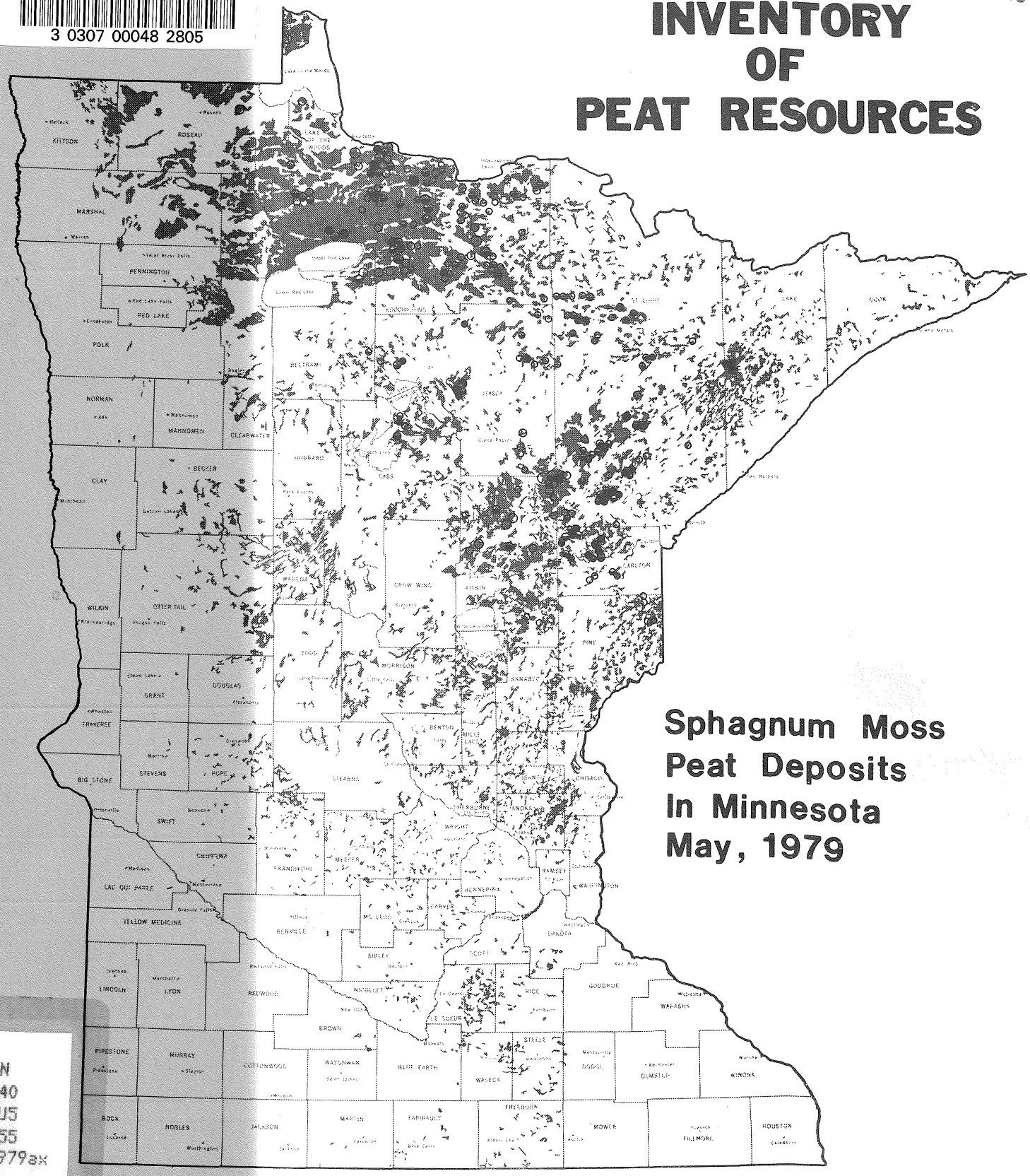
INVENTORY OF PEAT RESOURCES



Sphagnum Moss Peat Deposits In Minnesota May, 1979

MINNESOTA DEPARTMENT OF NATURAL RESOURCES

SPHAGNUM MOSS PEAT DEPOSITS IN MINNESOTA

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MINNESOTA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF MINERALS

PEAT INVENTORY PROJECT

Funding Provided By
Legislative Commission on Minnesota Resources

Hibbing, Minnesota
1979

This report is on deposit at
Minnesota Department of Natural Resources
Division of Minerals
345 Centennial Office Building
St. Paul, Minnesota 55155

ACKNOWLEDGMENTS

Special gratitude is extended to Arlo Knoll, Director of the Peat Information Program, Minnesota Department of Natural Resources, for his assistance and support in the preparation of this report. Don Grubich, Iron Range Research Supervisor, Iron Range Resources and Rehabilitation Board; Paul Rundell, Resource Coordinator, Minnesota Department of Natural Resources; Morris Eng, Hydrologist, Minnesota Department of Natural Resources; Dr. Howard Hobbs, Geologist, Minnesota Geological Survey; and Brian Conway, Graphic Arts Specialist, Minnesota Department of Natural Resources, are also acknowldged for their assistance, suggestions, and cooperation on this project.

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SPHAGNUM MOSS PEAT DEPOSITS IN MINNESOTA

I. INTRODUCTION

Demand and Reserves of Horticultural Peat

The demand for horticultural peat has been increasing since the early 1950's. United States production in 1954 was 240,000 tons* according to U. S. Bureau of Mines statistics (32). By 1977 production had reached 781,000 tons. The 1977 production more than tripled the 1954 production. Of the 781,000 tons produced in 1977, 725,812 tons were sold. The remainder was kept in inventory (26).

Known reserves of peat in the United States, exclusive of Alaska, as estimated on an air-dry basis by the U. S. Geological Survey in 1974, total 13.8 billion tons. Approximately nine-tenths of this occurs in the states of Minnesota, Florida, Michigan, and Wisconsin. Minnesota accounts for over one-half of the United States total, excluding Alaska (25).

The horticultural peat industry in the United States is dominated by a handful of large producers. Michigan, Florida, and Indiana are the largest peat producing states and accounted for 45 percent of the 1977 production. In the same year, Minnesota ranked eighth in peat production (26).

Horticultural peat produced in the United States is generally categorized, for commercial purposes, according to its botanical origin and its degree of decomposition. Three broad designations are used: 1) moss peat, formed from sphagnum, hypnum, and other mosses; 2) reed-sedge, formed from reeds, sedges, and other swamp plants; and 3) humus, peat so decomposed that all trace of its botanical origin are lost.

