A Guide To Bio-physical Land Classification In Manitoba

February 1976

NORTHERN
RESOURCE
INFORMATION
PROGRAM

Dept. of Renewable Resources and Transportation Services
and
Canada—Manitoba Soil Survey

A GUIDE

TO

BIOPHYSICAL LAND CLASSIFICATION

IN MANITOBA

by

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Department of Renewable Resources and Transportation Services
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Northern Resource Information Program

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1.0 Introduction

During the last few decades resource development activities in northern Manitoba have increased to a great extent. Developments in the north are often in the form of large projects; the establishment of Thompson, a community which became in a few years the third largest population centre in the province, and the hydro-electric developments on the Nelson and Churchill Rivers are examples of the kind and magnitude of some recent northern projects. It is apparent that the effects these developments have on the environment and the people in the north will be great. It can be expected that similar projects will be proposed and very likely implemented in the north in the not too distant future.

To be able to plan for future developments, resource use planners require information about the resources and the environment. These requirements will not be the same for all resource use planners, but all will have a common need for some kind of basic information. This information relates to elements in the environment-landforms, climate, soils, permafrost, vegetation, water bodies - that form homogeneous or ecologically significant land units which can be recognized and mapped. A system that classifies these land units is commonly referred to as a bio-physical land classification.

Recognizing a need for certain kinds of basic resource data in the planning process, the Manitoba Department of Mines, Resources and Environmental Management initiated the Northern Resources Information Program (NRIP) in 1974. The purpose of the Northern Resource Information Program is to provide data for resource use planners that will help them plan for the development of natural resources in a way that will benefit all Manitobans. This means generally the provision of data useful for macro scale planning, although the data may be in some instances sufficient for limited micro scale planning. However, because of the reconnaissance nature of the program, usefulness of the data will be greatest when applied at a broad regional level. This means the data will be useful for planning for the development of renewable and non-renewable resources on a regional basis; for planning for industrial and community development, the protection of the environment, the development of infrastructure, etc.

During the first year of this program, a system of bio-physical classification was developed for northern Manitoba and a systematic survey initiated. The main objective of this survey is to classify approximately 150,000 sq. miles of Manitoba into ecologically significant land units. The outline of the NRIP area and the status of work done to date are shown in Figure 1.

The aim of this Guide is to assist those who are using NRIP bio-physical information; the Guide is intended to accompany the maps and legends produced through the NRIP program. On completion of each new map and legend, the Guide will be updated to accommodate new data obtained from on-going surveys. In this way, the user will always be able to relate an individual map or group of maps to the updated Guide. Eventually, information contained in the Guide will help show relationships between all areas of the province, whether they be adjacent to, or far removed from each other.

Specifically, the Guide will:

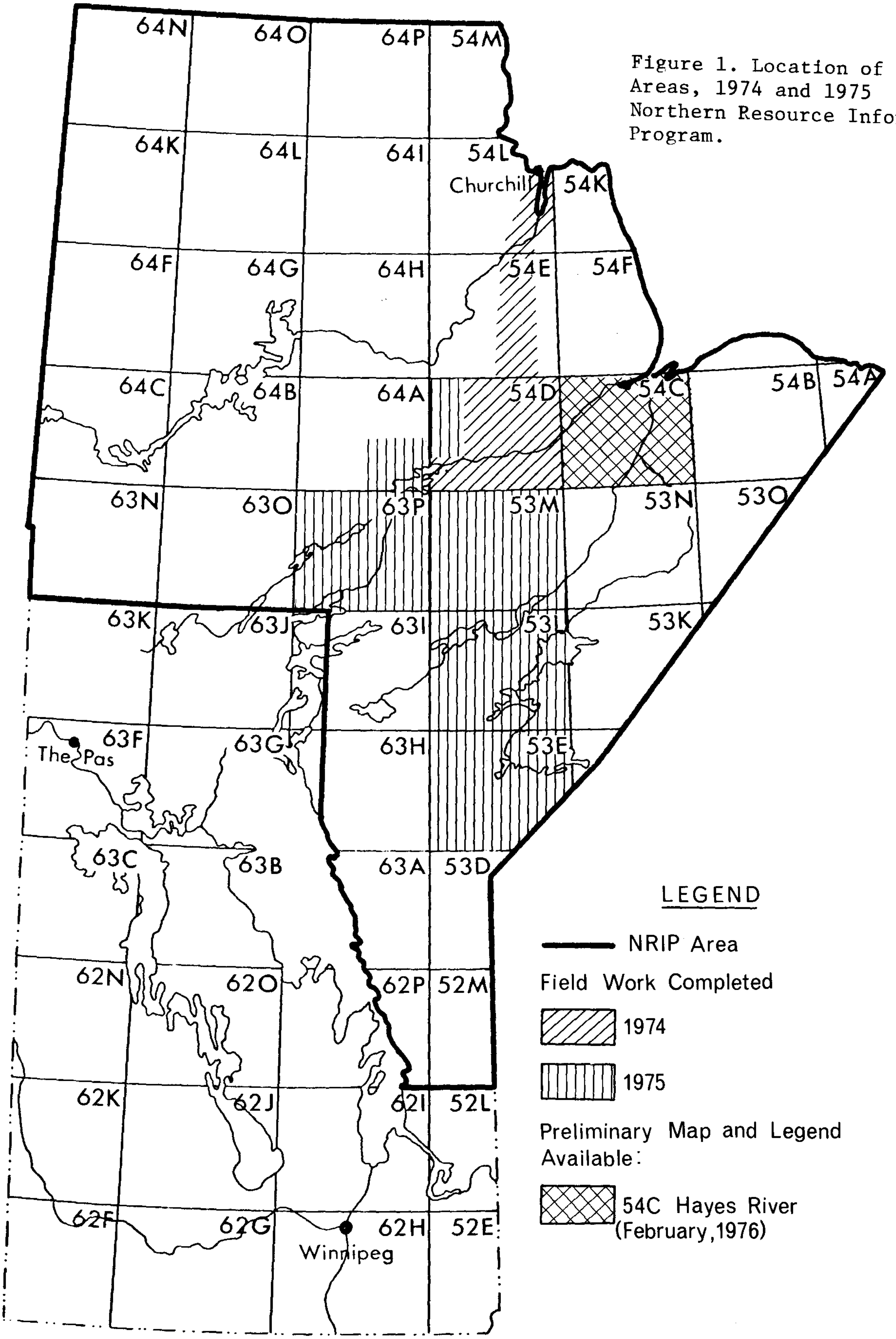
1. explain the concepts and rationale behind the bio-physical approach as currently applied in Manitoba
2. provide a summary of the major ecological and physical properties of those areas studied to date
3. define the concepts and terminology for understanding the bio-physical maps and legends.

