp birch

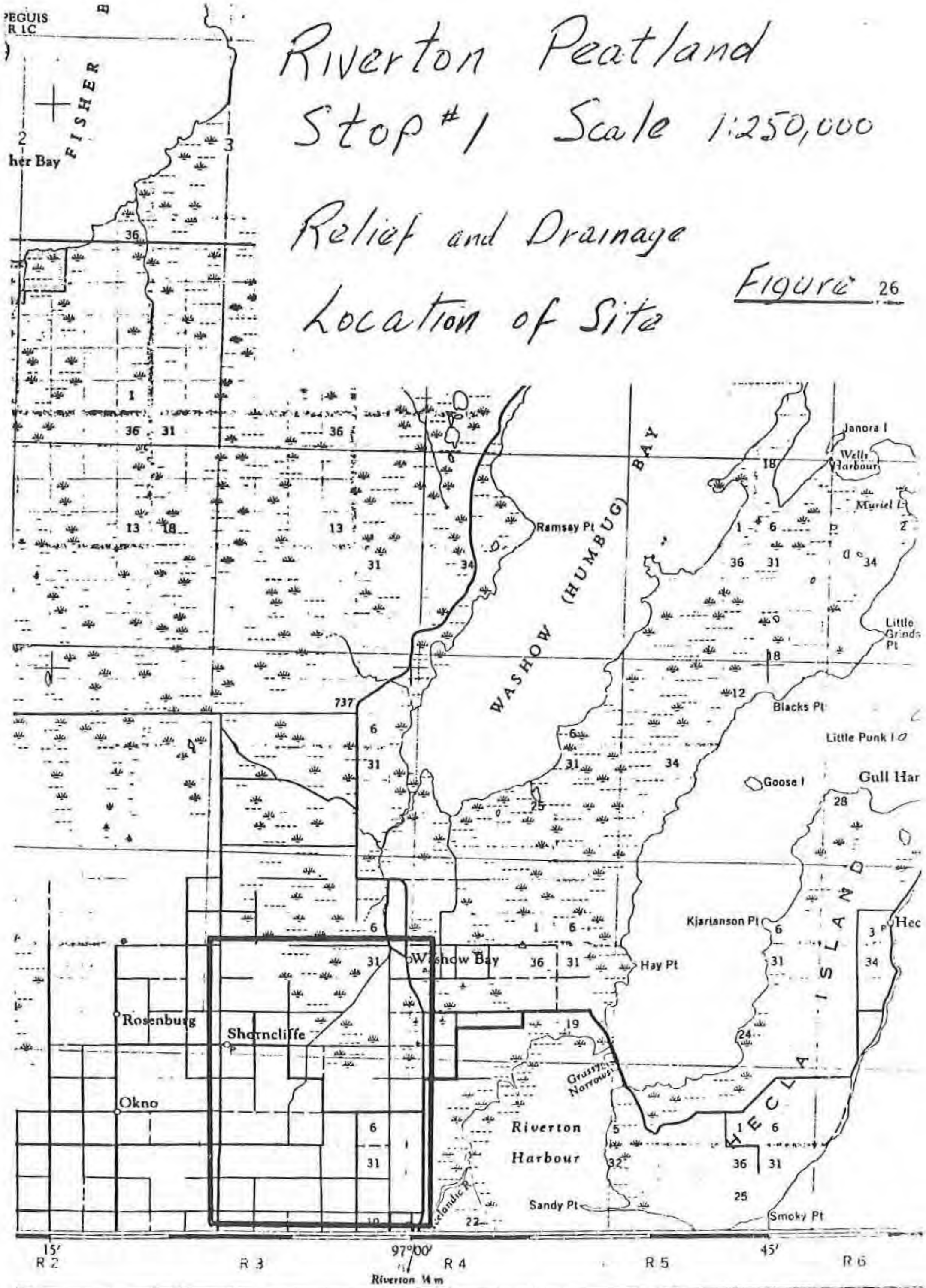
Riverton Peatland

Stop #1 Scale 1:250,000

Relief and Drainage

Location of Site

Figure 26



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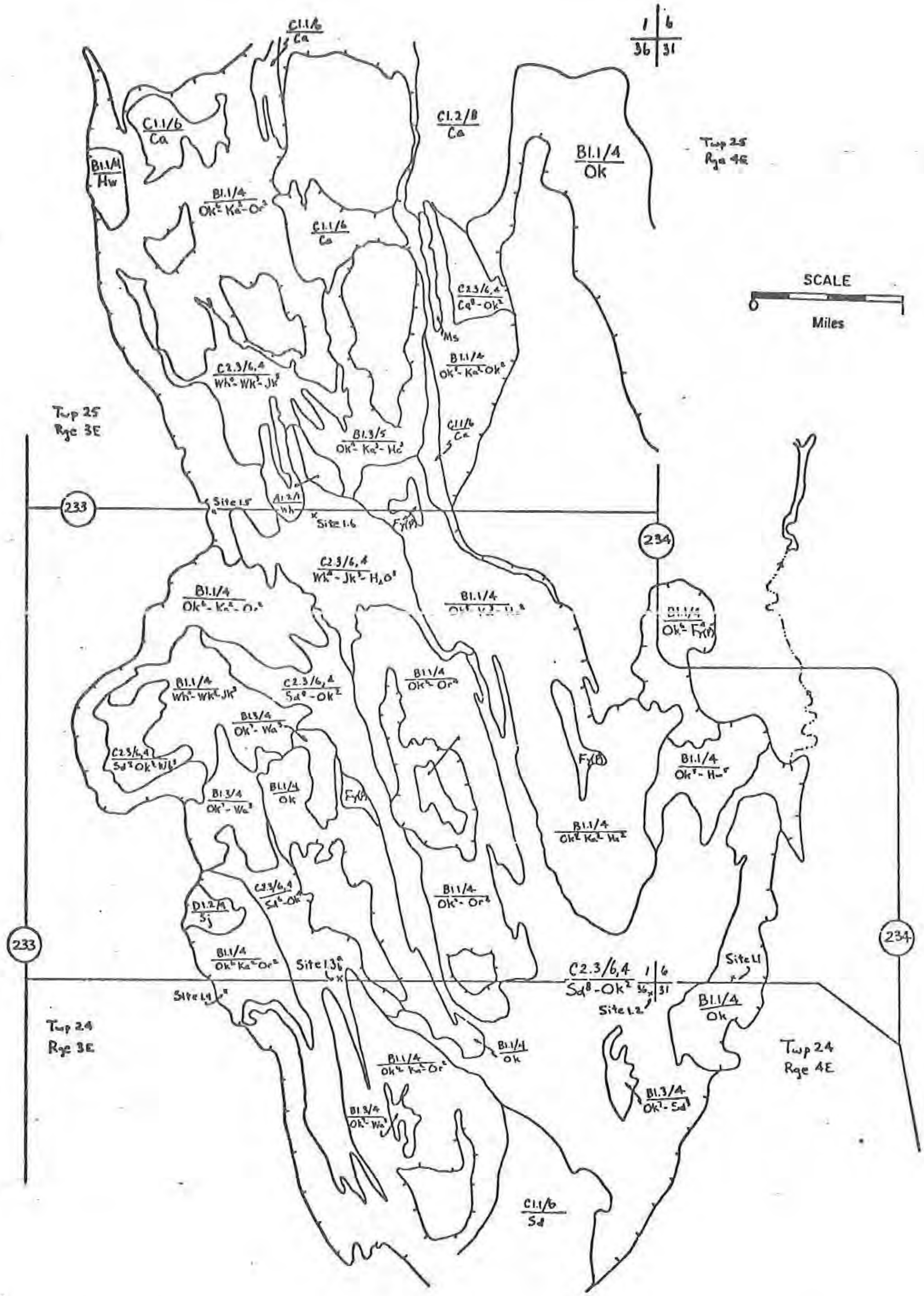
MANITOBA

RIVERTON PEATLAND - FIGURE 27



Soil Descriptive Legend

Map Symbol	Soil Name	Subgroup	Material
Ba	Baden Series	Terric Mesic Fibrisol	Sphagnum moss <35", mineral layer occurs >15" to <45".
Bm	Baynham Series	Typic Mesisol	Forest peat without surface layer of sphagnum moss.
Ca	Cayer Series	Terric Mesisol	Herbaceous peat, mineral soil <50" from surface.
Hw	Howell Series	Terric Mesisol	Same as Ca except for a very thin layer <15" of sphagnum.
Fy(P)	Fyala till sub-strate peaty phase	Peaty Rego Humic Gleysol	6" to 15" of peat over lacustrine clay, calc. till within 30" of the surface.
Hc	Hoctor Series	Terric Fibrisol	Sphagnum moss ≥15 and <30" mineral soil ≥15" and <45" from surface.
Jk	Jackhead Series	Limno Cumulic Mesisol	Alternate thin layers of marl and mesic herbaceous peat.
Ka	Kalevala Series	Terric Fibric Mesisol	Sphagnum <30" over-lying forest peat, mineral layer occurs ≥15" to <45" from the surface.
Ok	Okno Series	Terric Mesisol	Forest peat (mixture of feathermosses, shrubby and herbaceous remains). Usually <15" sphagnum on surface. Mineral soil <50" from surface.
Sd	Stead Series	Typic Mesisol	Herbaceous peat.
Sj	South Junction	Terric Humisol	Humic to mesic forest peat.
Wa	Wapah Series	Terric Mesisol	Layers of marl and peat, mineral within 50" of surface.
Wh	Whithorn	Mesic Fibrisol	Deep (90-128 cm) Sphag./ Forest and/or fen peat.
Wk	Waskwei Series	Typic Mesisol	Same as Bm, but with <25" of sphagnum on surface.

STOP 1: Riverton Peatland

Location: portions of Twp. 24 and 25, Rge. 3 and 4E P.M. north of Riverton, Manitoba in the Icelandic River Lowland section of the Lake Winnipeg Terrace Area. (Figures 26 and 27).

Area: approximately 16,600 acres

Climate: At Gimli, in the immediate area of the peatland, the yearly mean temperature is 34.5°F. Daily temperature ranges are normally 15 to 20 degrees with frequent sharp changes during fall, winter and spring months. The means for June, July and August are 59.6°, 62.4° and 64.3°F, respectively. The frost-free period ranges from 90 to 100 days and the vegetative season is approximately 175 days.

Precipitation at Gimli is 21.14 inches, June is wettest month with 3.38 inches of rainfall. Fifteen inches (ppt) falls as rain during April to October and five inches (ppt) occurs as snowfall during the winter months.

The soils of this peatland were mapped in 1967 for the Western Canada Organic Soil Tour. In May, 1974, the results of the soil studies were integrated with the organic landform and vegetation components of the peatland to produce the map in Figure 27.

Site 1.1 SC 6-25-4EPM

Landform: B1.1 Flat Bog - very gently sloping to level surface next to mineral upland. This bog is influenced by minerotrophic waters from adjacent mineral uplands as well as precipitation.

Vegetation: bS-Feathermoss-Ledum type

Tree - Dominant Black Spruce, minor tamarack

Shrub - Ledum

Ground - Mixed feathermosses dominant, occasional sphagnum pillow

Soil: Okno series - Terric Mesisol
Developed on shallow deposits of forest-peat overlying woody-fen and/or fen peat. Fine textured lacustrine sediments occur within 1 meter of the surface.

The peat material appears to be transitional between forest peat and woody fen peat. Fiber content is as follows:

Fiber Analysis

Horizon	Depth cm	Peat Material	Fiber Content, % Unrubbed	Rubbed
Om1	0-10	Mixed Moss	90	54
Om2	10-35	Forest	62	4
Om2	35-75	Woody-Fen	40	4
Om3	75-100	Fen	38	4

Site 1.2 NE Cor 36-24-3EPM

Landform: C2.3 Patterned Fen, Wooded Island and Fen Complex. Sample site occurs in Horizontal Fen portion of complex.

Vegetation: mapping unit consists mainly of very poorly drained Carex-Drepanocladus vegetation type with islands of poorly drained Black Spruce-Ledum-Mixed Moss vegetation. Sample site supports the Carex-Drepanocladus vegetation.

Soil: Stead Series - Typic Mesisol
Deep to very deep deposits of moderately well to well decomposed fen peat overlying fine-textured lacustrine sediments.

Description

Of 0-30 cm, very dark brown (10YR 2/2, moist), fine non-woody fibrous, with about 71 percent fiber content, neutral, dominantly sedge and significant mosses.

Om 30-115 cm, brown (7.5YR 4/2, moist) to very dark brown (10YR 2/2, moist) medium fibered moderately decomposed, matted to felt-like, medium acid, herbaceous material. Fiber content ranges from approximately 64 percent near top of layer to 58 percent near bottom of layer.