Table 1 shows the types of and amount of domestically produced peat sold in the United States in 1977 (26). The largest quantity of peat sold was reed-sedge, more than twice the amount of the moss sphagnum type.

Demand for horticultural peat, particularly sphagnum, has always exceeded the domestic supply in the United States. In 1977, for example, approximately 500,000 tons of moss peat was available for United States consumption. Of this total, 172,676 tons or 34.5 percent was domestically produced (26).

An important limiting factor in the production of sphagnum moss peat is the availability of sphagnum peat deposits. Primarily due to climatic conditions, sphagnum accumulation in North America is limited to an area north of a line reaching from central New Brunswick through south-central Maine and north-central New York to north-central Minnesota and into British Columbia (4) (Figure 1). The zone of occurrence of sphagnum moss deposits in Minnesota is shown on Figure 2.

The majority of the commercially harvestable sphagnum in the lower 48 states is located in Minnesota. Minnesota has between 7.2 and 7.6 million acres of peatland with an estimate as high as 12 billion tons (9, 10). There has been uncertainty about how much of the total is sphagnum. Past estimates suggested that between 2 percent and 5 percent of Minnesota's peat is sphagnum. Using 7.2 million acres, 2 percent would represent 144,000 acres and 5 percent would represent 360,000 acres.

* In this report one ton equals 2,000 pounds.

Table 1. Types and Amount of Domestically Produced Peat Sold in 1977.

Type	Quantity (tons)	Percent of Total
Reed-sedge peat	378,984	52.2
Humus peat	174,152	24.0
Moss peat	172,676	23.8
TOTAL	**725,812**	**100.0**

Figure 1. Approximate Southern Boundary of Sphagnum Moss Deposits in North America.

Minnesota is in a somewhat unique situation; the State owns or administers the majority of the peatlands. Currently, there are two major horticultural (containing both sphagnum and reed-sedge peat) peat leases in Minnesota encompassing 3,600 acres. In addition, there are five lease applications which total 41,280 acres of peatland. Three of the lease applications involve both the sphagnum type and the reed-sedge type. The other two leases are for reed-sedge type peat.

Besides the horticultural peat leases, the State has 11 leases (approximately 3,300 acres) for wild rice production. The leases are all on reed-sedge type peat.

Scope and Purpose of Report

The need for more information about Minnesota's sphagnum peat deposits is evident. The primary purpose of this report is to present the location, size, quantity, and selected characteristics of sphagnum peat deposits in Minnesota. Existing information was used in some of these determinations.

Reed-sedge peat represents approximately 80 percent of the areal extent of Minnesota's peatlands and humus represents about 18 percent. The evaluation of these deposits will be part of the total peat resources inventory being conducted by the Minnesota Peat Inventory Project (MPIP).

Selected background information on peat uses, geologic setting, classification, peat characteristics, and peat development is presented to add to the perspective of the report.

Uses of Peat

Generally, peat usage is divided into two main categories; in situ use and extractive use. Most of the in situ uses of peat fall into the areas of: 1) preservation of the peat in its natural state; 2) drainage of peatlands for agricultural purposes; 3) forestry; 4) use of peatlands for wastewater filtration; and 5) use of peatlands for wild rice production.

Peat that has been removed from peatlands falls into the extractive use category. In the United States, the principal use of this peat is for horticultural purposes. Horticultural peat, especially sphagnum moss peat, is important as a surface mulch, a component of potting soil mixes, a soil conditioner, a rooting and germinating medium, and a packing and shipping filler for tender plants. It is also used as a top dressing for golf courses and lawns, especially in the arid Southwest. The high water content, high acidity, low air-dried weight, and resistance to breakdown makes sphagnum moss peat a highly desirable horticultural peat.

Reed-sedge and humus types of peat are of somewhat less horticultural value. They have a lower water content, more neutral acidity, high air-dried weight, and tend to break down more readily when mixed with soil.

In Europe, extracted reed-sedge peat is used for chemical/industrial purposes and a few heating and generating plants burn peat. Recently, the Minnesota Gas Company has been testing reed-sedge for conversion into synthetic natural gas. At this point, the economic feasibility is questionable. However, it does have great potential and implication for peat utilization.