2.0 Bio-physical Land Classification

2.1 Introduction

The objective of the present land classification, as with numerous other integrated ecological surveys, is to classify and map terrain in terms of landforms and surface deposits, vegetation, soils, drainage, permafrost, associated aquatic systems and climate. Such an inventory will provide an ecologically sound basis for making land use decisions concerning forestry, agriculture, recreation, wildlife, community development and hydrology.

Figure 1. Location of Project Areas, 1974 and 1975 Northern Resource Information Program.



2.2 Methodology

Previous work in Canada has led to the establishment of a relatively uniform methodology for carrying out bio-physical classifications. A hierarchy of four basic classification units was proposed and defined by Lacate (1969) for the systematic description of terrain:

Land Region: an area of land characterized by a distinctive regional climate as expressed by vegetation

Land District: an area of land characterized by a distinctive pattern of relief, geology, geomorphology and associated vegetation

Land System: an area of land throughout which there is a recurring pattern of landforms, soils and vegetation

Land Type: an area of land on a particular landform segment having a fairly homogeneous combination of soils and chronosequence (i.e. successional development) of vegetation.

The approach taken in Manitoba is patterned after that of Lacate but includes some modification in the definition of the Land Region. All four levels of classification have been used in the Manitoba approach. The basic product of our bio-physical classification is a map depicting Land Systems at a scale of 1:125,000. The ground truth and sampling carried out to produce the Land System map is collected at the Land Type level. Land System units, in turn, have been grouped into Land Districts on the basis of general physiographic features. However, Land Districts can also be considered as subdivisions of a Land Region. It is emphasized that the boundaries for Land Districts and Land Regions become really meaningful only after a study of inter-relationships in patterns of land types and land systems.

2.3 The Land Region - Concepts and Rationale

The concept of Land Region as utilized in the present studies has been broadened somewhat in definition from that given above. Broad regions of uniform climate are identified not only on the basis of vegetation, but also on trends in soil development and permafrost features.

For example, the High Subarctic Land Region in Manitoba is defined to include those conditions of regional climate which result in a particular pattern of forest cover interspersed with treeless areas of Tundra, i.e. Forest-Tundra transition. This Land Region further exhibits permafrost conditions which are characteristic of the Continuous Permafrost Zone, i.e. depth, distribution and surface expression. The presence of permafrost in the soils of this region is associated with processes and properties which are a consequence of cold temperatures. Climate and, particularly, temperature, therefore, are major factors governing the development of the soils of this region. Thus, soil development, as it reflects climate, becomes a useful criterion for defining the Region.

An ecological description of extensive land areas must incorporate regional variations in climate; however, climatic information needed to classify such regions does not exist for the most part. In addition, we do not always know which climatic parameters have the greatest influence and are most significant to the ecology of an area or to potential land use developments. Because meteorological data can only show trends or gradients, the critical values or ecological thresholds can only be determined through knowledge of climate-vegetation-soil relationships. Existing climatic data serve only to corroborate to a certain extent the validity of the regional division but cannot define or identify them.

The degree of climatic uniformity observable in a Land Region favours the development of similar ecosystems on material having similar properties. For example, similar physiographic sites (i.e. those having the same landform, slope, parent soil material and drainage characteristics) may occur in several climatic regions. Within a region, these sites will support the same vegetation communities, but in other regions vegetation on the sites will be different. Thus, beach ridges in an Arctic Land Region support low growing shrubs and forbs, whereas beaches in the Boreal Region usually have dense growth of black spruce or jack-pine. Soils display similar trends, as the kind and development of soil profiles vary from region to region on similar physiographic sites. The depth of the thawed layer, and the form and kind of surface expression of permafrost also vary on similar sites between regions but remain relatively constant on comparable sites within a region (Zoltai, 1973). Land Regions, therefore, describe broad areas where one can expect to find the same kinds of vegetation and soil associations on similar sites.

Because climatic change from region to region has such importance to the ecology of an area, the Land Region is useful for establishing soil series and associations. The soils of each Land Region are associated with a range of climatic parameters which influence not only the thermal regime of the soil but also the various biological and physical activities involved in the processes of soil development. Soils developed on similar parent materials and drainage conditions but in different Land Regions are given different names according to the Land Region in which they occur to indicate that many of the associated ecologic conditions are dissimilar.

When considering Land Region differences, one should realize that regional boundaries indicate where significant ecologic changes are taking place, often over a transitional zone. A boundary occurs where change in the climate-soil-vegetation conditions appear to be most pronounced or significant when compared to adjacent areas. A line drawn in this way is only an approximation of where the majority of changes occur and there are many local variations which become obvious when mapping a smaller area in more detail (e.g. an NTS map sheet). For this reason, a particular soil name or vegetation type may be applied in two adjacent Land Regions when site conditions are similar in these regions. This situation usually occurs only within a limited area on either side of a Land Region boundary; as distance from the boundary line increases, climatic change is sufficient to produce major, significant differences in similar site condition.

3.0 Land Regions and Land Districts (Summary - February, 1976)

3.1 Introduction

The Land Region descriptions presented in this section provide a general overview of the climate and related biophysical conditions in northern Manitoba. The delineation and characterization of the Land Regions is based on review of existing information on climate, vegetation, soils and permafrost as well as data collected during the current biophysical survey. Boundaries and descriptions of the Land Regions are obviously defined more precisely where they cross map areas in which detailed field work has been carried out. Land Region descriptions for those areas not yet studied in detail are based on incomplete data and will be subject to revision as new information is gained from the biophysical inventory.