Oh 115-130 cm, very dark brown to black (10YR 2/2 to 2/1, moist) amorphous-granular, matted to felt-like, medium acid, herbaceous material. Fiber content approximately 23 percent.

IIAhg 130-137 cm, black (5Y 2/1, wet) clay; massive, breaking fine granular; sticky and very plastic when wet; mildly alkaline.

IICg 137 cm plus, light grey (5Y 2/1, wet) clay; massive, sticky and very plastic, mildly alkaline.

Site No. 1.2

Stead Series

Horizon	Of1	Om1	Oh1	IIAhg	IICg
Depth (cm)	0-30	30-115	115-130	130-137	137+
% Total Sand					35
% Total Silt					25
% Total Clay					40
pH 1NKCL	6.8	5.9	5.9	5.6	6.8
0.01M $CaCl_2$	6.8	5.9	5.8	5.6	7.7
% Organic Carbon	51.7	54.9	50.4	35.8	2.3
% Total Nitrogen	3.1	3.1	2.8	2.4	0.2
C/N Ratio	17	18	18	15	11
C.E.C.	108.8	123.9	131.8	143.3	28.0*
Ca M.Eq/100 gm	72.9	76.2	88.9	82.3	16.9
Mq M.Eq/100 gm	26.8	27.5	25.7	37.6	15.6
K M.Eq/100 gm	0.5	0.4	0.4	0.4	1.0
Na M.Eq/100 gm	0.6	0.6	0.8	0.8	0.6
H M.Eq/100 gm	9.7	12.8	10.9	11.7	3.9
C.E.C. (Calculated)	110.5	117.5	126.7	132.8	38.0
% Unrubbed Fiber	62	58	40		
% Rubbed Fiber	12	8	4		
% Pyrophosphate Sol.	0.11	0.12	0.18	0.92	--
% Ash	11.4	9.2	17.6	38.3	92.2
Bulk Density (gm/cc)	0.12	0.13	0.12	0.12	--

* C.E.C. determined by NH_4 distillation

Site 1.3 SE Cor 2-25-3EPM

Landform: C2.3, Patterned Fen Type, Wooded Island and Fen subtype. Site 1.3a occurs in the Horizontal Fen portion of area and Site 1.3b in the Wooded Island.

Vegetation: Site 1.3a supports open areas of sedges, grasses and mosses with scattered clumps of willow and swamp birch. The Wooded Island (Site 1.3b) portions of the landform have been burned and this in conjunction with drainage imporvement, has altered the vegetation from the original Black Spruce-Feathermoss-Ledum type from which the soil formed.

Soil: Wapah Series - Terric Limno Mesisol (Site 1.3a). Shallow to deep deposits of fen peat containing layers of marl within the control section. The development of the Wapah soil is related to the lateral movement of groundwater typical of this landform. The groundwater affecting this site is charged with carbonates dissolved from the surrounding high lime till and limestone bedrock.

Description - Initial subsidence has occurred

Lm1 0-30 cm, white to very pale brown (10YR 8/2 to 7/3, wet) marl, with thin layers of mesic to fibric herbaceous peat, snail shells profuse throughout the moderately strong fine granular, friable material (80% Calcite). Extremely calcareous.

Of1 30-45 cm, dark greyish brown (10YR 3/2, wet) partially decomposed, layered or matted medium non-woody fibrous herbaceous peat, fiber content about 70 percent. A profusion of snail shells and calcite particles throughout layer, several layers of light greyish brown (10YR 6/2, wet) of marl occur in this layer, calcareous and mildly alkaline.

Lm1 45-52 cm, light greyish brown (10YR 5/2, wet), 50 percent marl, about 30 percent marl, about 30 percent fiber (total weight basis). Extremely calcareous and mildly alkaline.

Of2 52-75 cm, dark brown (10YR 3/2, wet) about 76 percent fiber, compacted to felt-like structure fine non-woody fibrous. Fiber content rubs to approximately 50 percent. Neutral to slightly acid.

Site No. 1.3a

Wapah Series

Horizon	Lm1	Of1	Lm2	Of2	Om	IIAhg	IICg
Depth (cm)	0-30	30-45	45-52	52-75	75-85	85-90	90+
% Total Sand						17	11
% Total Silt						13	45
% Total Clay						70	44
pH 1NKCL	7.7	7.3	7.5	7.1	6.6	6.6	7.2
0.01M $CaCl_2$	7.5	7.1	7.5	6.6	6.3	7.3	7.8
% $CaCO_3$	81.1		54.3		--	3.1	17.5
% Calcite	81.1		54.3		--	--	14.1
% Dolomite	0		0		—	3.1	3.5
% Organic Carbon	11.9	48.7	25.4	53.3	49.7	3.5	1.2
% Total Nitrogen	0.6	1.7	3.0	1.7	2.5	0.2	<0.1
C/N Ratio	20	27	8	31	20	17	--
C.E.C.	64.0	111.2		123.4	117.6	40.4*	30.6*
Ca M.Eq/100 gm	75.9	107.4	95.9	99.2	86.5	34.1	72.2
Mq M.Eq/100 gm	7.4	17.7	10.7	20.8	19.3	14.3	14.6
K M.Eq/100 gm	0.3	0.2	0.1	0.2	0.2	0.7	0.8
Na M.Eq/100 gm	0.5	0.5	0.5	0.5	0.5	0.6	0.7
H M.Eq/100 gm	—	—	—	1.7	3.7	0.9	0.1
C.E.C. (Calculated)	84.1	126.2	107.2	122.1	110.2	50.6	88.4
% Unrubbed Fiber	16	86.0	30.3	80	58		
% Rubbed Fiber		10		8	6		
% Pyrophosphate Sol.	0.09	0.14	0.12	0.13	0.24		
% Ash	83.0	15.3	57.3	9.7	14.4		
Bulk Density (gm/cc)	0.35	0.15	0.32	0.14	0.14		

* C.E.C. determined by NH_4 distillation

Om 75-85 cm, very dark brown (10YR 3/2 to 2/1, wet) about 49 percent fiber, compacted to felt-like structure, fine to very fine, non-woody fibrous herbaceous peat; slightly acid.

IIAhg 85-90 cm, black (5Y 2/1, wet) clay; massive, breaking to fine granular, very sticky and plastic when wet, neutral in reaction, abrupt, wavy, lower boundary.

IICg 90 cm plus, grey to light grey (5Y 5/1 to 6/1, wet) clay; massive, very sticky and plastic when wet; moderately alkaline and calcareous.

Soil: Okno Series - Terric Mesisol (Site 1.3b) Shallow to deep deposits of moderately well decomposed forest peat overlying lacustrine clay. The fiber analysis of the forest peat sampled from the 50 to 75 cm indicate unrubbed fiber content of 76 percent and rubbed fiber content of 16 percent.

Note: The accumulation of the forest peat of this site has proceeded in spite of the calcareous environment. The mineral substrate underlying the wooded island is slightly raised above the clay deposits in the adjacent fen. The development of the wooded island was initiated on the raised portion and thereafter the growth and accumulation of mosses and the related bog vegetation kept ahead of the buildup of fen materials containing the marl deposition.

Site 1.4 SW 1/4 3-25-3EPM

Landform: Bl.1 Flat Bog. Level to very gently sloping surface adjacent to mineral upland. This landform is under the influence of minerotrophic waters from the adjacent upland.

Veg. Closed stand of Black spruce. Ericaceous shrubs (Labrador tea, Bog Laurel, etc.), Feathermosses, some Sphagnum mosses, although because of road dust, they have almost completely disappeared. (Radforth's AE1 Site).

Soil: Complex association of Okno Series - Terric Mesisol
Kalevala Series - Terric Fibric Mesisol
Orok Series - Terric Mesisol, sphagnic phase

Subgroup classification depends on relative depth at which the terric layer occurs. Sequence of materials is usually a thin fibric surface layer underlain by dominantly woody forest peat. Wood content decreases towards the underlying clay substrate.

Site No. 1.4

Kalevala Series

Horizon	Of	Om	Ahg	II Cg
Depth (cm)	0-50	50-75	75-82	82+
% Total Sand			2	1
% Total Silt			15	11
% Total Clay			83	88
1 N KCL	5.8	6.9	5.6	5.7
pH 0.01M$CaCl_2$	5.9	6.8	6.4	6.7
% Organic Carbon	47.6	45.2	3.4	0.7
% Total N	1.8	1.4	0.3	<0.1
C/N Ratio	27	33	13	—
C.E.C.	127.3	201.0	60.2*	46.0*
Ca M.Eq/100 gm	40.6	147.0	39.3	30.0
Mq M.Eq/100 gm	13.3	24.5	11.9	11.7
K M.Eq/100 gm	1.3	0.4	1.3	1.4
Na M.Eq/100 gm	0.8	0.6	0.5	0.6
H M.Eq/100 gm	69.4	6.2	3.9	3.3
C.E.C. (Calculated)	125.4	178.2	56.9	47.0
% Unrubbed Fiber	80	58		
% Rubbed Fiber	—	12		
% Pyrophosphate Sol.	0.15	0.20		
% Ash	13.7	14.2	87.3	92.2
Bulk Density (gm/cc)	0.05	0.12		

* C.E.C. determined by NH_4 distillation

Description of the Kalevala Series

Of 0-50 cm, pale brown to brown (10YR 5/3-6/3, moist) coarse fibered, non-woody, spongy, strongly acid (pH affected by road dust, sphagnum moss). Fiber content approximately 80 percent.

Om 50-75 cm, very dark brown to dark reddish brown (10YR 2/2 to 5YR 3/2, moist) fine fibered to amorphous granular, with considerable coarse woody material at contact between the two layers. Neutral to slightly acid, mixed moss, woody and herbaceous material, moderately to strongly decomposed with about 58 percent fiber content.

IIAhg 75-82 cm, black (2.5Y 3/0, wet), clay; strong fine granular; sticky and very plastic when wet; neutral to slightly acid; abrupt wavy boundary.

IICg 82 cm plus, light grey (5Y 5/1, wet), clay; massive breaking to fine granular, sticky and very plastic when wet; neutral to mildly alkaline.

Site 1.5 SW Cor 22-25-3EPM

Landform: Bl.1 Flat Bog

Veg: Black spruce-Featermoss-Ledum type

Soil: Complex association of Okno Series - Terric Mesisol
Kalevala Series - Terric Fibric Mesisol
Orok Series - Terric Mesisol, sphag. phase

Subgroup classification is dependent partly on depth from the surface at which the mineral substrate occurs. Sequence of peat materials is usually a shallow surface, layer of fibric peat (mixed mosses) overlying mesic woody forest peat. Moderately well to well decomposed herbaceous fen or woody fen peat may occur above the clayey substrates.

Fiber Analysis

Horizon	Depth cm	Peat Material	Fiber Content, % Unrubbed	Rubbed
Of	0-20	Sphagnum	--	--
Om1	20-60	Forest	64	10
Om2	60-100	Forest	54	6
Oh	100-130	Fen	30	4

Site 1.6 NE Cor 15-25-3E

Landform: A1.2 Raised Plateau Bog

Veg: Black Spruce-Sphagnum-Ledum
Stunted black spruce, Labrador tea, living mosses are mostly feathermosses, sphagnum moss has been killed off by road dust.

Soil: Whithorn Series
Deep (90-128 cm) fibric sphagnum peat overlying mesic forest and/or fen peat.

Description taken from SC 22-25-3EPM (ditch cut across road)

Of1 0-45 cm, light yellowish brown to very pale brown (10YR 6/4 to 7/3, wet) non-woody, coarse, fibered, spongy, sphagnum moss, about 93 percent fiber, extremely acid.

Of2 45-90 cm, dominantly reddish yellow (7.5YR 6/6, wet) compacted, non-woody, moderately coarse fibered, sphagnum moss, about 70 percent fiber, very strongly acid, with thin mesic layers of dark brown (7.5YR 3/2 to 2/2, wet) amorphous granular to coarse fibered material of mixad origin (feathermosses, woody fiber, shrubby remains and leaves), about 84 percent fiber, very strongly acid.

Om1 90-120 cm, dark reddish brown to very dark brown (5YR 3/2 to 2/2 and 10YR 2/2, wet) amorphous granular to coarse woody fibered compacted, fiber content ranges from about 68 percent. Upper portion of this layer contains a high percentage of woody fibers. The material appears to be of mixed origin and is very strongly acid.

Om2 120-170 cm, dark brown to very dark brown (7.5YR 4/4 to 3/2 and 10YR 2/2, wet), compacted or matted and felt-like, non-woody, moderately coarse fibered, fiber content about 62 percent, origin of material herbaceous, medium acid.