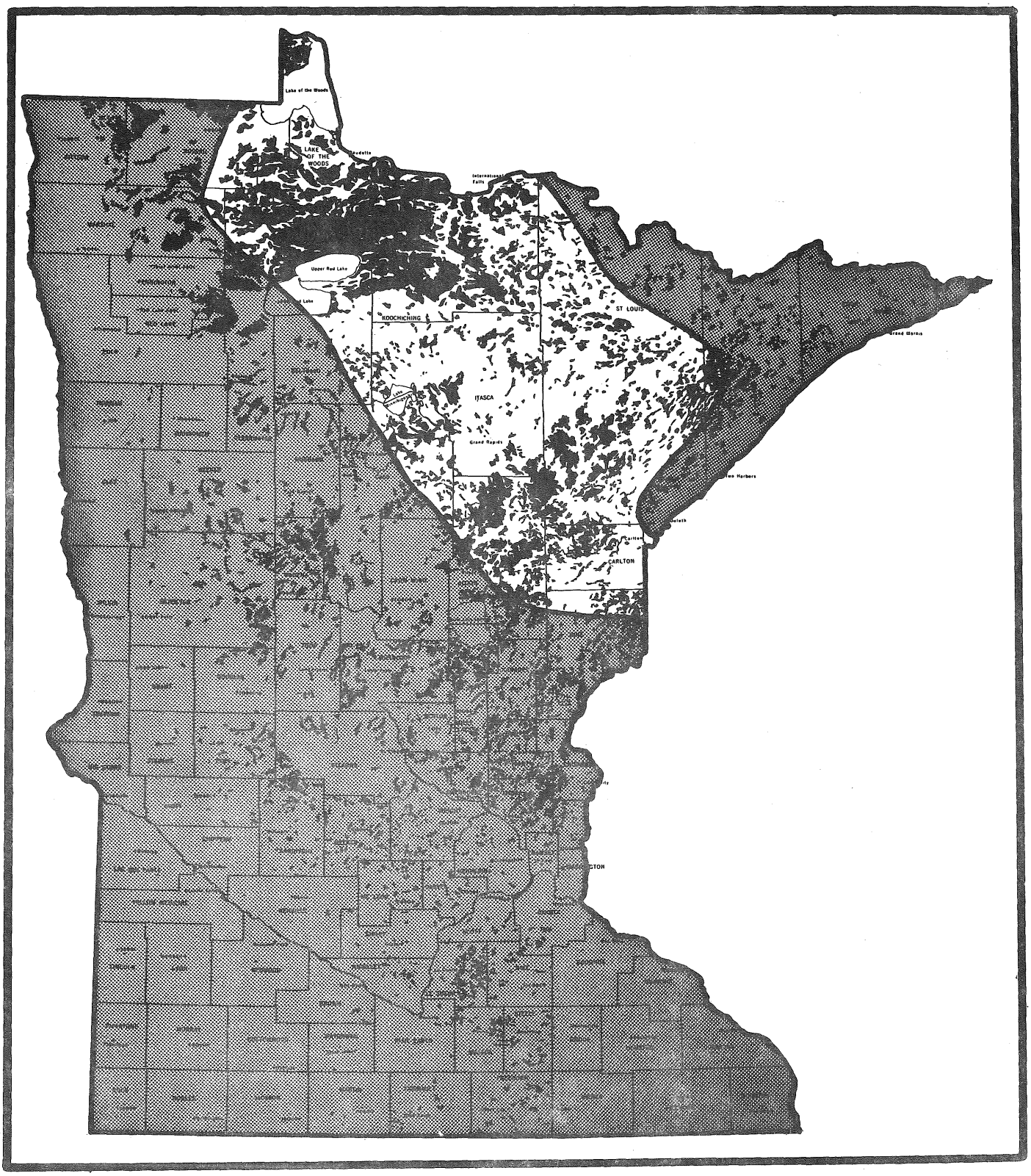


Figure 2. Zone of Occurrence of Sphagnum Moss Deposits in Relation to Total Peatlands in Minnesota.

II. GEOLOGIC SETTING

During the Pleistocene Epoch, Minnesota was subjected to multiple periods of continental glaciation. Each glacial period was separated by long interglacial (interstadial) periods when the climate moderated and the ice thawed and retreated into the Arctic regions. Most of the surficial features in Minnesota are a result of the most recent glaciation, which spanned a period from 50,000 to 10,000 years ago. This period is commonly called the Wisconsin Ice Stage (16).

The Wisconsin Ice Stage can be divided according to advances and retreats of individual ice lobes or sublobes. The lobes entered Minnesota from the northwest and northeast (Figure 3). Nearly all sphagnum moss deposits lie within the areas of advance and retreat of the Rainy and Superior lobes and the St. Louis sublobe.

From the northeast the Rainy lobe contemporaneously advanced with the Superior lobe to central Minnesota. As they retreated, the St. Louis sublobe of the Des Moines lobe advanced eastward across northern Minnesota and southward to central Minnesota (Figure 3).

The extent of glaciation of each lobe was reconstructed by interpreting the stratigraphic and topographic relations of the drifts. The glacial drift of each ice lobe has a distinctive color, texture, and stone content depending on its origin (36).

The erosional and depositional processes of these lobes resulted in a complex array of geomorphic features. The features are the primary basis for dividing Minnesota into physiographic areas (Figure 4).

Peat deposits occur in large areas of the State. However, the sphagnum moss deposits occur in 1) the lake plains of Glacial Lakes Upham, Aitkin, and the Beltrami Arm of Lake Agassiz; 2) the till plains of the Border lakes, Chisholm-Embarass, and Bemidji and the clay-till plains of the Aurora-Alborn and Barnum areas; 3) the Toimi and Brainerd-Automba drumlin areas; and 4) the Sugar Hills-Mille Lacs and western St. Croix moraine area. There are no raised bogs in the bedrock highlands of the Giants Range.

III. PEAT EVOLUTION

Peat, or organic soil, consists of dead and partly decomposed plant materials. It occurs in an unbalanced system where the rate of production of organic materials exceeds the rate of decomposition, usually under conditions of almost continuous saturation by water. The wet environment inhibits the exchange of gases that is necessary for microbial decomposers. When these anaerobic conditions develop, the rate of decomposition is greatly reduced and masses of partially decomposed material accumulate as peat.

Peat Formation

Contributing factors in the initiation and development of peatlands are topography, climate, and water. The rate of peat accumulation is dependent on the interaction of these factors.

Topography

In northern Minnesota, glacial depositional and erosional processes formed features that were particularly suited for peat accumulation. When geomorphic features slow water movement, they provide a base for peat accumulation (e.g. glacial lake basins, relatively flat ground moraines, outwash plains, and ice block depressions).

Large glacial lake basins were formed at ice sheet margins when meltwater became impounded between glacial ice and existing physical features. These ephemeral lakes are now marked by lacustrine soils (laminated silts and clays that were deposited by the sorting action of glacial lake waters). Impermeable soils and the low relief of the glacial lake basins inhibit good drainage.

Ground moraines are accumulations of till laid beneath glaciers. They tend to have low relief and relatively poor drainage; these areas provide conditions in which peat can accumulate.

Outwash plains are formed by a series of merging outwash fans built by streams extending beyond an ice front. These stratified sands and gravels provide a base for peat accumulation when the water table is at or near the surface.

Outwash fans were often deposited over stagnant ice; when the ice melted, subsidence of the overlying material occurred and kettles resulted. Where outwash was deposited over stagnant ice of varying thickness, numerous kettles resulted; this type of topography is commonly referred to as a pitted outwash plain. These kettle lakes are suitable environments for peat accumulation when the water table level occurs within the kettles.

Kettle lakes are also formed in end moraine complexes. In areas of relatively impermeable till, these depressions filled with water and some eventually filled with peat.

Climate

Climate is an equally important influence in peat development. Peat most frequently occurs in cool, humid climates where precipitation exceeds evapotranspiration. Northern Minnesota is such an area; the sub-humid continental climate provides about 65 cm ($\sim$ 25 in) of annual precipitation, and the long, cold winters and short, warm summers greatly reduce the potential evapotranspiration. Generally, climatic factors have been conducive to peat formation in Minnesota for about 8,000 years; however, there have been significant climatic variations since that time.