The Land District descriptions in this overview are specific only to those map areas in which field work is complete and biophysical information is portrayed at the Land System level. We intend by means of this overview to provide updated information for all Land Districts that are established as the biophysical inventory proceeds.

The updated Land Region and Land District descriptions provide a framework enabling biophysical information gathered for a particular map area to be related to other areas of the province. This framework will also provide background information of a generalized nature for the eventual publication of wildlife and water studies related to the biophysical classification.

3.2 Land Regions

The Land Regions shown in Figure 2 are delineated on the basis of dominant soil, vegetation and permafrost conditions occurring over large areas. Because the major changes in dominant soil, vegetation and permafrost conditions of a Region are related to climate, there is an orderly zonation from south to north. Zonation is complicated by the presence of local features such as large water bodies, valleys, extensive organic plains and north-south trending ridges. Some of these features favor development of soil-vegetation associations typical of adjacent Land Regions. Such atypical "outlier" associations were considered too small or insig-

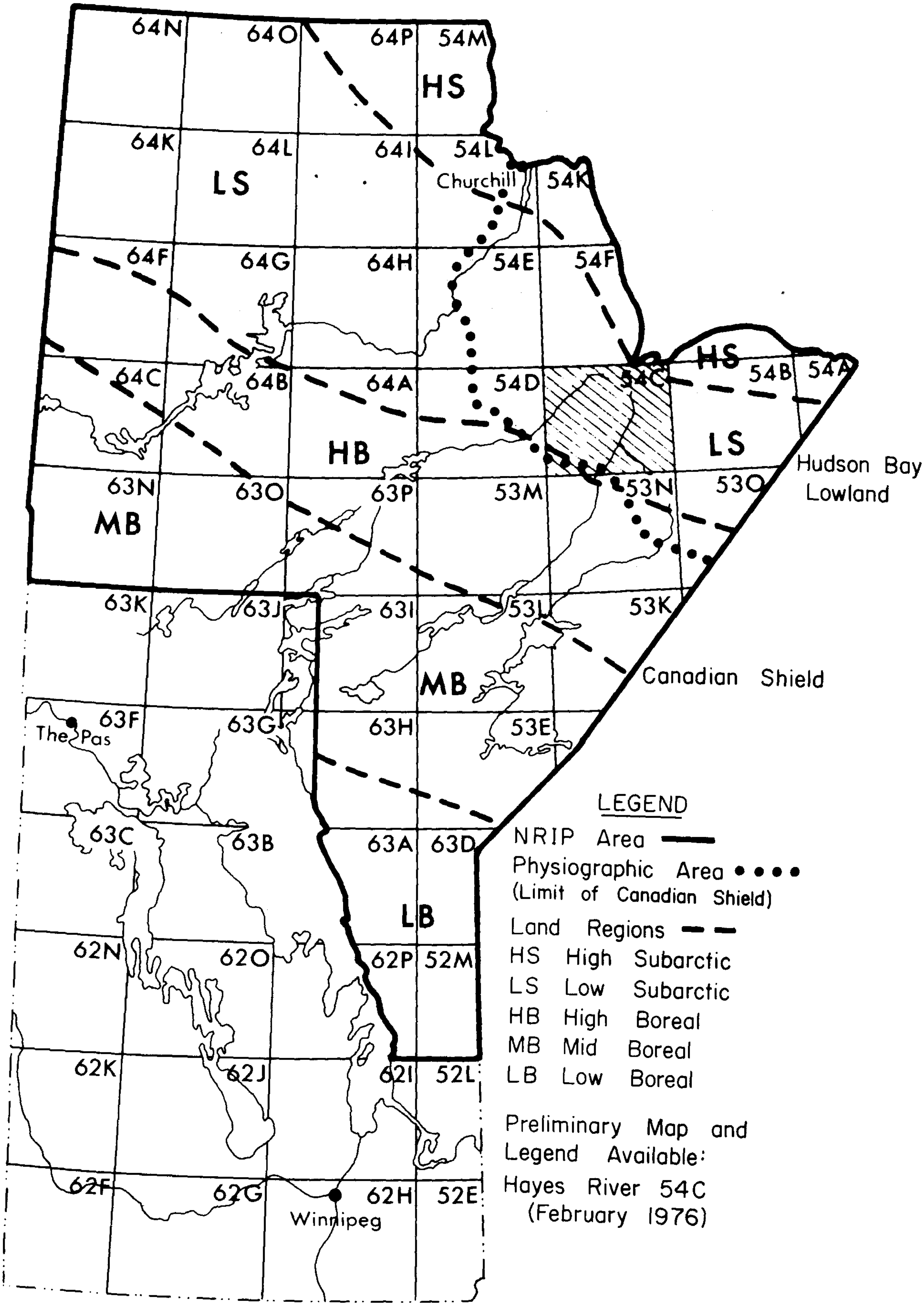


Figure 2. Land Regions in Northern Manitoba.

nificant to be delineated separately, but their presence should be recognized.

In order to compare the Land Regions in the study area, a tentative summary of some of their biophysical properties is presented in Table 1. Pertinent weather data for the Land Regions are summarized in Table 2 and vegetation characteristics are summarized in Table 3. The broad vegetation zonation is after Rowe (1972); permafrost regime has been defined by Brown (1970), and the soil characteristics are derived from exploratory surveys carried out by the Canada-Manitoba Soil Survey. An attempt has been made to describe the stable vegetation according to soil and soil moisture conditions. Local physiographic (site) conditions may change the local climate and hence vegetation development. Such conditions occur on steep south-facing slopes in protected valleys which may make the site warmer, or on north-facing slopes, exposed ridges, snow accumulation areas and in frost pockets, any of which may make the site colder. Sites which are not so influenced may be called normal or mesic, as the vegetation on them expresses the normal effect of the regional climate (Hills, 1960).

3.3 Land Districts

Six Land Districts are delineated and described to date; one in the High Subarctic Land Region, four in the Low Subarctic Land Region and one in the High Boreal Land Region. The location of the Land Districts is shown on the Bio-Physical Land Classification of the Hayes River area (accompanying map) and on Figure 3. The major physiographic, soil and hydrologic characteristics of each district are summarized in Table 4.