Oh 170-178 cm, very dark brown to black (10YR 2/2 to 2/1, wet) compacted or matted flet-like, amorphous granular to non-woody fine fibered, fiber content about 26 percent, origin of material is dominantly herbaceous, neutral.

IIAhg 178-185 cm, black (5Y 2/1, wet) clay, massive, breaking to granular, very sticky and very plastic, neutral.

Site No. 1.6

Whithorn Series

Horizon	Of1	Of2	Om1	Om2	Oh	IIAhg
Depth (cm)	0-45	45-90	90-120	120-170	170-178	178-185
% Total Sand						13
% Total Silt						31
% Total Clay						56
pH 1NKCL 0.01M $CaCl_2$	2.9 3.0	4.1 3.8	4.9 4.7	5.6 5.6	7.2 7.1	6.8 7.1
% $CaCO_3$ Equivalent						17.1
% Calcite						8.6
% Dolomite						7.8
% Organic Carbon	55.5	54.6	49.9	57.1	37.4	4.4
% Total Nitrogen	0.9	1.0	1.7	3.4	2.6	0.3
C/N Ratio	64	55	29	17	14	15
C.E.C.	138.9	162.2	221.8	125.8	140.9	36.0
Ca M.Eq/100 gm	14.0	61.2	94.4	76.9	131.5	75.7
Mq M.Eq/100 gm	15.0	28.8	41.0	26.7	27.4	16.7
K M.Eq/100 gm	0.5	0.3	0.4	0.3	0.4	1.0
Na M.Eq/100 gm	0.4	0.4	0.5	0.3	0.4	0.5
H M.Eq/100 gm	109.2	47.8	39.0	14.6	0.8	0.9
C.E.C. (Calculated)	139.1	138.5	175.3	118.8	160.5	94.8
% Unrubbed Fiber	93	84	68	62	26	
% Pyrophosphate Sol.	0.12	0.37	0.17	0.13	0.81	—
% Ash	2.7	7.2	9.8	8.9	37.6	88.5
Bulk Density (gm/cc)	0.05	0.08	0.11	0.09	0.11	

* C.E.C. determined by NH_4 distillation

Site 2.1 NW Cor 16-44-25WPM

Landform: Flat Bog - under the influence of minerotrophic waters flowing in adjacent swamp-like runway through Bog.

Veg: Black spruce and tamarack, a few tall shrubs (willow, swamp birch), a profusion of sedges, reeds, Equisetum sp., moss hummocks. (Radforth's AFl Site).

Soil: Okno Series - Terric Mesisol
Shallow to deep deposits of moderately well to well decomposed forest peat overlying medium to fine textured lacustrine and alluvial deposits.

Description

Om1 0-15 cm, very dark brown to dark reddish brown (10YR 2/2 to 5YR 2/2, wet) amorphous granular, woody, fiber content about 46 percent, neutral.

Om2 15-35 cm, very dark brown to dark brown (10YR 2/2 to 3/3, wet) a mixture of coarse woody fibered and moderately coarse non-woody fibered mossy material, fiber content about 64 percent, medium acid.

Om3 35-60 cm, very dark brown to dark reddish brown (10YR 2/2 to 5YR 2/2) mixture of mossy, herbaceous and woody material, compacted, fiber content about 63 percent, medium acid.

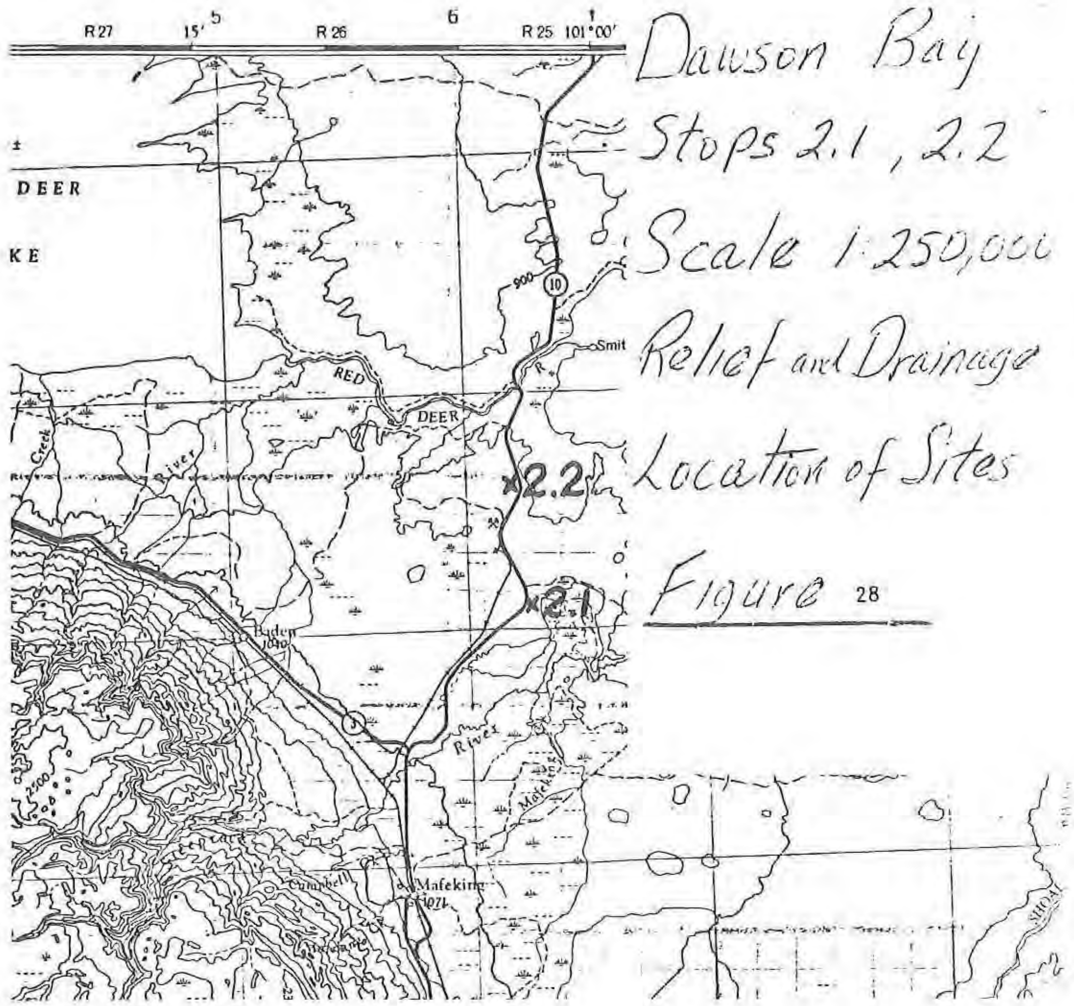
IIAhg 60-65 cm, black (2.5Y 2/1, wet), silty clay; massive; plastic and very sticky when wet; medium acid.

Site 2.2 5-45-25EPM

Landform: Flat Bog

Veg: Closed stand black spruce, ericaceous shrubs and mosses (dominantly feathermosses), sphagnum restricted to cushions. (Radforth's AE1 site).

Soil: Kanusk Series - Terric Fibric Mesisol
Thin fibric surfacy layer of Sphagnum and feathermosses, alternating layers of moderately well decomposed woody forest peat and fibric sphagnum peat, all overlying well decomposed forest and/or woody fen peat.

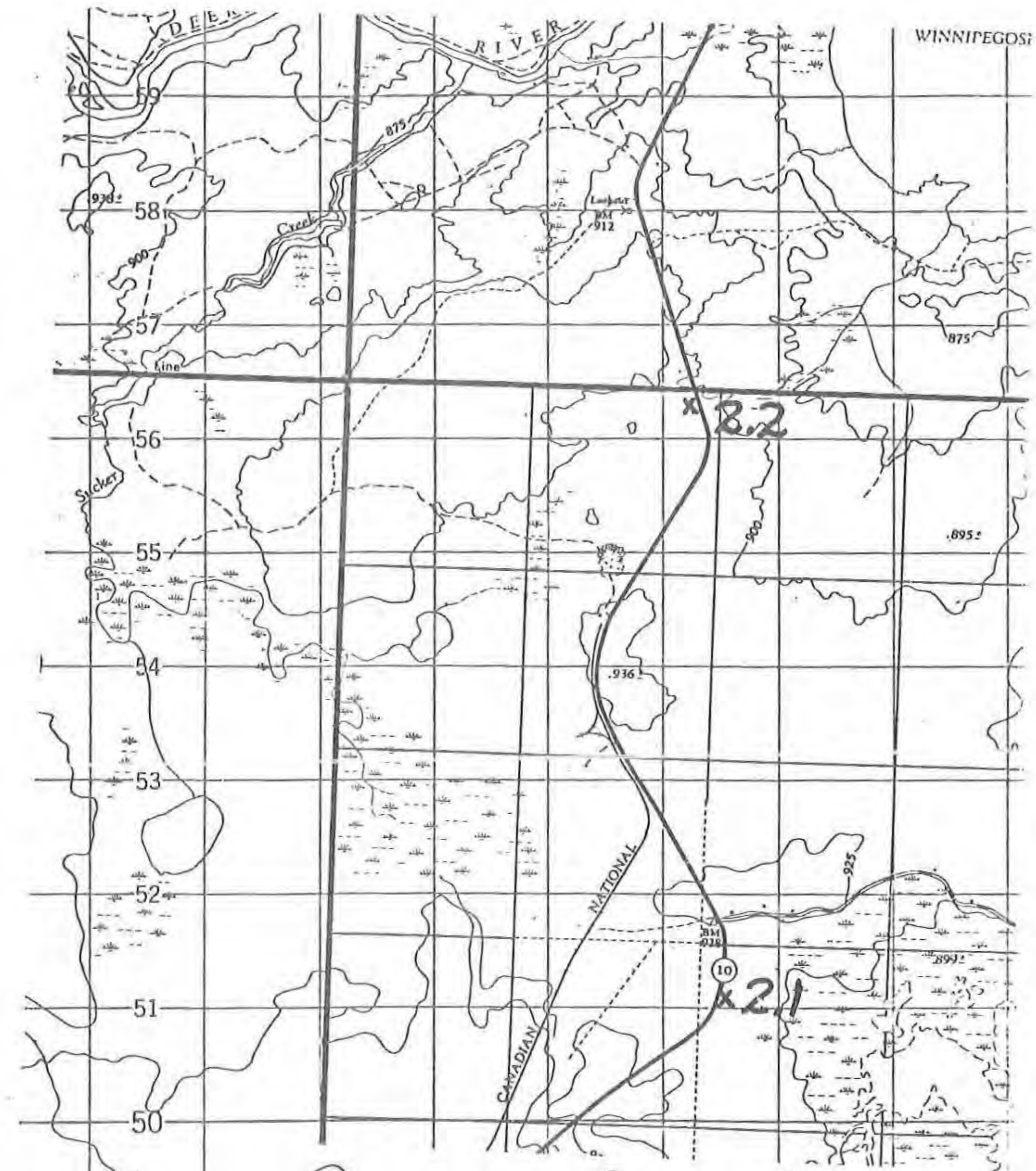


Dawson Bay
Stops 2.1, 2.2
Scale 1:250,000
Relief and Drainage
Location of Sites
Figure 28

STOP 2 Organic Terrain near Dawson Bay, Lake Winnipegosis

Location: The Armut River Plain sub-section of the Lower Escarpment Plains in the Manitoba Lowlands. Sites occur between the northeast slopes of the Porcupine Hills and Dawson Bay on Lake Winnipegosis (see Figures 28 and 29).

Climate: The two sites examined at Stop 2 occur near the northern limit of the climatic region and as such the M.A.A.T. is about $32^{\circ}F$. The area has approximately 95 frost-free days, about 2500 degree-days above $42^{\circ}F$ and 19 to 22 inches average annual precipitation. About three quarters of the precipitation occurs as rain during the summer months.