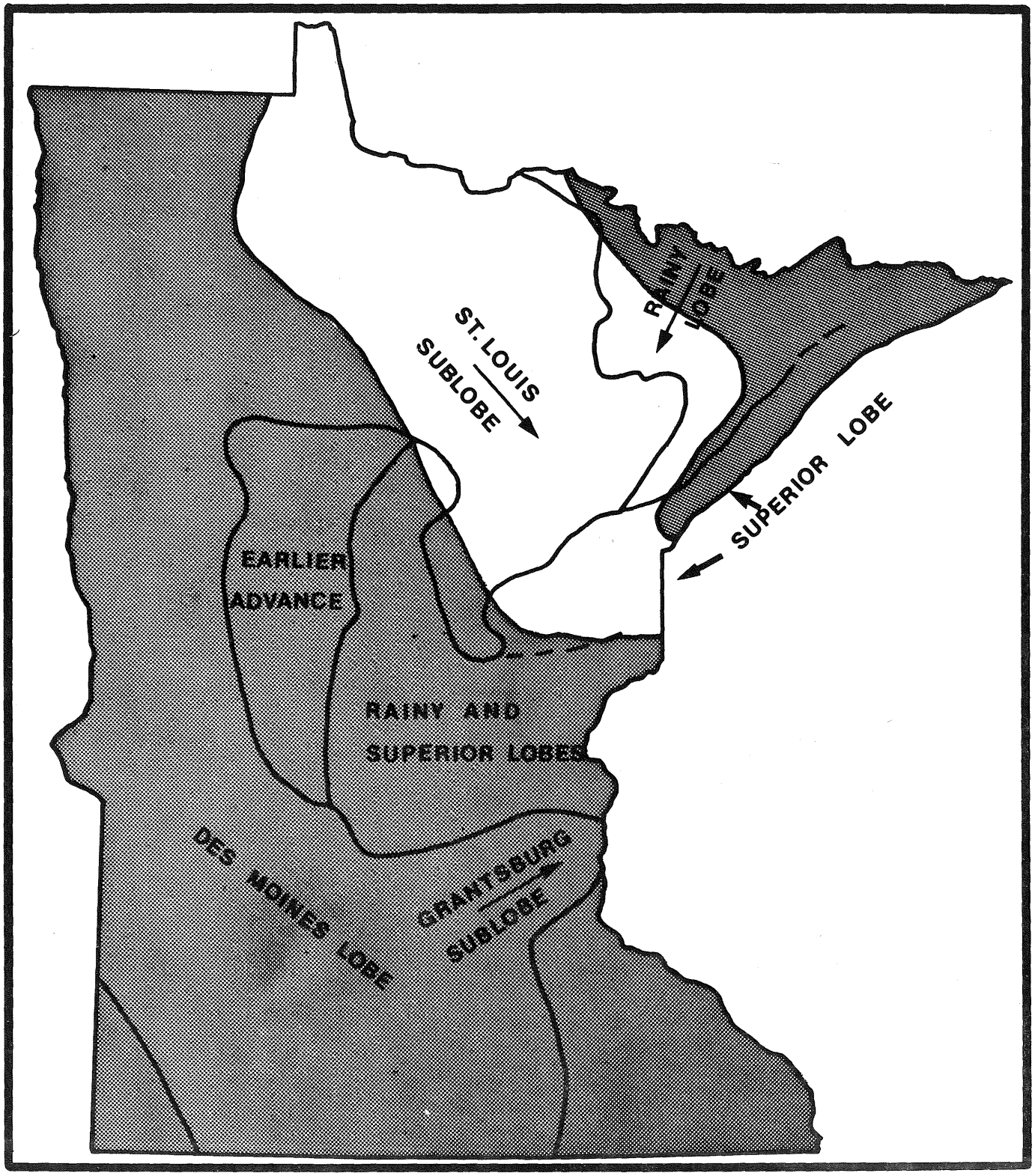
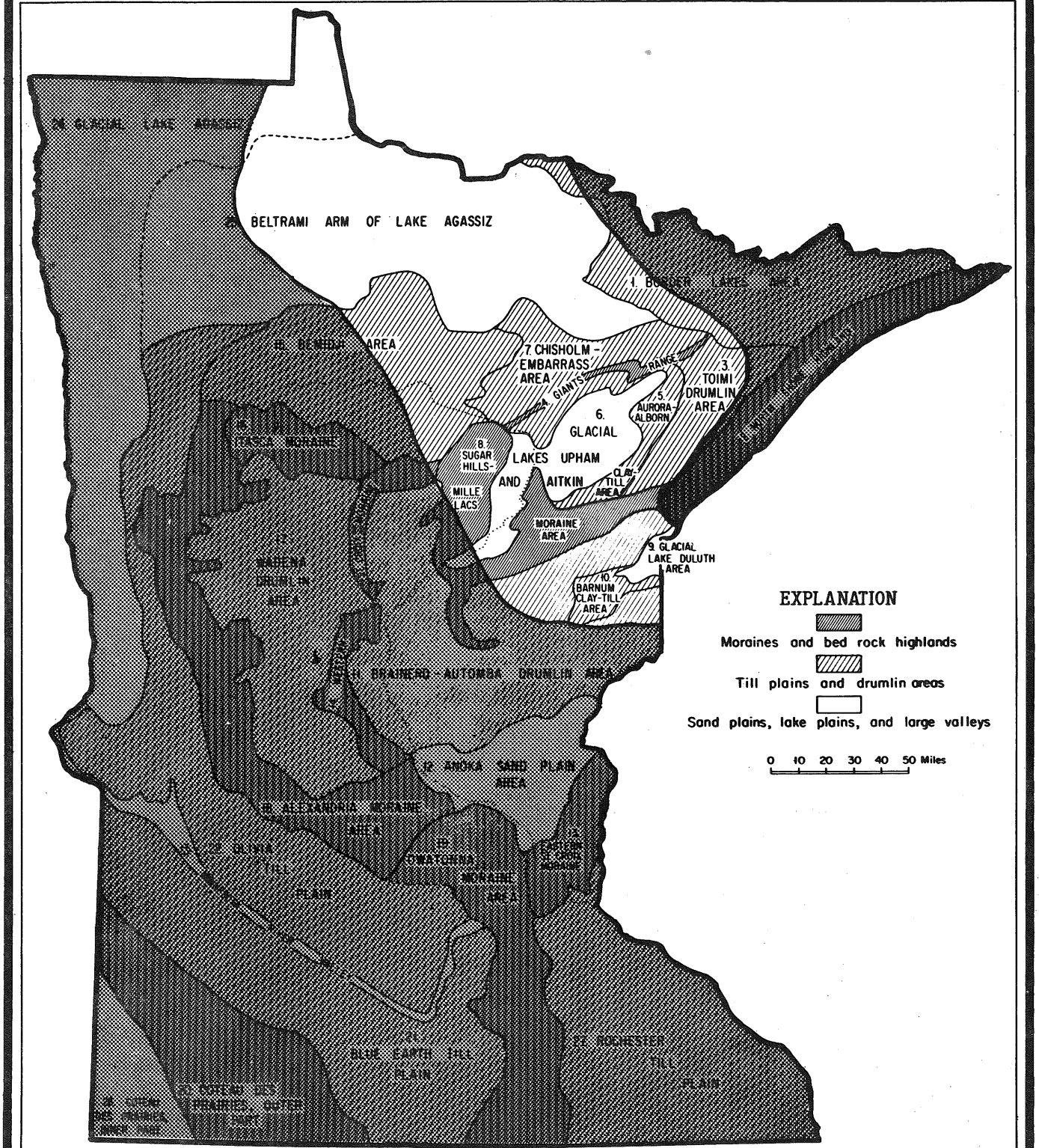


Figure 3. Zone of Occurrence of Sphagnum Moss Deposits in Relation to the Most Recent Glaciation. Base map generalized from Wright (36).