4.0 Land Systems

The basic document of the biophysical land classification is the map and legend depicting Land Systems at a scale of 1:125,000. The boundaries of most map units are drawn initially on the basis of landform and related surface deposits. The surficial geology for the Hayes River map area was available from the Geological Survey of Canada (Klassen, R.W. and J.A. Netterville, 1971-74). The landform units are usually further refined in terms of topographic variation and patterns of soils, drainage condition

Table 1. Selected Biophysical Characteristics of Land Regions in Northern Manitoba

Land Region		Vegetation Zone[1]	Dominant Soils[2]	Organic Landforms	Regime[3]	Permafrost Characteristics	
Symbol	Name					Occurrence and Active Layer, cm	Pattern Ground and Degree of Disturbance
HS	High Sub-arctic	Forest-tundra transition	Brunisolic Static Cryosol Brunisolic Turbic Cryosol Organo Cryosol	Peat plateaus, palsas, minerotrophic palsas, peat polygons, fens	Continuous	Mineral soils: sand, non-frozen;loam, 40-100+ Organic soils: forest peat 40-60, fen peat, non-frozen	Hummocks, sorted polygons, circles, stripes, nets; very active on all materials in all landscape positions except well drained sands
LS	Low Sub-arctic	Open coniferous forest	Brunisolic Static Cryosol Brunisols, Luvisols Gleysolic Static Cryosol Organo Cryosol	Peat plateaus, palsas, bog veneer, fens	Discontinuous, widespread	Mineral soils: sand, non-frozen;loam, 40-100+; clay 30-100+ Organic soils: forest peat, 40-60, fen peat, non-frozen	Hummocks & mounds, very active in poorly drained depressions & lower slopes; scattered mounding and broad depressions on upper and mid slopes; all materials except sands
HB	High Boreal	Closed coniferous forest	Brunisols, Luvisols Gleysolic Cryosol Organo Cryosol	Peat plateaus, palsas, bog veneers, fens	Discontinous, southern fringe, (north)	Mineral soils: sand, loam & clay, non-frozen except for poorly drained loam & clay, 40-100+ Organic soils: forest peat, 60, fen peat, non-frozen	Some hummocks and mounds in poorly drained depressions and lower slopes; apex & upper slope generally free of cryoturbation
MB	Mid Boreal	Closed coniferous forest	Brunisols, Luvisols Gleysolic Static Cryosol Organo Cryosol	Peat plateaus, palsas, bog veneers, bog plateaus, blanket bog, fen	Discontinuous, southern fringe (south)	Mineral soils: non-frozen except for poorly drained clay, 40-100+ Organic soils: forest peat, 60-200, fen peat, non-frozen	Minor occurrence of mounds in depressions and on lower slopes
LB	Low Boreal	Mixed deciduous-coniferous forest	Brunisols, Luvisols, Gleysols, Organic	Bog plateau, flat bog, blanket bog, fens	Localized	Mineral soils :non-frozen. Organic soils: non-frozen except for local occurrence of relict frost at 100-200 cm in forest peat	Absent

1. Rowe, J.S. 1972. Forest Regions of Canada, Department of the Environment, Canadian Forestry Service, Publ. No. 1300.
Ritchie, J.C. 1962. A Geobotanical Survey of Northern Manitoba, Arctic Institute of Northern Manitoba, Technical Paper No. 9.

2. The System of Soil Classification for Canada. 1974. Revised. Canada Department of Agriculture, Publ. No. 1455.
Proc. of the Ninth Meeting of the Canada Soil Survey Committee, Univ. of Sask., Saskatoon. 1973. p. 346-358.

3. Brown, R.J.E. 1967b. "Permafrost in Canada" map Publ. by Div. of Bldg. Res., Nat. Res. Council (NRC 9769) and Geol. Surv. of Can. (Map 1246A).

Table 2. Climatic Characteristics of Land Regions in Northern Manitoba

Land Region		Mean Temperature, °C			Degree Days 5.5°C May 1-Sept. 30	Frost Free Days	Precipitation mm		Soil Moisture Deficit, mm
Sym-bol	Name	Ann.	Jan.	July			Ann.	May 1-Sept. 30	
HS	High Sub-arctic	-8.3 to -6.4	-30.9 to -26.1	11.1 to 16.0	>500	60 to 75	340 to 450	210 to 270	10 to 20
LS	Low Sub-arctic	-5.2 to -4.9	-29.1 to -27.5	14.1 to 14.9	500 to 700	70 to 80	415 to 560	265 to 360	20 to 40
HB	High Boreal	-4.9 to -4.1	-27.5 to -26.3	14.9 to 15.8	700 to 900	80 to 90	415 to 560	265 to 360	20 to 60
MB	Mid Boreal	-3.9 to -0.3	-26.4 to -21.8	15.1 to 18.3	900 to 1250	90 to 100	420 to 555	260 to 350	50 to 75
LB	Low Boreal	-1.0 to 1.7	-22.8 to -19.8	17.8 to 19.5	1300 to 1445	100 to 116	410 to 535	250 to 355	25 to 75

References:

1. Temperature and Precipitation normals, 1941-1970, Vol. 1 & 2. Atmospheric Environment Service, Environment Canada.

2. Frost Data, 1941-1970 by G.M. Hemmerick and G.R. Kendall. Atmospheric Environment Service, Environment Canada.

3. Economic Atlas of Manitoba (1960). T.R. Weir (Ed.), Manitoba Dept. of Industry and Commerce.

Table 3. Vegetation Characteristics of Land Regions in Northern Manitoba

Land Region Symbol	Land Region Name	Physiographic Area	Stable Vegetation Types: Normal Facies: Warmer-drier (south slopes, sand)	Normal Facies: Normal-mesic (level-moderate slopes)	Normal Facies: Cooler-wetter (north slopes, bottom lands)	Wet Facies: Impeded drainage (sloughs, kettles, marshes, organic plains)	Wet Facies: Lakeshore	Wet Facies: Alluvial (streamside)
HS	High Sub-arctic	Hudson Bay Lowland	Lichen tundra	Lichen tundra-heath	Lichen-moss tundra	Lichen heath palsas and polygonal peat plateaus/sedge cottongrass fens	Sedge-grass meadow/ larch-birch^{d} fens/ willow	Willow-birch^{d}-alder scrub
		Canadian Shield	Heath tundra-lichens-spruce^{b}	Heath tundra-lichens-birch^{d}	Willow-heath tundra	Lichen heath palsas and polygonal peat plateaus/sedge cottongrass fens	Rush-sedge meadows	Spruce^{w}/willow birch^{d}-alder scrub
LS	Low Sub-arctic	Hudson Bay Lowland	Spruce^{w} (jack-pine)	Open spruce^{b}-lichen-mosses	Spruce^{b}-lichen-larch-mosses	Open spruce^{b}-lichen- moss on palsas and peat plateau/ sedge-larch fens	Rush-grass meadow/ willow-alder	Spruce^{w}-poplar^{b}/willow-birch^{d}-alder scrub
		Canadian Shield	Spruce^{w} (jack-pine)	Open spruce^{b}-lichens	Open spruce^{b}-lichen moss	Spruce^{b}-larch bogs/spruce^{b}-lichen-moss peat plateau and palsa/sedge-larch cottongrass fens	Sedge meadow	Spruce^{w}/willow-birch^{d}-alder
HB	High Boreal	Hudson Bay Lowland	Spruce^{b} (jack-pine, poplar^{w})	Spruce^{b}-mosses (jackpine)	Spruce^{b}-mosses	Spruce^{b}-larch sphagnum bogs/ spruce^{b}-lichen-moss peat plateau/sedge-larch-birch^{d} fens	Sedge meadow	Spruce^{w}/willow birch^{d}/alder
		Canadian Shield	Spruce^{b} (jack-pine, poplar^{w}, birch^{w})	Spruce^{b} (jack-pine, poplar^{w}, birch^{w})	Spruce^{b}-mosses	Spruce^{b}-larch-sphagnum bogs/ spruce^{b}-lichen-moss peat plateau/sedge-larch-birch^{d} fens	Sedge meadow	Spruce^{w}/willow birch^{d}-alder
MB	Mid Boreal	Canadian Shield	Open spruce^{w}-fir^{b}-poplar^{w} (jackpine)	Spruce^{b}-fir^{b}-mosses	Spruce^{b}-mosses	Spruce^{b}-larch-moss bogs (bog veneer, plateau bogs, sloping bog, patterned fen) Spruce^{b}-birch^{w} palsas and peat plateau	Rush-sedge meadow	Sedge-grass meadow
LB	Low Boreal	Canadian Shield	Poplar^{w}-birch^{w} (jackpine)	Spruce^{w}-poplar^{w}-fir^{b}-birch^{w}	Spruce^{b}-poplar^{w}-birch^{w}	Spruce^{b}-larch bogs	Sedge-rush meadow	Spruce^{w}-poplar^{b}

- = associated species or groups of plants

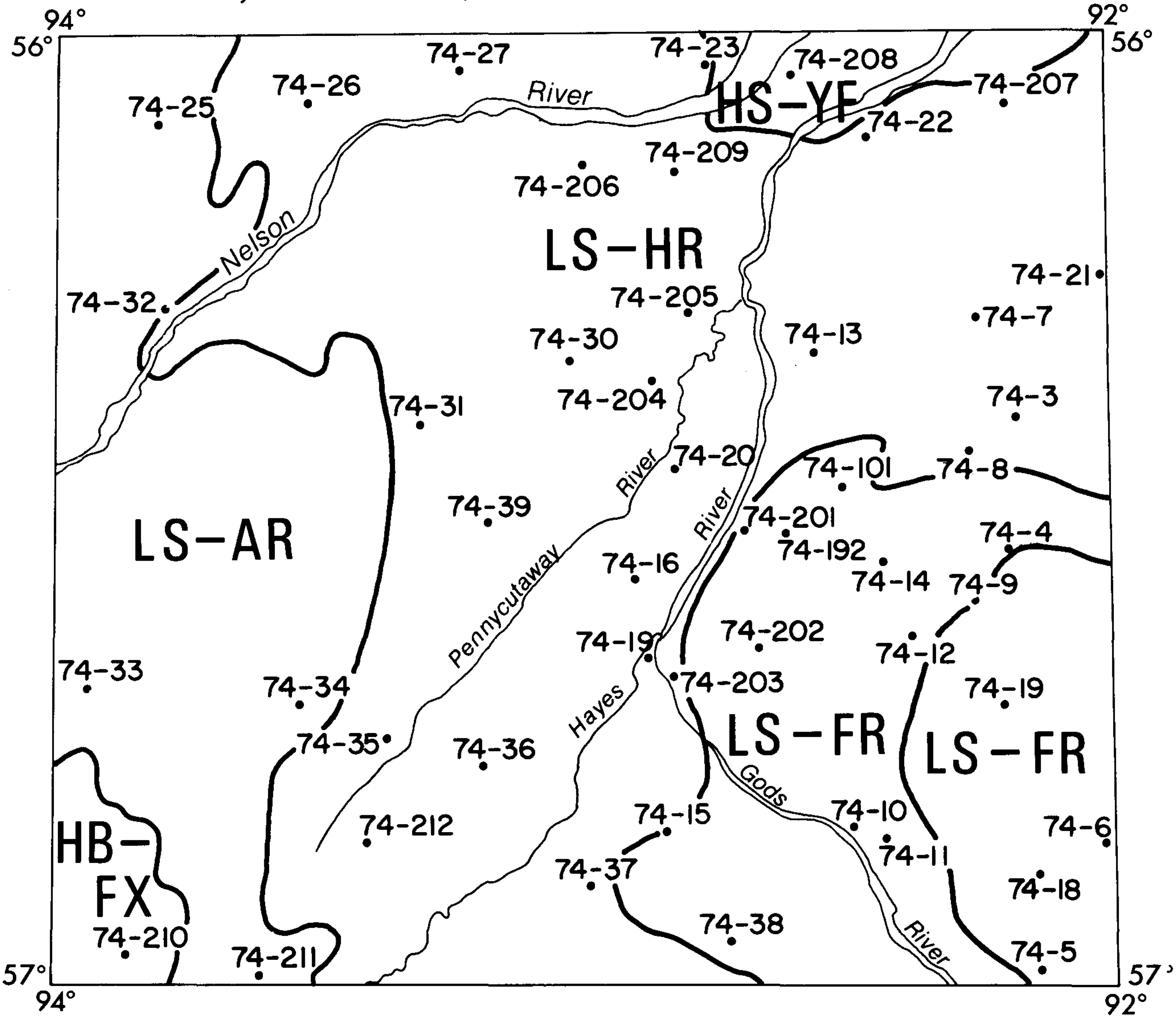
/ = different communities in same region