Dawson Bay
Stops 2.1, 2.2
Relief and Drainage
Location of Sites

Scale 1:50,000

Figure 29a

Site No. 2.1

Okno Series

Horizon	Om1	Om2	Om3	IIAhg
Depth (cm)	0-15	15-35	35-60	60-65
% Total Sand				1
% Total Silt				56
T Total Clay				43
pH 1NKCL	7.1	6.1	5.9	5.7
0.01M $CaCl_2$	7.1	6.3	5.9	5.7
% Organic Carbon	48.0	57.8	51.5	35.1
% Total Nitrogen	2.2	1.7	2.4	1.8
C/N Ratio	23	34	21	19
C.E.C.	143.7	128.5	176.9	101.1
Ca M.Eq/100 gm	107.6	83.9	108.9	65.6
Mq M.Eq/100 gm	22.9	16.0	18.6	16.6
K M.Eq/100 gm	3.6	0.8	0.8	1.1
Na M.Eq/100 gm	2.3	1.2	1.3	1.3
H M.Eq/100 gm	4.2	11.2	17.7	10.2
C.E.C. (Calculated)	140.6	113.1	146.5	94.8
% Unrubbed Fiber	68	64	63	37
% Rubbed Fiber	24	8		
% Pyrophosphate Sol.	0.55	0.23	0.51	0.68
% Ash	14.9	8.2	12.2	36.3
Bulk Density (gm/cc)	0.09			

Description - Site is drained by Highway ditch; effect of altered moisture regime is difficult to assess. Water Table fluctuates between surface and approximately two feet below surface as the growing season advances.

Of1 0-30 cm, light yellowish brown to very pale brown (10YR 6/4 to 7/3, moist) non-woody, coarse fibered spongy sphagnum moss about 90 fiber, slightly to medium acid (due to calcareous road dust and improved drainage).

Om1 30-37 cm, reddish brown to very dark brown (5YR 5/4 to 10YR 2/2, wet) woody coarse textured layer, fiber content approximately 39 percent, neutral, woody material more than 20 percent of the layer.

Of2 37-60 cm, reddish brown (5YR 4/4, wet) medium fibered, compacted sphagnum moss alternating with very dark brown (10YR 2/2, wet) thin moderately decomposed, mixed, woody, mossy and herbaceous material fiber content in layer is approximately 68 percent.

Om2 60-67 cm, reddish brown to dark reddish brown (5YR 4/4 to 2/2, wet) coarse fibered, woody material mixed with very dark brown to black (10YR 2/2 to 2/1, wet) non-woody material, layer contains approximately 59 percent fiber.

Oh1 67 to 85 cm, very dark brown (10YR 2/2, wet), fine fibered, felt-like, herbaceous material, fiber content approx. 30 percent, neutral to slightly acid in reaction.

Oh2 85-90 cm, very dark brown to black (10YR 2/2 to 2/1, wet) very fine fibered, felt-like herbaceous material, fiber content approx. 15 percent, neutral to slightly acid in reaction.

IICg 90 cm plus, high lime, stony, glacial till.

STOP 3 The Big Bog Peatland

Location: The Overflowing River Lowland sub-section of the Westlake Lowland Section in the Manitoba Lowland. Mainly organic dominated terrain underlain by sandy to clayey lacustrine sediments (see Figure 4a and 4b).

Climate: MAAT less than 32°F, frost-free period is 90 to 95 days, average annual precipitation is 17 to 19 inches with a definite summer maximum.

Site No. 2.2

Kanusk Series

Horizon	Of1	Om1	Of2	Om2	Oh1	Oh2
Depth (cm)	0-30	30-37	37-60	60-67	67-85	85-90
pH 1NKCL 0.01M $CaCl_2$	6.5 6.5	7.0 7.1	7.1 7.1	7.1 7.0	6.7 6.9	6. 6.
% Organic Carbon	49.7	44.6	44.4	46.8	43.4	39.
% Total Nitrogen	1.0	1.6	1.0	1.1	1.6	1.
C/N Ratio	50	28	44	43	27	22
C.E.C.	117.9	265.0	236.4	215.8	264.7	250.
Ca M.Eq/100 gm	80.3	169.9	171.3	164.3	169.6	160.
Mg M.Eq/100 gm	20.7	27.7	25.6	25.5	24.8	21.
K M.Eq/100 gm	2.5	0.5	0.3	0.6	0.3	0.
Na M.Eq/100 gm	0.7	0.7	0.8	1.6	0.9	0.
H M.Eq/100 gm	10.3	1.8	2.4	--	5.7	4.
C.E.C. (Calculated)	114.5	200.6	200.4	192.0	201.3	187.
% Unrubbed Fiber % Rubbed Riber	90	39	68	48	44	15.3
% Pyrophosphate Sol.	0.21	0.79	0.64	0.41	1.28	2.
% Ash	10.6	19.1	16.1	14.5	19.0	24.
Bulk Density (gm/cc)	0.04		0.11		0.21	

Site 3.1

Landform: Horizontal Fen, wooded sub-type
Likely Heinselman's Poor Swamp (Hydric Swamp)

Veg: Tamarack-Carex-Mixed Moss-Swamp birch type. Near continuous Sphagnum cover, abundant Carex, some Ledum. Abundant Betula, some willow.

Soil: Katimik Series - Typic Mesisol, sphag. phase.

<u>Description</u>

Of 0-25 cm, mixed Sphagnum and feathermoss materials.

Om1 25-100 cm, Woody-fen peat % Unrubbed 44 % Rubbed 6

Om2 100-175 cm, Fen peat % Unrubbed 42 % Rubbed 8

Om3 175-200 cm, Fen peat % Unrubbed 38 % Rubbed 6

STOP 4 Organic Terrain on The Pas Moraine

Location: The Pas Moraine subsection of the Lakes Till Plain portion of the Manitoba Lowlands (see Figure 29 and Figure 30).

Climate: Vegetation and landform characteristics of the organic terrain are indicative of still cooler climatic conditions, than evidence at STOP 3. MAAT slightly above 30°F and average annual precipitation is between 17 and 19 inches.

Site 4.1

Landform: Blanket Bog - shallow organic deposits overlying the fluted surface of the moraine.

Veg: Black spruce-Sphagnum type

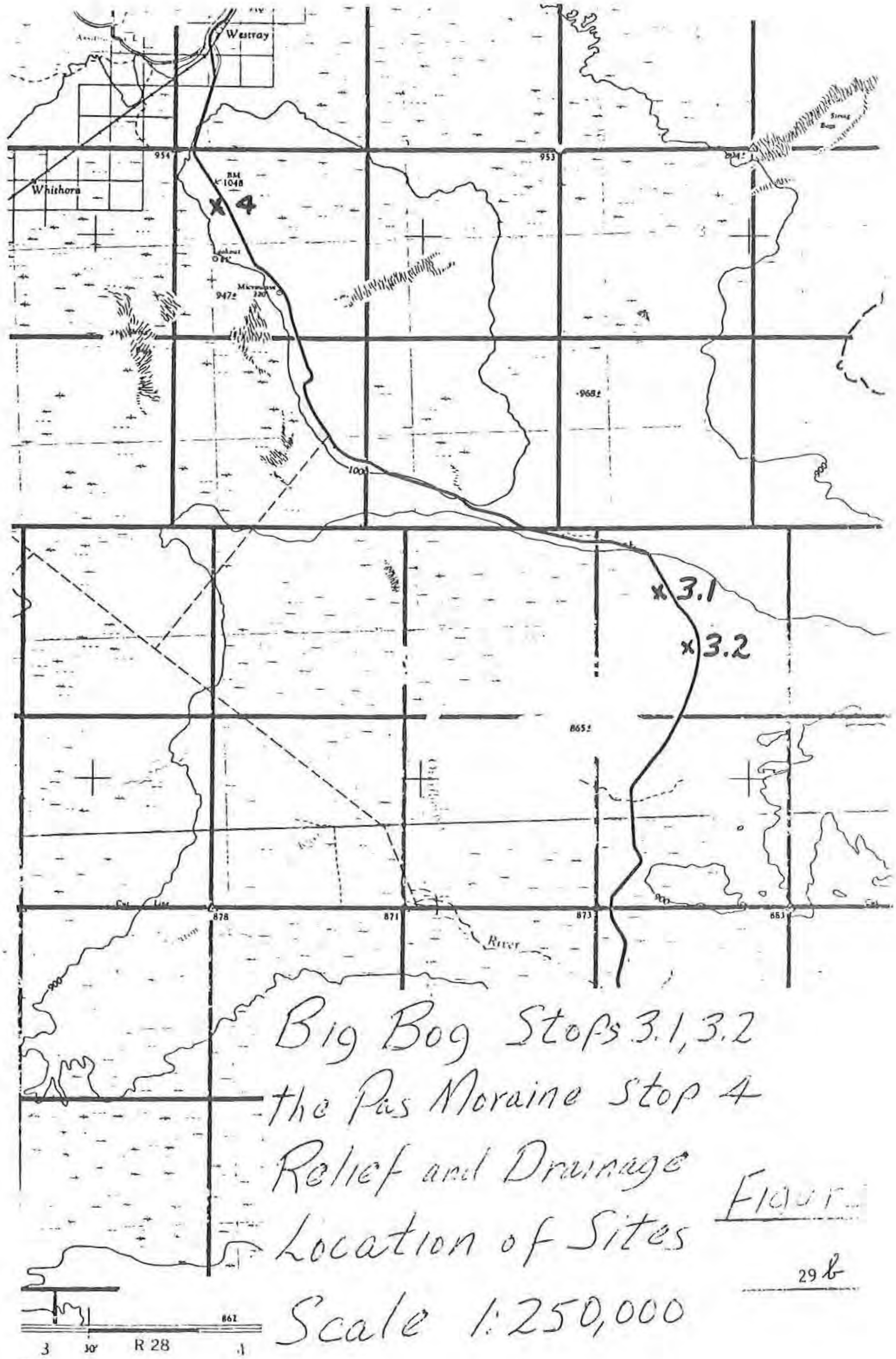
Soil: Laronde Series - Terric Fibrisol
Area is a complex assofication of Peaty Gleysols and Terric Fibrisol soils underlain by water worked high lime till.

<u>Description</u>

Of 0-40 cm, Sphagnum Peat % Unrubbed 96 % Rubbed 72

Om 40-60-100 cm, Mesic to Humic Forest peat Unrubbed 40 Rubbed 10

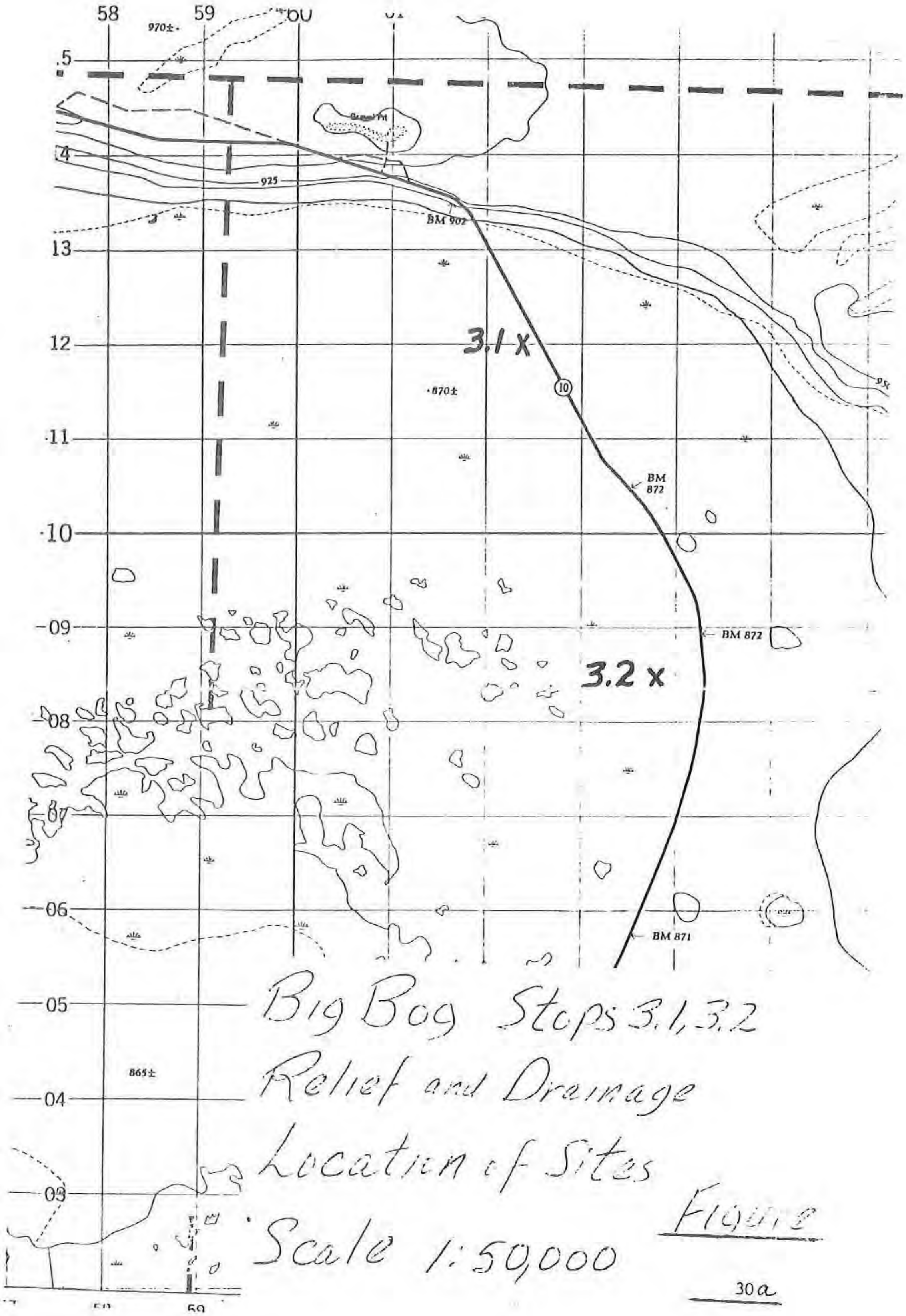
IICkg 60-100+ cm, Water-worked loamy skeletal glacial till