Map of physiographic areas in Minnesota. 1, border lakes area; 2, North Shore Highland; 3, Toimi drumlin area; 4, Giants range; 5, Aurora-Alborn clay-till area; 6, Glacial Lakes Upham and Aitkin; 7, Chisholm-Embarrass area; 8, Sugar Hills-Mille Lacs area; 9, Glacial Lake Duluth area; 10, Barnum clay-till area; 11, Brainerd-Automba drumlin area; 12, Anoka sandplain area; 13, eastern St. Croix moraine; 14, western St. Croix moraine; 15, Bemidji area; 16, Itasca moraine; 17, Wadena drumlin area; 18, Alexandria moraine area; 19, Owatonna moraine area; 20, Coteau des Prairies, outer part; 21, Blue Earth till plain; 22, Olivia till plain; 23, Minnesota River Valley; 24, Glacial Lake Agassiz; 25, Beltrami arm of Lake Agassiz; 26, Coteau des Prairies, inner part; 27, Rochester till plain.

Figure 4. Zone of Occurrence of Sphagnum Moss Deposits in Relation to Physiographic Areas in Minnesota. Base map after Wright (37).

Water

A saturated environment must exist for most of the year for peat to accumulate. The amount, nutrient content, and acidity of peatland water determine the vegetation and; hence, peat present. Sphagnum moss growth occurs where there is a localized high water table; whereas, dense black spruce growth occurs in areas of greater slope (>1.6 m/km or >8 ft/mi) that allow sufficient aeration (2). Acidic water, low in available nutrients, favors the growth of sphagnum moss but stunts the growth of black spruce. Less acidic water, with more available nutrients, is more favorable for the growth of black spruce, tamarack, and herbaceous material. Neutral water environments tend to enhance the growth of northern white cedar.

Peat Formation Processes

Peat formation generally occurs by two means — paludification and lakefill. Paludification (swamping) is a process of bog expansion caused by a gradual raising of the water table as peat accumulation impedes drainage (17) (Figure 5). This process begins with reed or sedge growth in areas of little or no relief; these herbaceous materials accumulate as peat. Due to the low relief and the blockage of drainage by the peat, the water table begins to rise leading to the growth of more herbaceous plants. As more peat accumulates, it begins to creep upslope and may gradually cover the divides. Thus, the elevations of peat-covered areas may actually be higher than the elevation of mineral soil along rivers flowing through the bogs.

Lakefill is defined as the filling in of lakes or ponds by vegetation (30) (Figure 6). It is initiated when limnic materials (organic or inorganic materials deposited in water by the action of aquatic organisms or derived from underwater and floating organisms) begin to accumulate on the lake bottom. This type of accumulation is sometimes referred to as aquatic peat. Simultaneously, sedge growth is initiated around the edges of the water-filled basin and gradually grows inward. The encroachment of the plant communities may actually occur as a floating mat. As the migration of plant communities continues to the center of the basin, dead plant matter eventually collects as peat. The more stable or outer portions of the peat allow other species of plants to migrate towards the center. Peat continues to accumulate inward, filling the basin, until the lake disappears (23).

Raised Bogs

As the ice sheets retreated about 11,000 years ago, aquatic peat began to collect in lakes and ponds (2). About 8,000 years ago herbaceous peat, composed of reed, sedge, and cattail vegetation, began to accumulate as a result of the paludification and lakefill processes.

As herbaceous peat began to accumulate, forest vegetation advanced to bog areas where the nutrient content of the water was relatively greater, such as along beach margins, near mineral islands, and in areas of localized upwelling. Woody peat eventually accumulated from this forest vegetation.

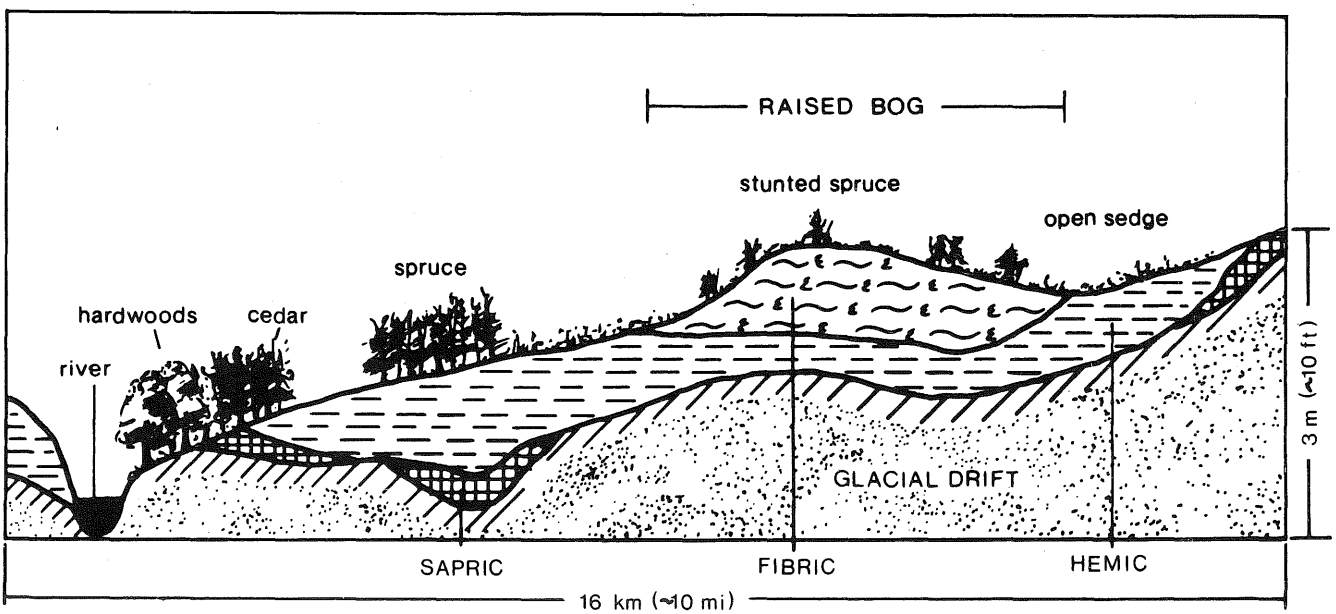


Figure 5. Paludification Process.