(= successional communities

DOMINANT PLANT SPECIES

Common Name	Symbol	Scientific Name
Alder		*Alnus crispa*
Birch, Dwarf	birch^{d}	*Betula glandulosa*
Birch, White or Paper	birch^{w}	*Betula papyrifera*
Cottongrass		*Eriophorum* spp.
Heath	He	Various ericaceous shrubs, including species of *Vaccinium*, *Arctostaphylos*, & *Kalmia*
Fir	fir^{b}	*Abies balsamifera*
Larch	larch	*Larix laricina*
Lichens	lichens	Many species
Mosses	mosses	Many species
Pine, Jack	pine^{j}	*Pinus banksiana*
Poplar, Balsam	poplar^{b}	*Populus balsamifera*
Poplar, white (aspen)	poplar^{w}	*Populus tremuloides*
Sphagnum		*Sphagnum* spp.
Spruce, Black	spruce^{b}	*Picea mariana*
Spruce, White	spruce^{w}	*Picea glauca*
Willow	willow	*Salix* spp.

Figure 3. Land Districts and Location of Groundtruth Sites in the Hayes River Map Area.



Land Regions: HS High Subarctic
LS Low Subarctic
HB High Boreal

Land Districts: AR Angling River
FR French River
FX Fox River
HR Hayes River
WC Wigwam Creek
YF York Factory

Table 4

LAND DISTRICTS OF THE HAYES RIVER MAP AREA (54C)

Land District		Physiographic Characteristics			Soil Type		Drainage and Hydrologic Characteristics
Symbol	Name	Elevation meters a.s.l.	Mineral Surficial Materials	Topography and Landforms	Dominant	Sub-dominant	
AR	Angling River	90-120	Thin, discontinuous VFSL-SiL marine sediments overlying eroded, stony loam textured till	Extensive level to depressional organic plains, area south of Nelson River contains many lake-filled depressions oriented in NE-SW direction; horizontal and patterned fens, peat plateaus and palsas. The Nelson River has eroded a U-shaped valley some 30 m below surface of District. Minor marine beaches of moderate relief occur on eastern edge of District at approximately 90 m a.s.l.	Typic Mesisol Cryic Mesisol Eutric Brunisol	Hydric Mesisol Rego Gleysol	Dominantly very poorly drained, poor stream development, sub-parallel pattern; portions of Nelson, Hayes and Owl River Watersheds. Impeded drainage behind beach ridges perpendicular to fall of land
FR	French River	75-120	Thin discontinuous VFSL-SiL marine sediments overlying eroded, stony loam textured till; stony water-worked and eroded till	Extensive level organic plains dissected in the south by the deep U-shaped valley of the Gods River; peat plateaus & horizontal fens. Subdued NW-SE trending drumlinized terrain occurs south of the Gods River. A major complex of low linear marine beaches marks the northerly extent of District at approximately 90 m a.s.l.	Typic Mesisol Cryic Mesisol Eutric Brunisol Eutric Brunisol	Rego Gleysol	Dominantly very poorly drained except in drumlinized terrain; weak stream development, sub-parallel pattern; numerous elongate lake-filled depressions; drainage impeded by beach ridges perpendicular to fall of land
FX	Fox River	120-135	Water-worked and eroded loam textured till; minor lacustrine and/or marine deposition in depressional areas	Extensive level organic plains dominated by peat plateau-fen complexes; level terrain broken by few narrow & meandering stream channels. District boundary marked by low, narrow marine beach ridges at lower elevations	Terric Mesisol Cryic Mesisol Eutric Brunisol		Dominantly very poorly drained, better drainage adjacent to stream channels, minimal stream development
HR	Hayes River	15-90	Thin, continuous VFSL-SiL marine veneer underlain by water-worked loam textured till; deepest marine sediments occur near major river valleys	Extensive, level to depressional organic plains; broken by deep U-shaped valleys of the Gods, Hayes & Nelson Rivers. U-shaped valleys contain alluvial sands and gravels on terraces above present river level; also recent alluvium in minor areas along river banks and larger islands	Typic Mesisol Cryic Mesisol Eutric Brunisol Rego Gleysol	Hydric Mesisol Cumulo Regosol	Dominantly very poorly drained; much shallow open water in form of small lakes and fen pools; somewhat better drainage occurs adjacent to the many meandering streams
WC	Wigwam Creek	120->150	Water-worked & eroded, stony, loam textured till; minor amounts of thin marine deposits may occur in depressional areas & as low beach ridges at higher elevations	Extensive level organic plains characterized by peat plateau-fen complexes. Lower elevational limits of District marked by complexes of many long narrow marine beach ridges. Low lying drumlins characterize the terrain above the 150 m contour with a gently undulating NE-SW oriented ridge and swale topography.	Typic Mesisol Cryic Mesisol Eutric Brunisol Eutric Brunisol Rego Gleysol	Terric Mesisol	Dominantly very poorly drained in organic plains; drainage by few small streams, at times impeded by NE-SW drumlin pattern; drainage better in undulating topography above 150 m elevation.
YF	York Factory	0-15	Thin continuous VFSL-SiL marine veneer underlain by water-worked loam textured till; gravelly & sandy to silty alluvial sediments occur within the Hayes & Nelson River valleys.	Extensive level organic plains dominated by sparsely treed fens broken by peat plateaus oriented along buried marine strandlines. A narrow band of recent alluvium is associated with the river channels. Past flooding by the Hayes and Nelson Rivers has resulted in thin bands of alluvial deposition in the organic soils.	Terric Mesisol Hydric Mesisol Cumulo Mesisol Rego Gleysol Cumulo Mesisol	Cryic Mesisol Cumulo Regosol	Dominantly very poorly drained, water movement to the coast is impeded by buried marine beaches across the fall of the land.

and vegetation. Such characterization of the landform units is accomplished through a field program involving detailed descriptions of the soil, vegetation and topographic conditions on selected portions of a landform. These site descriptions generally apply to a landscape segment equivalent to a Land Type or a complex of Land Types. The location of the detailed site investigations in the Hayes River Map Area is shown on Figure 3.