Big Bog Stops 3.1, 3.2
the Pas Moraine Stop 4
Relief and Drainage
Location of Sites
Scale 1:250,000

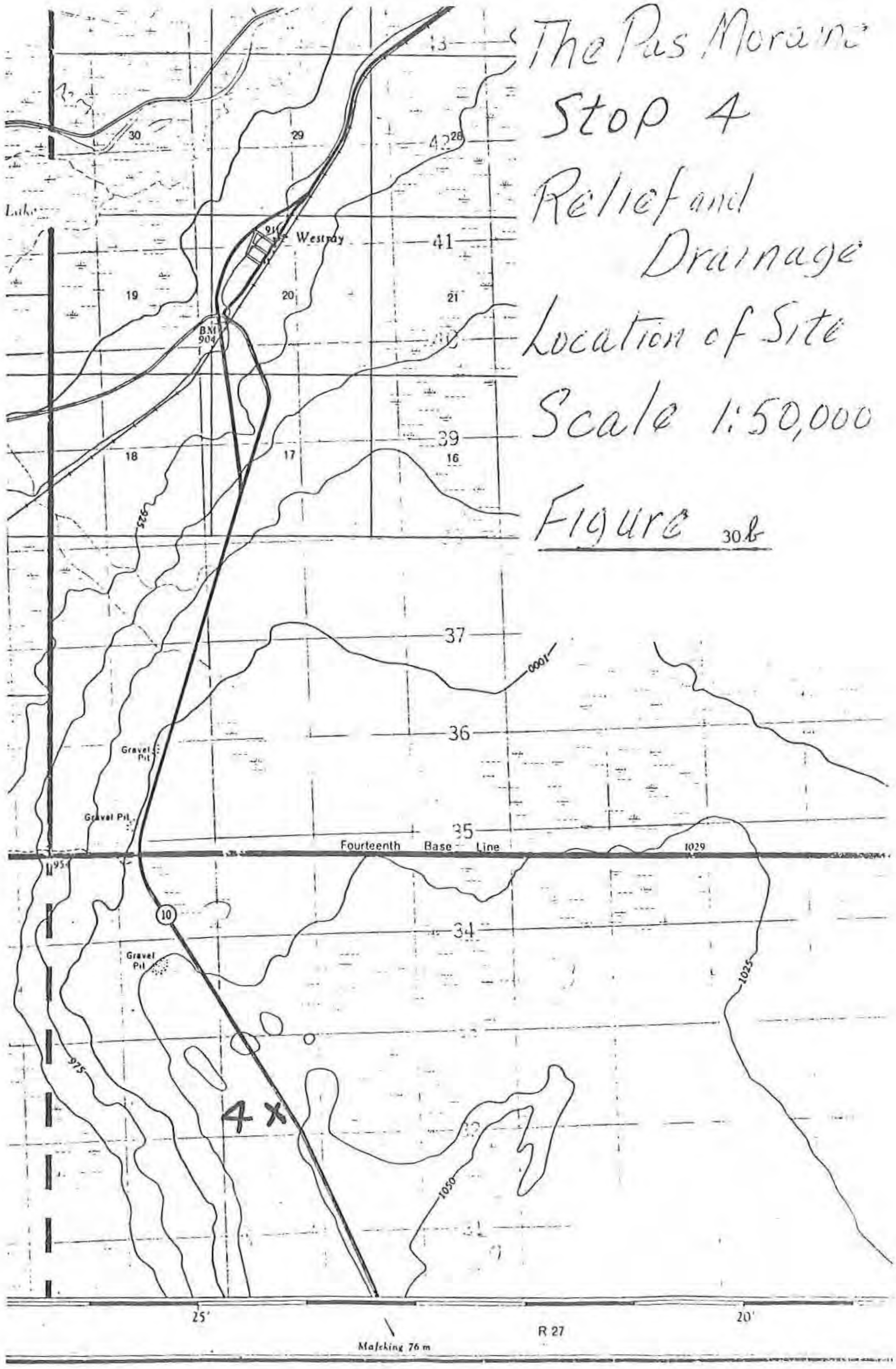
Figur...

29 b



Big Bog Stops 3.1, 3.2
Relief and Drainage
Locatn of Sites
Scale 1:50,000

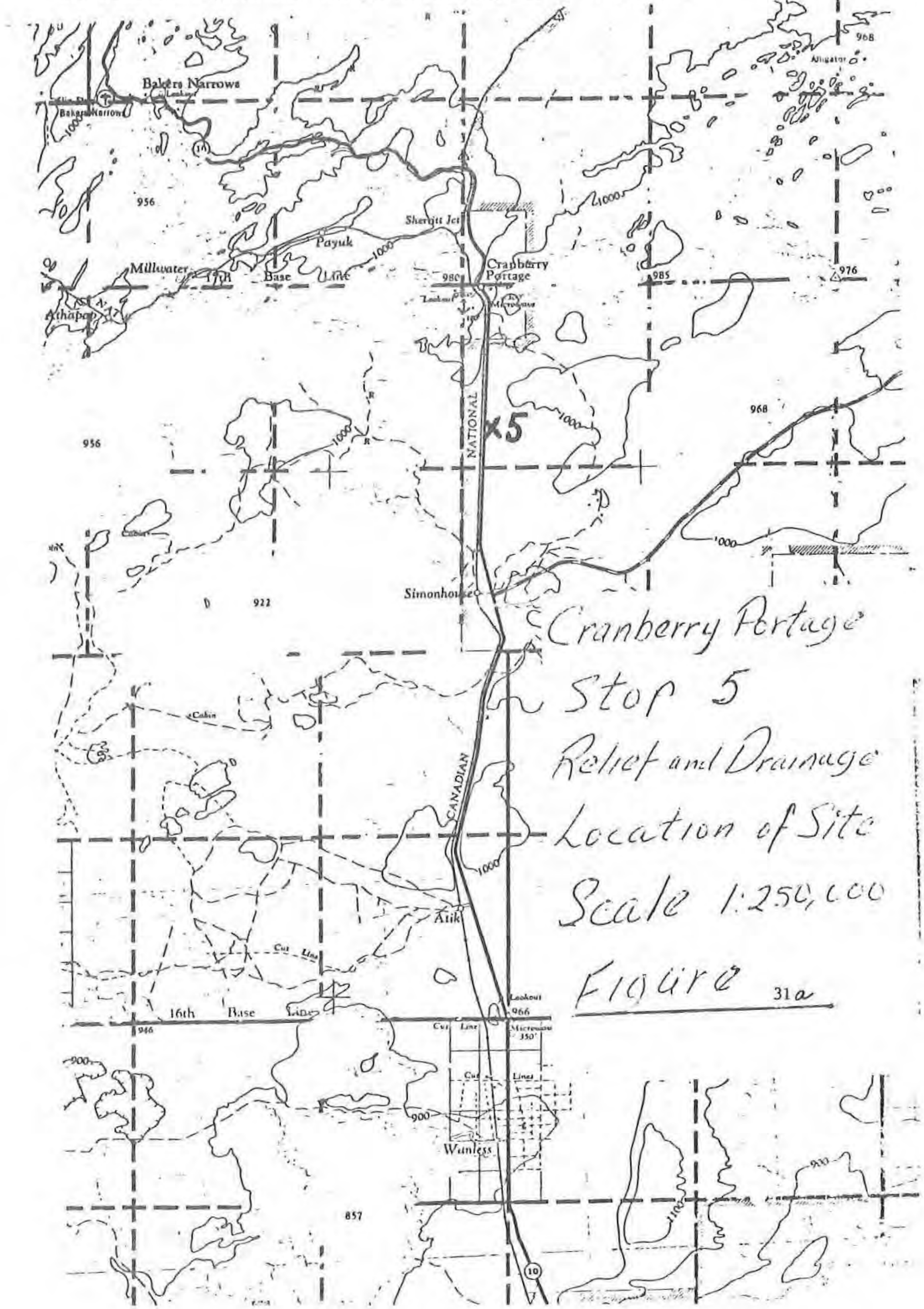
Figure
30a



The Pas Moraine
Stop 4
Relief and Drainage
Location of Site
Scale 1:50,000
Figure 30b

STOP 5 CRANBERRY PEATLAND

See Site Description and Interpretation prepared by C. Tarnocai



STOP 5 CRANBERRY PEATLAND

See Site Description and Interpretation prepared by C. Tarnocai

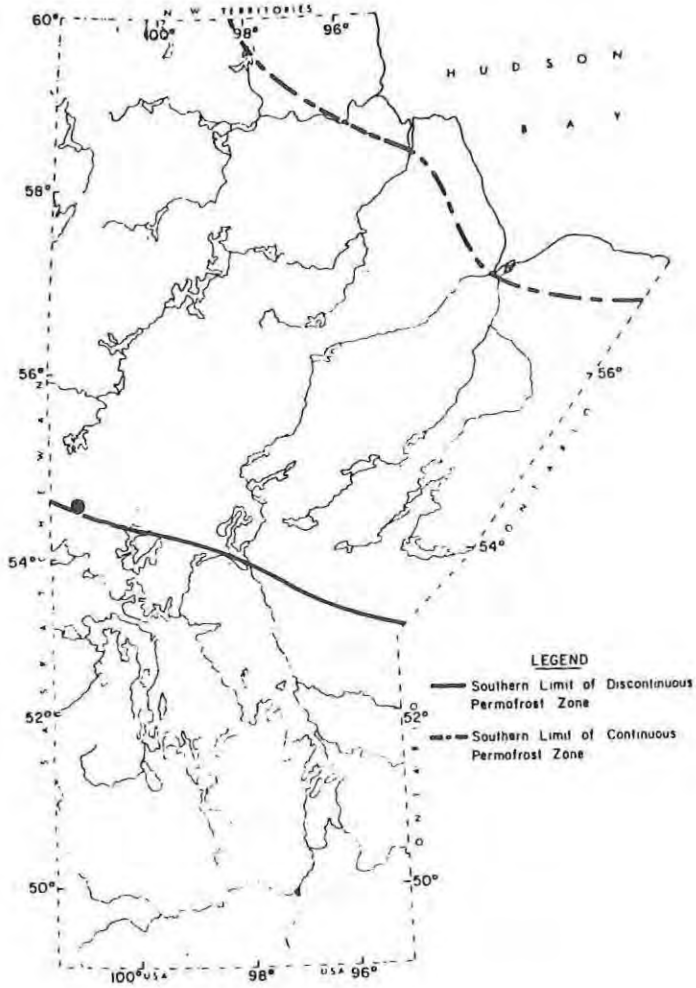


Figure 31b. Location of Cranberry Bog (●) at approximately 54° 28'N lat. and 101° 22'W long.

T H E   C R A N B E R R Y   B O G

Organic Soil Mapping Workshop
Field Tour

C. Tarnocai

Introduction

The Cranberry Bog is one of the peatlands associated with the northern coniferous forest (Boreal Forest Region). It contains both bogs and fens which are the characteristic peatland components of the Boreal region. Permafrost, a very widespread component of the Boreal peatlands, also occurs extensively in this area. Thus, the Cranberry Bog is a good example of the boreal peatlands occurring in Canada.

Some portions of this bog have been studied since 1969 (S.C. Zoltai and C. Tarnocai. 1971. Properties of a wooded palsa in northern Manitoba. Arctic and Alpine Res. 3:115-129; and C. Tarnocai. 1972. Some characteristics of cryic organic soils in northern Manitoba. Can. J. Soil Sci. 52:485-496), and studies relating to soil temperature, active layer and snow cover are still going on. The northern portion of the bog is designated as an IBP site.