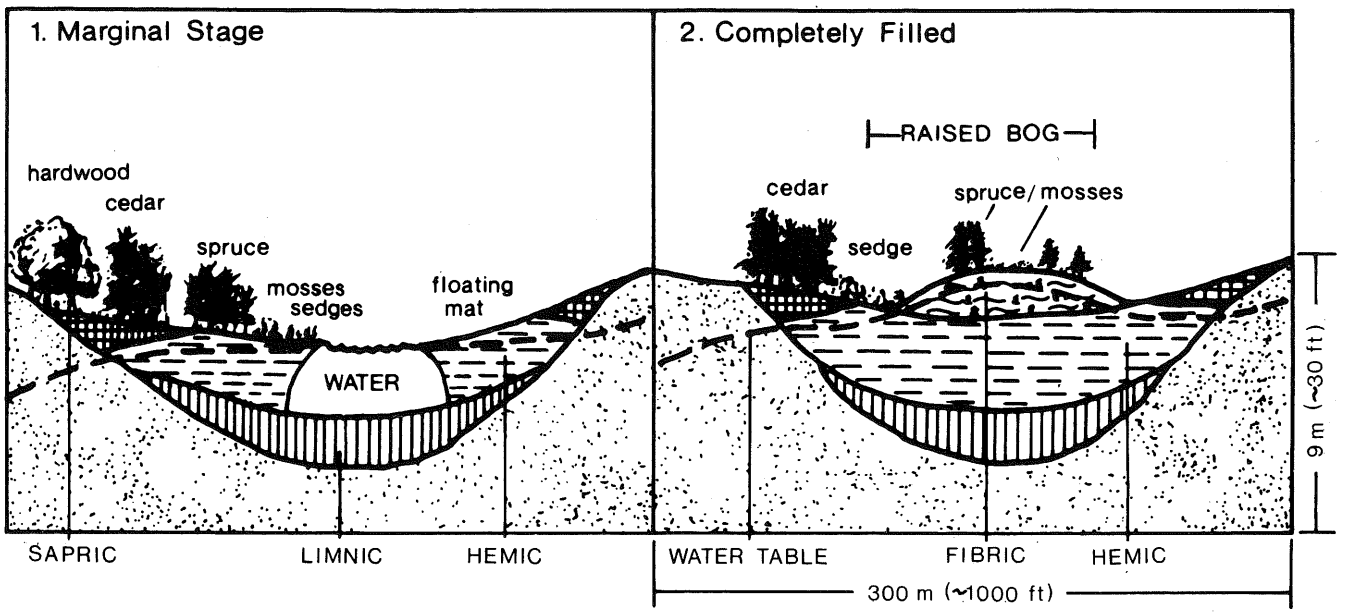


Figure 6. Lakefill Process.

About 3,000 years ago, sphagnum moss appeared in Minnesota bogs (18). Bogs that contain deposits of sphagnum moss peat are commonly called "raised bogs". They can form either by the lakefill or paludification process.

Raised bogs began to develop in Minnesota when there was: 1) a climate favorable to sphagnum growth, with an elevated water table; 2) the appropriate species of sphagnum present; 3) a water table divide, causing mineral depletion — either present in the original physiography, or developed by peat accumulation or by stream piracy (18).

Sphagnum selectively invades areas of low nutrient status and high acidity where it outcompetes less tolerant species. Sphagnum growth occurs in hummocks which may be 60 cm (~ 2 ft) high and 100 cm (~ 3.3 ft) across. This growth pattern tends to isolate it from the local water table. After sphagnum growth is initiated, its pH level is further reduced by the high cation exchange capacity of the sphagnum itself. The lower pH levels further limit the actions of decomposers which allows a more rapid accumulation of peat.

A dome of sphagnum moss may eventually form over reed-sedge peat; hence, the term "raised bog". The depth or amount of accumulation of moss is directly related to how high (elevated) the raised bog is above the surrounding peatland.

Raised bogs characteristically have a ground cover of sphagnum moss. The understory consists primarily of leatherleaf, bog rosemary, swamp laurel, Labrador tea, and cotton grass. Tree growth is generally stunted black spruce or a black spruce/tamarack association.

The size of Minnesota's raised bogs range from a few acres to two thousand or more acres and comprise about two percent of the total peatland.

IV. PEAT CLASSIFICATION

For classification purposes, peat is usually subdivided into types. Subdivision is generally done on the basis of degree of decomposition and the botanical composition of the plant remains.

The degree of decomposition is dependent upon the amount of plant residue, the amount of humus, the wood content, the structure of the peat, and the amount of water. Botanical composition is dependent on the dominant plants that are in the peat.

U. S. Bureau of Mines

For horticultural purposes, generally the most sought after and desirable type of peat is one in which the plant remains are primarily composed of nearly undecomposed mosses. This peat type has a very high water-holding capacity which is important in soil amendment uses. The term "moss peat" has been used to describe this type of peat. Because of availability, the moderately decomposed reed-sedge peat has been used extensively. The highly decomposed humus peat has also been used for horticultural purposes.

The U. S. Bureau of Mines defines these three types of peat:

1) Moss peat is formed principally from sphagnum, hypnum, and other mosses. Sphagnum moss peat is light tan to brown, light in weight, porous, high in water-holding capacity, high in acidity, and low in nitrogen content; "top moss" is the living part of the sphagnum plant and should not be confused with moss peat which has aged and partially decomposed. Hypnum moss peat is darker brown, of low acidity, and physically similar to reed-sedge peat.

2) Reed-sedge peat is formed principally from reeds, sedges, marsh grasses, cattails, and associated plants. Fibrous, partially decomposed reed-sedge peat is brown to reddish brown, but more decomposed peats are darker. The water-holding capacity and the nitrogen content of reed-sedge peat are of medium values.

3) Peat humus is derived from peat so decomposed that the original plant remains are not identifiable. It is dark brown to black, has low water-holding capacity, and has medium to high nitrogen content.

The U. S. Bureau of Mines definitions have historically been used for statistical purposes on peat reserves, production, and sale in the United States.

American Society for Testing Materials

More specific classifications have been developed by the American Society for Testing Materials (ASTM). The ASTM classification developed primarily as a result of consumer demand for uniformity of product by the producers. The producers also recognized that consistent nomenclature and product standards would improve the sales of United States peat.