5.0 Definition of Terms (Acton, 1975; Tarnocai, 1974; Flint, 1971)

GENETIC MINERAL LANDFORM CLASSES

ALLUVIAL (A): accumulation of material deposited during comparatively recent geologic time by a stream or other body of running water as a sorted or semi-sorted sediment in the bed of the stream or on its flood plain or delta, or as a cone or fen at the base of a mountain slope.

COLLUVIAL (C): accumulation of any loose, heterogenous and incoherent mass of material or rock fragments (variable mixture of boulder to clay) deposited chiefly by mass-wasting, usually at the base of a steep slope or cliff.

EOLIAN (E): accumulation of deposits (sand and silt) whose constituents were transported (blown) and laid down by atmospheric currents, or of deposits produced or eroded by the wind.

GLACIOFLUVIAL (G): pertaining to the outwash deposits and landforms, produced by meltwater streams associated with and flowing from wasting glacier ice. Such stratified sediments, depending on the depositional environment, are classed as ice contact deposits or outwash sediments.

Ice contact outwash includes kames, eskers and kame moraines deposited upon or immediately adjacent to glacier ice. In addition to a distinctive surface form, ice contact deposits are characterized by extreme range and abrupt changes in grain-size, inclusions of till bodies and marked deformation.

Outwash sediments include stratified materials, mainly well sorted sands and gravels deposited by streams usually in the form of fans, terraces and valley trains.

GLACIOLACUSTRINE (L): Materials deposited in glacial lakes; specifically, landforms and deposits composed of suspended materials transported by streams into lakes bordering a glacier which has since disappeared.

MORAINAL (M): accumulations of unsorted, unstratified glacial drift, predominantly till, deposited chiefly by the direct action of glacier ice in a variety of landforms that are primarily independent of control by the surface underlying the drift.

MARINE (W): Materials deposited in marine environments. These may form a blanket of deeper-water silts and clays, or occur as a series of marine nearshore features composed largely of gravels and sands and deposited as spits, bars and beaches.

UNDIFFERENTIATED (U): Deposits whose genesis cannot be determined from the available evidence, or mixtures of deposits resulting from the interaction of several genetic processes.

BEDROCK CLASSES

ACIDIC (aR): igneous intrusive or extrusive bedrock having more than 66 percent SiO_2.

BASIC (bR): igneous intrusive or extrusive bedrock having less than 66 percent SiO_2.

BEDROCK (R): A general term for the rock, usually solid, that is exposed or underlies unconsolidated surficial material. Types of bedrock encountered are grouped into "acidic, basic or carbonatic" classes.

CARBONATIC (cR): Sedimentary rocks containing large amounts of calcite and other carbonate materials.

UNDIFFERENTIATED (uR): a bedrock material where differentiation into a specific class is impractical or impossible.

MORPHOLOGY AND SURFACE FORM CATEGORY

APRON (a): An extensive, continuous, gently sloping and blanket-like deposit of unconsolidated material derived from an identifiable source such as the edge of a large esker or along fault scarps.

BLANKET (b): an extensive area of relatively thick (>1 m) surface deposits which subdue but do not completely mask the configuration of the underlying bedrock or deposit.

DELTA ($\triangle$): usually a triangular shaped area composed of stratified materials (ranging from coarse to fine) deposited by streams into large bodies of water.

DRUMLINIZED (d): Elongated, smooth, streamlined ridges with long axes parallel to the direction of ice movement.

FAN (f): A gently sloping, fan-shaped mass of detritus forming a section of a very shallow cone, commonly at a place where there is a noticeable change in gradient.

HUMMOCKY (h): Terrain having a broken, irregular surface with distinct knobs or mounds and depressions.

KETTLED (k): An area of glacial drift pitted with numerous steep-sided, bowl- or basin-shaped depressions that often contain lakes; surface drainage is generally deranged.

PLAIN (p): An area of comparatively flat, smooth, and level land having few or no prominent surface irregularities, but sometimes having a considerable unit tilt.

RIDGED (r): Terrain characterized by long, narrow elevations which may occur independently or in parallel or intersecting patterns. Ridges usually have sharp crests and steep sides.

ROLLING (m) : Terrain having a smooth, regular surface with broad topographic lows and broad topographic highs. Slopes are usually more than 1 meter in length.

TERRACED (t): a long, narrow, relatively level or gently inclined surface bounded along one edge by a steeper descending slope and along the other by a steeper ascending slope; a large bench or step-like ledge breaking the continuity of a slope.

UNDULATING (u): Terrain having a smooth, regular surface with broad shallow topographic lows and broad medium to subdued topographic highs. Slopes are usually less than 0.5 miles in length.

VENEER (v): an extensive area of thin (<1 m) unconsolidated surficial deposits which mask little of the configuration of the underlying bedrock or deposits.

EROSIONAL MODIFIER

CHANNELED (c): Modification of a deposit or feature by the cutting of channels and removal of material from along local drainage ways.

DEFLATED (1): Modification by erosive action of wind.

DISSECTED (i): A network of gullies, ravines, valleys and remnant flat-topped interstream ridges formed by stream erosion acting on a relatively even topographic surface.

ERODED (e): The production or modification of a landform by the action of streams, waves or glaciers.