Description of the Area

The Cranberry Bog (see Figs. 30, 31,38) is located approximately 5 miles south of Cranberry Portage (approximately 54^{o} 28' N lat. and 101^{o} 22' W long.) and is situated in a basin underlain mainly by lacustrine clay. On the south it is bordered by a low dolomite plateau, on the north and east by low ridges of calcareous till and on the west by a lacustrine plain. Highway No. 10 crosses the bog in a north-south direction. This highway, fortunately, has not blocked the drainage; culverts allow free drainage westward.

This peatland is a large (approximately 8 square miles) bog and fen complex. The bogs are mainly of the domed, patterned and spring fen types. Permafrost is associated with the domed and plateau bogs (peat plateaus and palsas). This permafrost is approximately 15 feet deep.

Mapping of the Cranberry Peatland

The mapping was carried out at six different scales ranging from 1:250,000 to 1:800 to show how the scale of the map or remote sensing data affects both the level of information provided on the map and legend and the amount of ground truth required for interpretation.

Scale 1:250,000 (broad reconnaissance) See Figure 32.

This mapping was done by using the one inch to one mile (1:60,000) photography. This photography, however, provides far more information that can be handled at this scale. Thus, this photography was interpreted very quickly rather than in detail and only broad basic peatland units were identified. The ground truth requirement for this scale is a helicopter and fixed wing traverse with highly selected stops - approximately one per hundred square miles. For this mapping scale, high altitude photography (1:250,000) or ERTS data is adequate.

Scale 1:125,000 (reconnaissance) See Figure 33.

This mapping was done by using the one inch to one mile (1:60,000) photography. This photography was still too detailed for this scale and thus complexing was necessary. The information provided in the legend definitely requires the use of this scale of photography. The ground truth requirement for this scale is helicopter traversing with selected stops - approximately one per every forty square miles.

Scale 1:60,000 (detailed reconnaissance) See Figure 34.

This mapping was also done by using the one inch to one mile (1:60,000) photography. This photography was quite adequate for this scale but, in some cases however, still contained more detailed information than the mapping scale could handle and so complexing was necessary. The ground truth requirement for this scale of mapping is helicopter traverses and stops and, in addition to this, detailed work along the roads and trials averaging approximately one stop per 10 square miles.

Scale 1:16,000 (detailed) See Figure 35.

This mapping was done by using the four inch to one mile (1:16,000) photography. The information that this photography provided was too detailed for this mapping scale. Complexing was necessary and the result of this was that most of the detailed information provided by this photo scale was lost. All of the mapping units were ground truthed on this map with not less than one stop per square mile being made. The area was traversed on foot, but if large areas are involved, helicopter traversing is necessary.

Scale 1:7,000 (very detailed) See Figure 36.

This map was prepared by using the four inch to one mile (1:16,000) photography. This scale of photography provided the detail that this mapping scale could handle, but in some cases, contained more information than the map could handle and thus complexing was necessary. The ground truth for this study was collected on foot traverses with approximately 10 stops per one square mile being made and in some cases, more depending on the complexity of the mapping unit.

Scale 1:800 (super detailed) See Figure 37.

This map was based on ground survey data without the use of aerial photography. A cut line bisecting the area was utilized as the centre line. Survey lines were run normal to this line at 15.25 m intervals. Elevation above water level was determined along the centre line and the survey lines. Vegetation quadrats of 1 m^2 were located along the survey lines at 1.5 m intervals. The frozen and unfrozen peat was sampled along the survey lines. The mapping of this area (approximately 1,000 m^2) was based on 359 quadrats and 21 peat borings.

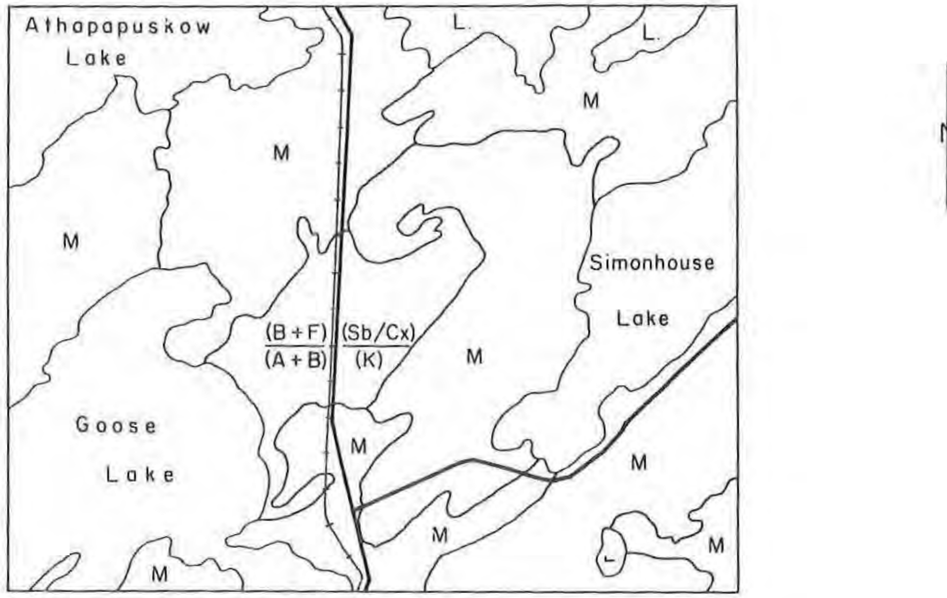
Interpretation of Map Symbols

The map symbol is interpreted as follows:

Peat Landform ( ) ( ) Vegetation

———————————

Soil ( ) ( ) Permafrost

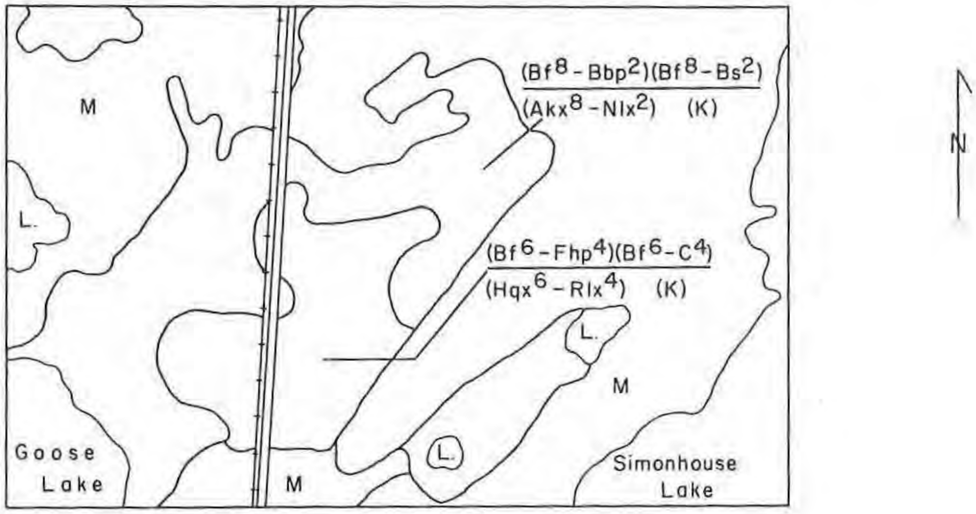


LEGEND

Landform		Parent Material	Ecoregion	Drainage (deciles)	Dominant Soil		Dominant Vegetation	
Map Symbol	Name				Classification	Map Symbol Association	Vegetation Group	Map Symbol
B	Bog	Dominantly forest and/ or sphagnum peat underlain by fen peat.	IV	Well to Imperfect (3)	Organo Cryosol (Mesic Organo Cryosol)	A	Black spruce forest	S
				Poor (7)	Mesisol (Terric Fibric Mesisol and Typic Mesisol)			
F	Fen	Dominantly fen peat.	IV	Poor to Very Poor	Mesisol (Typic Mesisol)	R	Carex Tamarack forest	C T

Note: + Second named unit is 10-20% of total unit area
/ Second or third unit is 20-50% of total unit area
K Presence of permafrost
M Mineral soils

Figure 32. 1:250,000 scale (approximately 1/4 inch = 1 mile or 1 cm = 2.5 km) map of the Cranberry Bog.

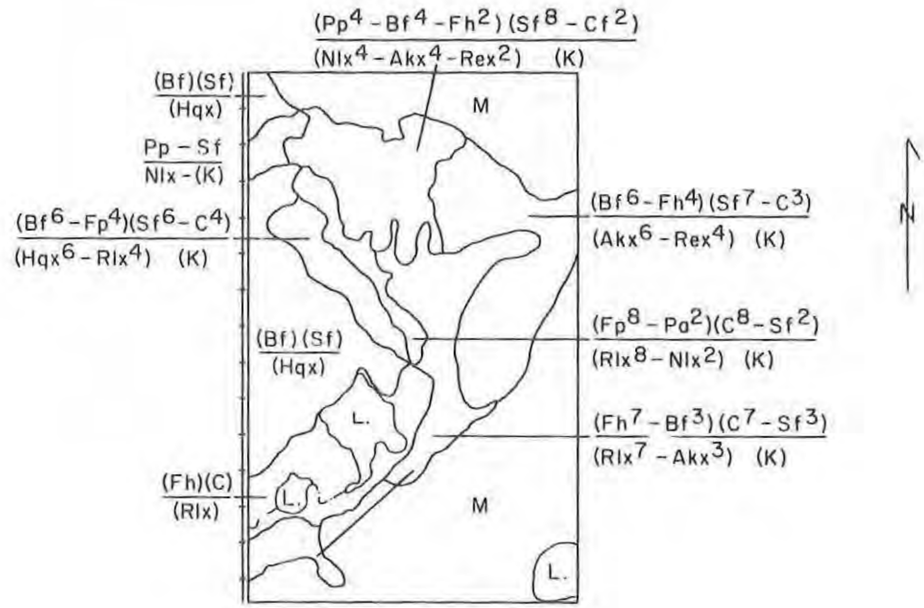


LEGEND

Landform		Parent Material	Ecoregion	Drainage	Dominant Soil			Dominant Vegetation	
Map Symbol	Name				Soil Complex	Classification	Map Symbol	Vegetation Complex	Map Symbol
Bdp	Domed and Plateau Bog	Deep to very deep perennially frozen forest peat or thin sphagnum peat overlying forest peat	IV	Well to Imp.	Nekik Lake Complex	Mesic Organo Cryosol	Nlx	Black spruce-Feather moss, Black spruce-Cladonia Complex	Bs
Bf	Flat Bog	16 to 52 inches of mesic forest peat or thin (<24") of sphagnum peat overlying forest peat	IV	Poor	Atik Complex	Terric Fibric Mesisol* Terric Mesic Fibrisol Terric Mesisol	Akx	Black spruce-Feather moss, Black spruce-Feather moss-Ledum, Treeless sphagnum complex	Bf
		Mesic forest peat greater than 52" or thin (<24") sphagnum peat overlying forest peat	IV	Poor	Hargrave Complex	Typic Mesisol* Mesic Fibrisol	Hgx	Same as above	Bf
Fhps	Horizontal Fen Patterned Fen Spring Fen Complex	Greater than 52" of mesic fen peat with little (<6") or no sphagnum peat	IV	Very Poor	Rock Island Complex	Typic Mesisol* Fibric Mesisol	Rlx	Carex, Tamarack-Carex Complex	C

Note: K Presence of permafrost
M Mineral soils
* Dominant soil

Figure 33. 1:125,000 scale (approximately 1/2 inch = 1 mile or 1 cm = 1.25 km) map of the Cranberry Bog.