In 1969, the ASTM Committee on Peat defined peat in terms of materials and size of fibers (1). Accordingly, the term peat refers only to the organic matter of geologic origin, excluding coal, formed from dead plant remains in water and in the absence of air. It occurs in a bog, swampland, or marsh, and it has an ash content not exceeding 25 percent by dry weight. Fiber is defined as plant material retained in an ASTM No. 100 (150 µm) sieve, that is, material 0.15 mm (0.006 in) or larger consisting of stems, leaves, or fragments of bog plants, but containing no particles larger than 12.7 mm (0.5 in). It excludes fragments of other materials such as shells, stones, sand, and gravel.

Having defined peat, they classified it into five major types according to generic origin and fiber content. The percentages of fiber are based on oven-dried weight at 105°C (223°F), not on volume.

The five ASTM peat types are:

1) Sphagnum moss peat (peat moss) — The oven-dried peat contains a minimum of 66 2/3 percent sphagnum moss fiber of the total content by weight. These fibers are stems and leaves of sphagnum in which the fibrous and cellular structure is recognizable.

2) Hypnum moss peat — The oven-dried peat contains a minimum of 33 1/3 percent fiber content by weight, of which hypnum moss fibers compose more than 50 percent. These fibers are stems and leaves of various hypnum mosses in which the fibrous and cellular structure is recognizable.

3) Reed-sedge peat — The oven-dried peat contains a minimum of 33 1/3 percent fiber by weight, of which reed-sedge and other nonmoss fibers compose more than 50 percent.

4) Peat humus — The oven-dried peat contains less than 33 1/3 percent fiber by weight.

5) Other peat — All forms of peat not classified herein.

For horticultural purposes, this classification system seems to provide the most consistency between producers and consumers.

International Peat Society and the Soil Conservation Service

The International Peat Society (IPS) and the U.S. Department of Agriculture, Soil Conservation Service (SCS) have very similar classification systems that are widely used (20, 28, 29). The IPS system is widely used in Europe, whereas, the SCS system is used in mapping soils in the United States.

The IPS system uses three grades to classify peat according to the degree of decomposition; weakly decomposed peats (R_1), medium decomposed peats (R_2), and strongly decomposed peats (R_3). At the higher levels of classification, these correspond to the SCS classifications of fibric, hemic, and sapric. Both systems are capable of considerable detail in subclassifying peat. IPS field classification of peat is shown in Table 2.

The MPIP classifies horticultural peat by combining the best aspects of the IPS, SCS, and ASTM systems. This allows more versatility so that peat types in Minnesota can be compared with peat types in Europe where the technology of peat utilization is much more advanced than in the United States. At the higher levels of classification, all systems essentially describe the same types of peat. In order to maximize communication, the MPIP made the decision to continue to use the IPS system but to refer to the IPS weakly decomposed peats (R_1) as fibric, medium decomposition peats (R_2) as hemic, and strongly decomposed peats (R_3) as sapric. The terms fibric, hemic, and sapric are readily exchangeable with the three-grade IPS system.

Table 2. Three-Grade Scale of Peat Decomposition.

Scale grade	Percent of Fibers	Structure and look of the peat bulk	Presence and look of humus	Amount and look of water
Fibric (R_1) weakly decomposed peats	> 70%	Spongy or fibrous, built of plant residues tied with one another. For separation tearing off the plant residues is required. Easily recognizable plant residues/well preserved. Elastic, compact.	Not visible or occurs in little amounts as a dispersed dark mass, saturating and coloring plant residues.	Great amounts of water, which can be easily pressed out and pours as a streamlet. Almost totally pure or slightly brownish. May contain dark humus spots.
Hemic (R_2) medium decomposed peats	70-40%	Amorphous-fibrous; grass and moss peats contain numerous plant residues of various size; woody peats are more friable due to the presence of wood residues in amorphous humus When pressed in fingers transforms into an amorphous, plastic mass.	Distinctly discernible against which plant residues are visible. Humus can be pressed out between fingers of the clenched fist, but not more than 1/3 of the taken sample.	Can be pressed out or flows by few drops; usually thick and of dark color/humus. In drained peat slightly colored with humus coagulated in consequence of partial drying.
Sapric (R_3) strongly decomposed peats	> 40%	Lumpy-amorphous, consisting in main part of humus. In lumpy-amorphous peat greater fragments of plant residues/wood, rhizomes, greater rootlets/occur. Friable, disintegrates under pressure Amorphous peat strongly plastic, with sporadic greater plant residues.	Uniform mass, can be pressed out between fingers of the clenched fist in the amount of a half or the whole of the taken sample.	Cannot be pressed out, instead the humus mass is squeezed.

Based on International Peat Society (20).

It should again be mentioned that throughout all classification systems, a strong relationship exists between botanical composition and degree of decomposition. Peats composed primarily of sphagnum mosses are almost exclusively classified as fibric (weakly decomposed); reed-sedge dominant peats are consistently classified as hemic (medium decomposition). Peats unidentifiable by botanical origin are always classified as sapric (strongly decomposed peat, humus).

V. PHYSICAL PROPERTIES OF PEAT

There are a number of basic peat characteristics that can be measured which are manifestations of the varying genesis and pedological processes that occur in peat formation. The characteristics of bulk density, water content, pH, and mineral content, along with the inferred degree of decomposition, facilitate comparison with other existing peat data.

A number of explicit and implicit relationships exist between the basic peat characteristics that can be interpreted to determine the potentiality of various peat deposits and predict possible implications involving their use.

Bulk Density

Bulk density is defined as the weight of a given volume of soil. It is usually expressed on a dry-volume basis. The core method of determining bulk density was used; a sampler of a known volume (Macaulay peat sampler) was inserted into the soil and a core was extracted. The oven-dry weight of the soil within the sampler was then determined.

There is a curvilinear relationship between bulk density values and water content values; as bulk density decreases, water content values increase (35).

Bulk density values increase with increased mineral content due to contamination of the peat and mineralization of plant materials.

Water Content

Water content is defined as the total moisture content of organic soil and is expressed as the weight of water per unit weight of oven-dry soil. It was determined by oven-drying a saturated organic soil sample and calculating the water loss by weight.

Higher water content values of relatively undecomposed peat are due to their greater pore size distribution (35). Water content values are also related to the botanical origin of the peat; sphagnum moss peat has a larger water-holding capacity than herbaceous peat due to the cellular structure of the moss fibers.

pH

Hydrogen ion activity or pH is defined as the degree of acidity or alkalinity of a soil. The pH values were measured in a deionized water solution and in a 0.01M $CaCl_2$ solution. Organic soil is generally acidic, but has pH values ranging from 3.0 to 8.0. Low pH values indicate the presence of sulfides, whereas higher values are indicative of adsorbed calcium or sodium (35).