WASHED (w): Landforms which have been modified in some manner by wave action are said to be washed. The process results in the sorting of surface materials or the formation of scattered minor beaches.

TEXTURAL CATEGORY

Three categories of texture are utilized to describe the nature of the deposits associated with a landform. The texture classes within each category are estimated in terms of size and the distribution of primary particles. Significant inclusions of very coarse particles (gravel, cobbles and boulders) within a deposit are indicated by adding the term "skeletal" as a modifier to the symbol for a textural category.

PRIMARY PARTICLES

Name of Separate	Diameter, mm
Boulders, stones	>250
Cobbles	250-75
Gravel	75-2.0
Very coarse sand	2.0-1.0
Coarse sand	1.0-0.5
Medium sand	0.5-0.25
Fine sand	0.25-0.10
Very fine sand	0.10-0.05
Silt	0.05-0.002
Clay	Less than 0.002

BROAD TEXTURAL CATEGORIES

CLAYEY (c): material less than 2 mm contains 35% or more clay by weight and particles 2 mm to 25 cm size are less than 35% by volume.

Includes heavy clay loam, heavy silty clay loam, sandy clay, silty clay, clay and heavy clay.

FRAGMENTAL (f): gravel, cobbles and boulders (2 mm to more than 25 cm) containing too little fine materials to fill the spaces larger than 1 mm.

LOAMY (l): material less than 2 mm contains less than 35% clay by weight and includes coarser materials up to very fine sand size. Particles of 2 mm to 25 cm size are less than 35% by volume.

Includes 2 main groups of texture:

(1) Light (less than 18% clay by weight):
sandy loam, fine sandy loam, loam, very fine sandy loam, loamy very fine sand, loam, silt loam, silt.

(2) Heavy (18-35% clay by weight):
sandy loam, fine sandy loam, loam, very fine sandy loam, silt loam, sandy clay loam, clay loam, silty clay loam.

SANDY (s): material less than 2 mm contains less than 18% clay and more than 70% sand exclusive of loamy very fine sand and very fine sand. Particles of 2 mm to 25 cm size are less than 35% by volume.

Includes sands and loamy sands.

SKELETAL (s): modifies the main textural categories containing more than 35% by volume of particles coarser than 2 mm size.

GENETIC ORGANIC LANDFORM CLASSES AND CATEGORIES

BOG (B): 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 groundwaters from the surrounding mineral soils. The groundwater is generally acidic and low in nutrients (ombrotrophic). The dominant peat materials are sphagnum and forest peat, underlain, at times, by fen peat.

Categories of Bogs

BOG PLATEAU (Bp) : The height of these peat landforms varies from 0.5 to 1 meter and is due to greater peat deposition as compared to the surrounding wet fen areas. Bog plateaus are often tear-drop shaped.

BOG VENEER (Bv): This type of bog occurs when a shallow peat (generally between 40-100 cm thick) covers slopes and to some degree, depressions and uplands. The surface topography is often micro-hummocky (sphagnum mounds). Permafrost is discontinuous in this type of bog, and most often found in the better developed mounds.

BOWL BOG (Bp): This type of bog has developed in topographic depressions and has a concave peat surface.

BLANKET BOG (Bl): This type of bog occurs when peat covers the uplands, slopes and depressions alike up to a considerable degree of slope.

FLAT BOG (Bf): This type of bog is a level peatland area having only slight differences in the level of its surface. Irregularities or slopes of the substratum are completely or almost completely masked by the peat deposit.

PALSA (Ba): A mound of peat with a frozen peat and/or mineral core, occurring in waterlogged, treeless or sparsely wooded fens. The height of a palsa is generally between 1 and 3 meters, while the width is in the order of some tens of meters.

PEAT MOUND (Bm): Permanently frozen treeless mounds (0.5 to 1 meter in diameter and about 30 to 50 cm high) which occur in water saturated fens.

PEAT PLATEAU (Bt): Peat plateaus are associated with permafrost and their height (approximately 1 m) is dominantly due to ice lens formation in the frozen core. Their sizes range from several acres to tens of acres.

POLYGONAL PEAT PLATEAU (By): These frozen organic landforms resemble peat plateaus as they are elevated about 1 m above the surrounding fen areas. The surface of this type of peat plateau is dominated by a polygonal pattern caused by ice wedge formation. The surface morphology resulting from ice wedge formation is expressed as a network of polygons having high, near level or slightly depressed centers. The outline of each polygon is marked by a polygonal trench often containing a wedge-shaped accumulation of ice.

FEN (F): A fen is a peat-covered or peat-filled area with a high water table, which is usually at the surface. The dominant materials are shallow to deep, well to moderately decomposed fen peat. The waters are mainly rich in nutrients (minerotrophic) and are derived from mineral soils. The peat materials are therefore higher in both nutrients and pH than the peats associated with bogs.

Categories of Fens

COLLAPSE SCAR (Fc): These fen areas have developed as a result of melting of permafrost in organic landforms such as peat plateaus and palsas. The collapsed portion of the landform has a high water table and the collapsing edge may form a steep bank. Characteristic are the leaning trees on the banks and submerged or partly submerged dead trees in the collapse area.

FLOATING FEN (Ff): This type of fen occupies areas over a shallow water surface. The fen vegetation forms a floating or quaking peat mat encroaching on a water surface.

HORIZONTAL FEN (Fh): This type of fen consists of extensive flat, low lying areas that show very slight differences in the level of the peat surface. The water table is usually at or close to the surface.

MINEROTROPHIC PALSA (Fm): This type of fen occurs mainly in the coastal area of the Hudson Bay Lowlands. These organic landforms have an elevated, slightly convex surface (due to ice lens formation in both the organic layers and the underlying minerals) and are generally surrounded by water saturated fens. The organic material is often layered with alluvial deposits.

PATTERNED FEN (Fp): This type of fen occupies very gently sloping areas and its characteristic feature is a pattern of ridges (strangs) and hollows (flarks). These sites are extremely wet throughout the summer.

SLOPING FEN (Fl): This type of 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.

SWAMP (S): 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 micro-relief 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.

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