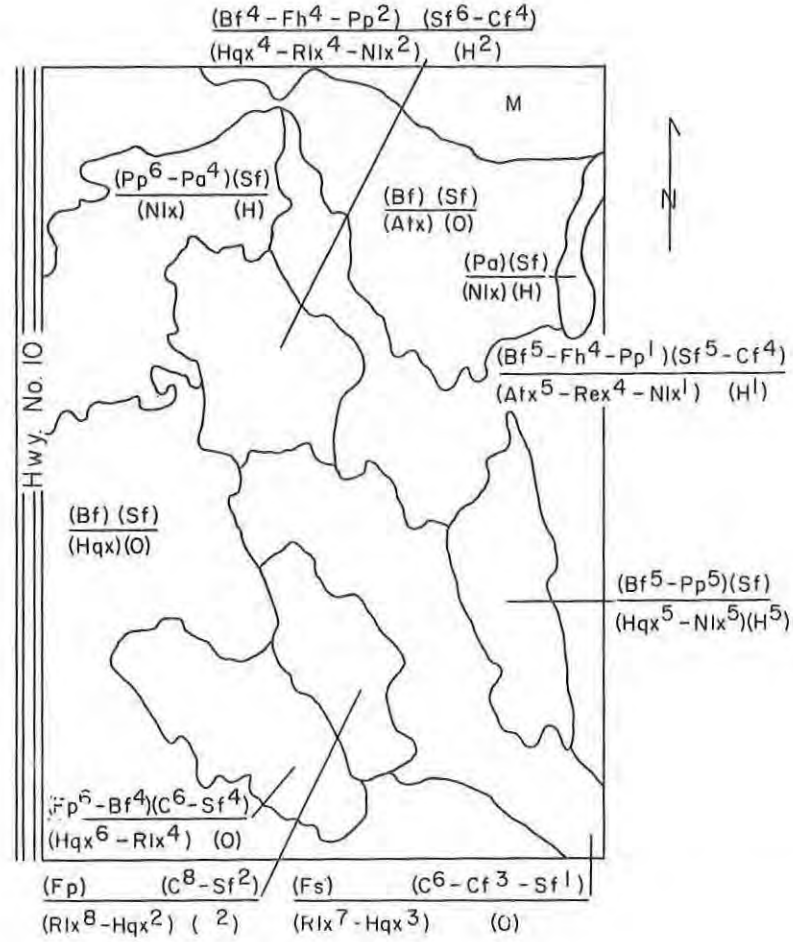


LEGEND

Landform		Parent Material	Drainage	Soil			Vegetation	
Map Symbol	Name			Soil Complex	Classification	Map Symbol	Vegetation Type	Map Symbol
Pp Pa	Peat Plateau Palsa	Deep to very deep perennially frozen forest peat or thin (<24") sphagnum peat overlying forest peat	Well to Imp.	Nekik Lake Complex	Mesic Organo Cryosol	Nlx	Black spruce-Feather moss Black spruce-Cladonia	Sf Sc
Bf	Flat Bog	16 to 52 inches of mesic forest peat or thin (<24") of sphagnum peat overlying forest peat	Poor	Atik Complex	Terric Fibric Mesisol* Terric Mesic Fibrisol Terric Mesisol	Akx	Black spruce-Feather moss	Sf
		Mesic forest peat greater than 52" or thin (<24") sphagnum peat overlying forest peat	Poor	Hargrave Complex	Typic Mesisol* Mesic Fibrisol	Hgx		
Fh Fp	Horizontal Fen Patterned Fen	12 to 52 inches of fen peat with little (<6") or no sphagnum peat	Very Poor	Reed Lake Complex	Terric Mesisol* Terric Fibric Mesisol	Rex	Carex Tamarack-Carex	C Cf
		Greater than 52" of fen peat with little (<6") or no sphagnum peat	Very Poor	Rock Island Complex	Typic Mesisol* Fibric Mesisol	Rlx		

Note: K Presence of permafrost
M Mineral soils
* Dominant soil

Figure 34. 1:60,000 scale (approximately 1 inch = 1 mile or 1 cm = 0.6 km) map showing a portion of the Cranberry Bog.

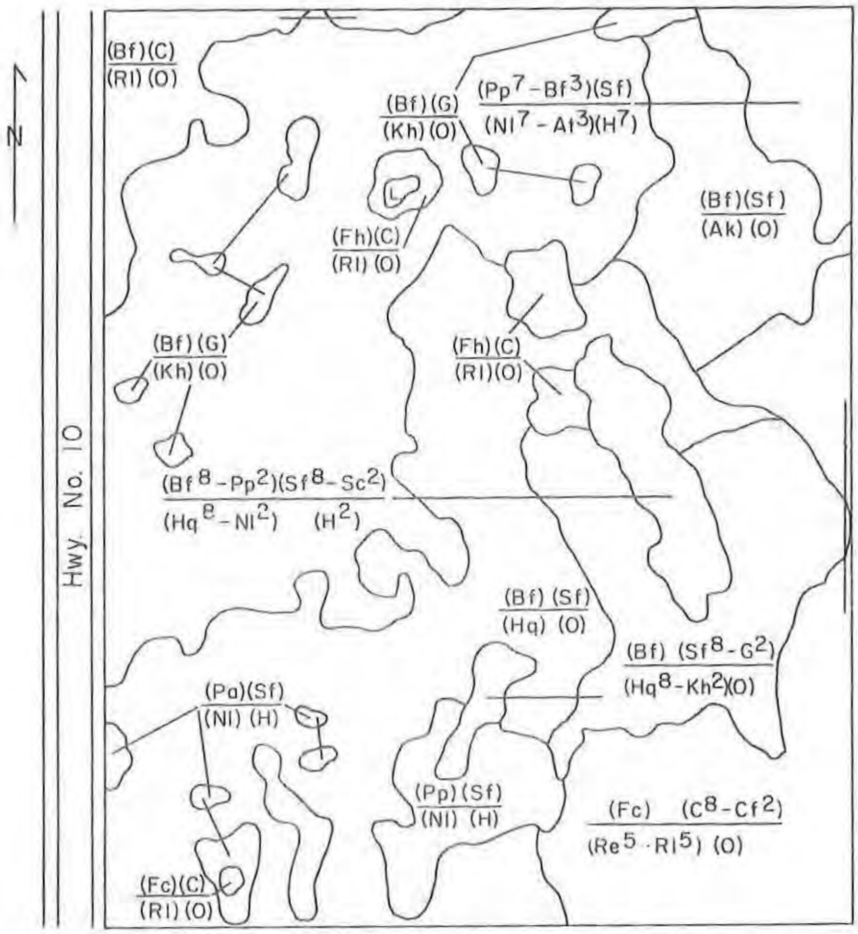


L E G E N D

Landform Map Symbol	Landform Name	Parent Material	Drainage	Soil Complex	Soil Classification	Soil Map Symbol	Vegetation Type	Vegetation Map Symbol
Fp Pa	Peat Plateau Palsa	Deep to very deep perennially frozen forest peat or thin (<24") sphagnum peat overlying forest peat	Well to Imp.	Nekik Lake Complex	Mesic Organo Cryosol	Nlx	Black spruce-Feather moss Black spruce-Cladonia	Sf Sc
Bf	Flat Bog	16 to 52 inches of mesic forest peat or thin (<24") of sphagnum peat over-lying forest peat	Poor	Atik Complex	Terric Fibric Mesisol* Terric Mesic Fibrisol Terric Mesisol	Akx	Black spruce-Feathermoss Black spruce-Feathermoss-Ledum	Sf Sl
		Mesic forest peat greater than 52" or thin (<24") sphagnum peat overlying forest peat	Poor	Hargrave Complex	Typic Mesisol* Mesic Fibrisol	Hgx		
Fh Fp	Horizontal Fen Patterned Fen	12 to 52 inches of fen peat with little (<6") or no sphagnum peat	Very Poor	Reed Lake Complex	Terric Mesisol* Terric Fibric Mesisol	Rex	Carex Tamarack-Carex	C Cf
Fs	Spring Fen	Greater than 52" of fen peat with little (<6") or no sphagnum peat	Very Poor	Rock Island Complex	Typic Mesisol* Fibric Mesisol	Rlx		

Note: O Indicating no permafrost
H Indicating high ice content permafrost
M Mineral soils
* Dominant soil

Figure 35. 1:16,000 scale (approximately 4 inches = 1 mile or 1 cm = 160 m) map showing a portion of the Cranberry Bog.



LEGEND

Landform		Parent Material	Drainage	Soil			Vegetation	
Map Symbol	Name			Soil Series	Classification	Map Symbol	Vegetation Type	Map Symbol
Pp Pa	Peat Plateau Palsa	Deep to very deep perennially frozen forest peat or thin (<24") sphagnum peat overlying forest peat	Well to Imp.	Nekik Lake Series	Mesic Organo Cryosol	Nl	Black spruce-Feathermoss Black spruce-Cladonia	Sf Sc
Bf	Flat Bog	16 to 52 inches of mesic peat or thin (<24") of sphagnum peat overlying forest peat	Poor	Atik Series	Terric Fibric Mesisol	Ak	Black spruce-Feathermoss Black spruce-Feathermoss-Ledum	Sf Sl
		Mesic forest peat greater than 52" or thin (<24") sphagnum peat overlying forest peat	Poor	Hargrave Series	Terric Mesisol	Hg		
		Greater than 36 inches of fibric sphagnum peat, underlain by significant layer or layers of forest and fen peat	Poor	Kiskitto Series	Mesic Fibrisol	Kh	Treeless-sphagnum	G
Fh Fp	Horizontal Fen Patterned Fen	12 to 52 inches of fen peat with little (<6") or no sphagnum peat	Very Poor	Reed Lake Series	Terric Mesisol	Re	Carex Tamarack-Carex	C Cf
Fs Fc	Spring Fen Collapse Scar	Greater than 52" of fen or mixed peat with little (<6") or no sphagnum peat	Very Poor	Rock Island Series	Typic Mesisol	Rl		

Note: O Indicating no permafrost
H Indicating high ice content permafrost
M Mineral soils

Figure 36. 1:7,000 scale (approximately 9 inches = 1 mile or 1 cm = 70 m) map showing a portion of the Cranberry Bog.

LEGEND

Landform Map Symbol	Landform Name	Parent Material	Drainage	Soil Series	Soil Classification	Soil Map Symbol	Vegetation Type	Vegetation Map Symbol
Pp	Wooded Peat Plateau	Deep to very deep perennially frozen forest peat or thin (<24") sphagnum peat overlying forest peat	Well to Imp.	Nekik Lake Series	Mesic Organo Cryosol	Nl	Black spruce-Feathermoss Black spruce-Cladonia	Sf Sc
				Nekik Lake Series sphagnic phase	Mesic Organo Cryosol	Nls		
	Sphagnum Peat Plateau	Deep to very deep perennially frozen sphagnum peat overlying forest and/or fen peat	Imp.	Cormorant Lake Series	Fibric Organo Cryosol	Cm	Treeless Sphagnum	G
Pa	Wooded Palsa	Deep to very deep perennially frozen forest peat	Well to Imp.	Nekik Lake Series	Mesic Organo Cryosol	Nl	Black spruce-Feathermoss	Sf
Bf	Flat Bog	Greater than 36" of sphagnum peat, underlain by a significant layer or layers of forest and fen peat	Poor	Kiskitto Series	Mesic Fibrisol	Kh	Treeless Sphagnum	G
Bf	Flat Bog	24 to 64 inches of fibric sphagnum peat, which may be underlain by significant amounts of forest or fen peat	Poor	Chocolate Series	Terric Mesic Fibrisol	Ch	Treeless Sphagnum	G
Fh	Horizontal Fen	Greater than 52" of fen or mixed peat with little or no sphagnum peat	Very Poor	Rock Island Series	Typic Mesisol	Rl	Carex	C
Fc	Collapse Scar							

Note: O Indicating no permafrost
H Indicating high ice content permafrost

Figure 37. 1:800 scale (approximately 1 cm = 8 m) map showing peat plateau palsa area of the Cranberry Bog.

LEGEND

Landform		Parent Material	Drainage	Soil			Vegetation	
Map Symbol	Name			Soil Series	Classification	Map Symbol	Vegetation Type	Map Symbol
Pp	Wooded Peat Plateau	Deep to very deep perennially frozen forest peat or thin (<24") sphagnum peat overlying forest peat	Well to Imp.	Nekik Lake Series	Mesic Organo Cryosol	Nl	Black spruce-Feathermoss Black spruce-Cladonia	Sf Sc
				Nekik Lake Series sphagnic phase	Mesic Organo Cryosol	Nls		
	Sphagnum Peat Plateau	Deep to very deep perennially frozen sphagnum peat over-lying forest and/or fen peat	Imp.	Cormorant Lake Series	Fibric Organo Cryosol	Cm	Treeless Sphagnum	G
Pa	Wooded Palsa	Deep to very deep perennially frozen forest peat	Well to Imp.	Nekik Lake Series	Mesic Organo Cryosol	Nl	Black spruce-Feathermoss	Sf
Bf	Flat Bog	Greater than 36" of sphagnum peat, under-lain by a significant layer or layers of forest and fen peat	Poor	Kiskitto Series	Mesic Fibrisol	Kh	Treeless Sphagnum	G
Bf	Flat Bog	24 to 64 inches of fibric sphagnum peat, which may be under-lain by significant amounts of forest or fen peat	Poor	Chocolate Series	Terric Mesic Fibrisol	Ch	Treeless Sphagnum	G
Fh Fc	Horizontal Fen Collapse Scar	Greater than 52" of fen or mixed peat with little or no sphagnum peat	Very Poor	Rock Island Series	Typic Mesisol	Rl	Carex	C

Note: O Indicating no permafrost
H Indicating high ice content permafrost

L E G E N D

Landform		Parent Material	Drainage	Soil			Vegetation	
Map Symbol	Name			Soil Complex	Classification	Map Symbol	Vegetation Type	Map Symbol
Pp Pa	Peat Plateau Palsa	Deep to very deep perennially frozen forest peat or thin (<24") sphagnum peat overlying forest peat	Well to Imp.	Nekik Lake Complex	Mesic Organo Cryosol	Nlx	Black spruce-Feather moss Black spruce-Cladonia	Sf Sc
Bf	Flat Bog	16 to 52 inches of mesic forest peat or thin (<24") of sphagnum peat overlying forest peat	Poor	Atik Complex	Terric Fibric Mesisol* Terric Mesic Fibrisol Terric Mesisol	Akx	Black spruce-Feathermoss Black spruce-Feathermoss-Ledum	Sf Sl
		Mesic forest peat greater than 52" or thin (<24") sphagnum peat overlying forest peat	Poor	Hargrave Complex	Typic Mesisol* Mesic Fibrisol	Hgx		
Fh Fp	Horizontal Fen Patterned Fen	12 to 52 inches of fen peat with little (<6") or no sphagnum peat	Very Poor	Reed Lake Complex	Terric Mesisol* Terric Fibric Mesisol	Rex	Carex Tamarack-Carex	C Cf
Fs	Spring Fen	Greater than 52" of fen peat with little (<6") or no sphagnum peat	Very Poor	Rock Island Complex	Typic Mesisol* Fibric Mesisol	Rlx		

Note: O Indicating no permafrost
H Indicating high ice content permafrost
M Mineral soils
* Dominant soil

LEGEND

Landform Map Symbol	Landform Name	Parent Material	Drainage	Soil Complex	Soil Classification	Soil Map Symbol	Vegetation Type	Vegetation Map Symbol
Pp Pa	Peat Plateau Palsa	Deep to very deep perennially frozen forest peat or thin (<24") sphagnum peat overlying forest peat	Well to Imp.	Nekik Lake Complex	Mesic Organo Cryosol	Nlx	Black spruce-Feather moss Black spruce-Cladonia	Sf Sc
Bf	Flat Bog	16 to 52 inches of mesic forest peat or thin (<24") of sphagnum peat overlying forest peat	Poor	Atik Complex	Terric Fibric Mesisol* Terric Mesic Fibrisol Terric Mesisol	Akx	Black spruce-Feather moss	Sf
		Mesic forest peat greater than 52" or thin (<24") sphagnum peat overlying forest peat	Poor	Hargrave Complex	Typic Mesisol* Mesic Fibrisol	Hgx		
Fh Fp	Horizontal Fen Patterned Fen	12 to 52 inches of fen peat with little (<6") or no sphagnum peat	Very Poor	Reed Lake Complex	Terric Mesisol* Terric Fibric Mesisol	Rex	Carex Tamarack-Carex	C Cf
		Greater than 52" of fen peat with little (<6") or no sphagnum peat	Very Poor	Rock Island Complex	Typic Mesisol* Fibric Mesisol	Rlx		

Note: K Presence of permafrost
M Mineral soils
* Dominant soil

LEGEND

Landform		Parent Material	Ecoregion	Drainage (deciles)	Dominant Soil		Dominant Vegetation	
Map Symbol	Name				Classification	Map Symbol Association	Vegetation Group	Map Symbol
B	Bog	Dominantly forest and/ or sphagnum peat underlain by fen peat.	IV	Well to Imperfect (3)	Organo Cryosol (Mesic Organo Cryosol)	A	Black spruce forest	S
				Poor (7)	Mesisol (Terric Fibric Mesisol and Typic Mesisol)			
F	Fen	Dominantly fen peat.	IV	Poor to Very Poor	Mesisol (Typic Mesisol)	R	Carex Tamarack forest	C T

Note: + Second named unit is 10-20% of total unit area
/ Second or third unit is 20-50% of total unit area
K Presence of permafrost
M Mineral soils

L E G E N D

Landform		Parent Material	Ecoregion	Drainage	Dominant Soil			Dominant Vegetation	
Map Symbol	Name				Soil Complex	Classification	Map Symbol	Vegetation Complex	Map Symbol
Bdp	Domed and Plateau Bog	Deep to very deep perennially frozen forest peat or thin sphagnum peat overlying forest peat	IV	Well to Imp.	Nekik Lake Complex	Mesic Organo Cryosol	Nlx	Black spruce-Feather moss, Black spruce-Cladonia Complex	Bs
Bf	Flat Bog	16 to 52 inches of mesic forest peat or thin (<24") of sphagnum peat overlying forest peat	IV	Poor	Atik Complex	Terric Fibric Mesisol* Terric Mesic Fibrisol Terric Mesisol	Akx	Black spruce-Feather moss, Black spruce-Feather moss-Ledum, Treeless sphagnum complex	Bf
		Mesic forest peat greater than 52" or thin (<24") sphagnum peat overlying forest peat	IV	Poor	Hargrave Complex	Typic Mesisol* Mesic Fibrisol	Hgx	Same as above	Bf
Fhps	Horizontal Fen Patterned Fen Spring Fen Complex	Greater than 52" of mesic fen peat with little (<6") or no sphagnum peat	IV	Very Poor	Rock Island Complex	Typic Mesisol* Fibric Mesisol	Rlx	Carex, Tamarack-Carex Complex	C

Note: K Presence of permafrost
M Mineral soils
* Dominant soil

LEGEND

Landform Map Symbol	Landform Name	Parent Material	Drainage	Soil Series	Soil Classification	Soil Map Symbol	Vegetation Type	Vegetation Map Symbol
Pp Pa	Peat Plateau Palsa	Deep to very deep perennially frozen forest peat or thin (<24") sphagnum peat overlying forest peat	Well to Imp.	Nekik Lake Series	Mesic Organo Cryosol	Nl	Black spruce-Feathermoss Black spruce-Cladonia	Sf Sc
Bf	Flat Bog	16 to 52 inches of mesic peat or thin (<24") of sphagnum peat overlying forest peat	Poor	Atik Series	Terric Fibric Mesisol	Ak	Black spruce-Feathermoss Black spruce-Feathermoss-Ledum	Sf Sl
		Mesic forest peat greater than 52" or thin (<24") sphagnum peat overlying forest peat	Poor	Hargrave Series	Terric Mesisol	Hg		
		Greater than 36 inches of fibric sphagnum peat, underlain by significant layer or layers of forest and fen peat	Poor	Kiskitto Series	Mesic Fibrisol	Kh	Treeless-sphagnum	G
Fh Fp	Horizontal Fen Patterned Fen	12 to 52 inches of fen peat with little (<6") or no sphagnum peat	Very Poor	Reed Lake Series	Terric Mesisol	Re	Carex Tamarack-Carex	C Cf
Fs Fc	Spring Fen Collapse Scar	Greater than 52" of fen or mixed peat with little (<6") or no sphagnum peat	Very Poor	Rock Island Series	Typic Mesisol	Rl		

Note: O Indicating no permafrost
H Indicating high ice content permafrost
M Mineral soils

Organic Soil Mapping Workshop and Field Tour

Evening Meeting Held at The Pas

June 6, 1974 8:30 PM

Attendance consisted of the entire group participating in the Workshop and the Tour. J.H. Day was Chairman of this meeting.

1. Assessment of the usefulness of Landforms as a mapping tool in organic terrain.

DISCUSSION

Veer - necessary to modify description or definition of landforms with respect to the vegetative parameters. They are not really plant associations and they will vary across the country with climatic changes.

Day - The associated soils are defined on the basis of climatic regions.

Dumanski - address ourselves to the philosophy of landforms as a mapping tool.

Nowland - are we concerned with 3 components? Is vegetation a part of the system (mapping) or adjacent to it?

Smith - Landform is defined in terms of features which are a part of it or influence their development.

Belair - necessary to define the vegetative association.

Nowland - question of interpretation of Fen vs Bog in the landform context as seen in one site on the Tour.

Tarnocai - peat materials are fen in origin, associated vegetation may be Transitional or Pure Bog, the landform incorporates everything.

MOVED BY J. Shields: That the system of mapping organic terrain as proposed by the Manitoba Soil Survey be used and evaluated by regional survey groups, subject to modification by the Region and that a review of these evaluations be initially the responsibility of a working group interested in organic soils and the final assessment given to the Landform Subcommittee.

Ammendment by Pettapiece - that the working group in their evaluation, be cognizant of the recommendations and approach published by the Wetland Subcommittee.

- John Day will act as Chairman of this Evaluation Group and cooperate with the Regions.

Dumanski - The evaluations, etc. should be complete by the end of 1974 in order to better relate to CanSIS.

Smith - Consider other inputs, say from Forestry.

Belair - the present work and membership is representative

Day - evaluators should consult with all other knowledgeable people in their area. We should draw on our own experience with a minimum of field work to make the evaluation. The major evaluation should come from outside the Great Plains. Therefore, B.C. Quebec, Ontario and the Maritimes must accept this responsibility.

Heringa - the approach is a step forward but it is phytosociological and we don't consistently use the various parameters all the time. More input is needed from plant ecologists.

Tarnocai - considers Landforms as a Tool to aid in mapping peatlands.

Heringa - need to indicate depth of organic material.

Belair - approach is not phytosociological. Its weakness for mapping is not the landform but the indication of vegetation at one site.

Day - scheduling of evaluation - a copy of the Wetland Classification will be circulated to all regions. The regions agreed to test approach in the field and to return evaluations to the Chairman by October 1, 1974.

2. Discussion on methods of mapping and showing data on maps and legends.

Shields - desirable to have a common approach with respect to scale and method of presentation of data.

Nowland - although uniformity of legends is important for correlation, the map symbol is very important: a five character complex symbol for the Avalon Survey could not go on the map for cartographic reasons. Simple map symbols mean a complex legend.

Smith - Tarnocai demonstrated that at different scales we cannot be rigid on symbol methodology.

Tarnocai - the main concern is to accept principle of including the 3 major components - how to show them can be left up to the regions.

Belair - vegetation should not be included in map symbol as it is not a stable parameter. It could go on the legend.

Tarnocai - The same principle applies to the mapping of mineral terrain. G.S.C. wants a vegetation input.

Belair - impossible to show vegetation for an individual landform as it has several drainage positions.

3. Discussion on Interpretations and Capability Ratings for Organic Soils for various uses.

Smith - should attempt to establish guidelines for the evaluation of organic soils for various uses.

Day - we have interpretation subcommittees of CSSC for Engineering, Biotic, Agriculture, etc. - each region must evaluate. Proposal to follow the approach taken at the U.S. National Task Force meeting at St. Paul in 1972, and report back in one year.

Dumanski - Suggestion of a workshop on Organic Soil Rating in lieu of a National C.S.S.C. meeting.

Day - testing of guidelines is needed.

Smith - circulate guidelines from the U.S. Task Force. They have already tested them; therefore, we want the results of the upcoming U.S. meeting on these guidelines in July, 1974.

Veer - climatic evaluation of organic terrain is essential to use. Some correlation is needed between climatic conditions in organic dominated terrain and the climate as evaluated in a region by existing Met. Stations

Baril - we need guidelines.

Mills - guidelines are available. Evaluation entails a certain amount of research and experimentation to determine the validity of the guidelines on a regional basis.

Day - mapping of Organic Terrain is necessary before we carry out evaluations of Interpretive Guidelines.
- for evaluation of organic soils for particular uses we consult with specialists from Forestry, Engineering, etc.
- Recommendation that evaluations for Agriculture could proceed by naming a Committee and Chairman for these interpretations.

Smith - This could fragment the problem. We need coordination of all effort for all interpretations for organic soils.

Day - This would be too much for one Chairman.

Hoffman - we must organize research projects to assess and evaluate schemes. Evaluation without testing by experimental design and measurement of productivity on various soil types means little.

Meeting adjourned.

List of Participants

P. Heringa	St. John's
C. Veer	Charlottetown
J-L Belair	Quebec
R. Baril	Quebec
B. Rochefort	Quebec
C. Acton	Guelph
D. Hoffman	Guelph
R. Smith	Winnipeg
C. Tarnocai	Winnipeg
G. Mills	Winnipeg
W. Michalyna	Winnipeg
L. Hopkins	Winnipeg
H. Veldhuis	Winnipeg
J. Ellis	Saskatoon
G. Padbury	Saskatoon
L. Knapik	Edmonton
W. Pettapiece	Edmonton
A. Twardy	Edmonton
H. Luttmerding	Kelowna
A. van Ryswyk	Kamloops
I. Sneddon	Vancouver
H. Finney	St. Paul, Minnesota
J. Shields	Ottawa
J. Nowland	Ottawa
J. Day	Ottawa
J. Dumanski	Ottawa