The range of pH values is related to peat vegetation and the degree of decomposition. Sphagnum moss peat acidity is higher than that of herbaceous peat; this can be attributed to the ion-exchange mechanism of the sphagnum (17). Higher acidity also indicates lower levels of microorganism activity and a slower rate of decomposition; hence, a more rapid rate of peat accumulation.

Mineral Content

Mineral content is defined as the solids remaining after heating a sample of oven-dried peat to 500°C (932°F) for 30 minutes. These constituents, which are incombustible, are derived from the release of mineral components of organic matter through decomposition and from aeolian mineral contamination from surrounding areas.

Mineral content, as previously discussed, is directly related to bulk density; as mineral content increases, bulk density values increase. High mineral content is also an indication of highly decomposed peat.

Degree of Decomposition

Decomposition of peat is a pedological process which generally reflects a change in peatland environment. More decomposed peat is a result of a lower water table that allows accelerated oxidation or decomposition of plant remains to occur.

The characteristics of bulk density and water content are indirect measurements of the degree of decomposition (Table 3). These two characteristics are, perhaps, the most significant parameters for determining potential uses of peat.

A direct measurement of the degree of decomposition of peat is indicated by the percentage of original plant fibers not decomposed. However, this parameter (fiber content) is difficult to determine. A fiber is defined as a fragment or piece of plant tissue, excluding live roots, that is large enough to be retained on a 100-mesh sieve, openings 0.15 mm (0.006 in) in diameter, and that retains recognizable cellular structure of the plant from which it came (29).

Table 3. Properties Diagnostic for Organic Soils at the Suborder Level.

DEGREE OF DECOMPOSITION	FIBER CONTENT		BULK DENSITY		WATER CONTENT AT SATURATION OR OVEN-DRY MATERIAL
	UNRUBBED (percent)	RUBBED (percent)	(g/cm^3)	(lb/ft)	(percent)
Fibric	> 66 2/3	> 40	< 0.10	< 6.2	850 - 3000
Hemic	33 1/3 - 66 2/3	17-40	0.07 - 0.18	4.4 - 11.2	450 - 850
Sapric	< 33 1/3	< 17	> 0.20	> 12.5	< 450

Based on *Soil Taxonomy* (7th Approximation) (29).

VI. METHODOLOGY OF INVESTIGATION

Early studies of Minnesota's raised bogs dealt primarily with specific bogs. Gradually the studies were expanded to county and regional evaluations. This report is the first statewide evaluation of raised bogs.

Existing Information

Between 1960 and 1970, the Iron Range Resources and Rehabilitation Board (IRRRB) in cooperation with the Soil Science Department, University of Minnesota, maintained a peat inventory program which, during that decade, mapped and inventoried more than 45 individual peat bogs in the northern part of the State. Four of the surveys have been published (7, 11, 12, 13) and the remaining surveys are unpublished (21). IRRRB surveyed approximately 230,000 acres in considerable detail. Many of the surveyed bogs were raised bogs.

Another source of raised bog information is the Arrowhead General Soil Maps (31). They were prepared by the Soil Conservation Service in cooperation with the Forest Service and the Agricultural Experiment Station, University of Minnesota. These maps cover the following counties: Aitkin, Carlton, Cook, Itasca, Koochiching, Lake, and St. Louis. The main virtue of these maps is that they delineate three types of organic soil; fibric, hemic, and fibric/hemic mixture. The maps are general in nature, but give valuable information about the location, areal extent, and depth of sphagnum moss peat.

Carlton County has a recent detailed soil survey (22). The soil survey was prepared by the Soil Conservation Service in cooperation with the Agricultural Experiment Station, University of Minnesota. Soils in the county were mapped to a resolution of about 2 1/2 acres. Fibric, fibric/hemic, hemic, and sapric peats were delineated.

The Department of Natural Resources has unpublished surficial geology maps of Koochiching and portions of Beltrami and Lake of the Woods Counties (5). The maps were made by air photo interpretation with selected field checking. The DNR also has a similar forthcoming publication for SW St. Louis County (6). The maps show glacial landforms, rock formations, peat areas, and bog patterns. Raised bogs are delineated and shown with respect to other bog patterns and landforms on a regional basis.

Scientific studies by Heinselman (17, 18) provided important information about bogs in Koochiching County. Similar studies by Finney (14, 15) provided information about raised bogs in Beltrami, Koochiching, and Lake Counties. Farnham reported a study of a large raised bog complex in St. Louis County (8).

Statewide Identification of Raised Bogs

The existing raised bog information is valuable. However, these earlier investigations lacked the continuity necessary for a statewide evaluation of raised bogs.

The author and Paul Rundell, DNR Parks and Recreation Division, made a statewide identification of raised bogs. The identification was by air photo interpretation. Rundell identified about two hundred raised bogs. The author confirmed Rundell's identifications and further identified twenty-five more raised bogs.

The primary identifying characteristic is the distribution of tree growth. On aerial photographs, the trees appear as irregular wavy lines or striations radiating out from a central core or axis resembling rays on a feather (Figures 7 and 9). The intensity and spacing of rays seem to reflect stages of development. Burns and drainage ditches altered the appearance of some raised bogs. However, remnant patterns usually allowed for identification in these cases. Also, many raised bogs were often in clusters. Some appeared to have coalesced or are beginning to coalesce to form large raised bog complexes.

Field Work

The MPIP field-checked sixty-one of the identified raised bogs. Aerial photos and U.S.G.S. quadrangle maps were used in selecting traverses across individual bogs. The traverses were laid out so that they would cross the bog where the air photo indicated the most pattern development. The relationship of the raised bog to surrounding peatlands, mineral soil, drainage, and existing information was also considered. Frequently, drainage ditches and dense tree growth required adjusting the traverses.

An all-terrain vehicle (J-5 Bombardier) was used to traverse the bogs. The density of observation and sampling sites along traverse lines varied from 0.17 to 0.52 km (1/10 to 3/10 mi) apart. The distance between the sites was determined by the appearance on the aerial photo and the homogeneity of the peat. At each site, a Macaulay or Davis peat sampler was used to examine the peat.

Peat characteristics, subsurface soil texture, native vegetation, microrelief, and water table levels were recorded at sample sites. Samples were collected using a Macaulay peat auger mounted on a J-5 Bombardier. Twin samples were collected at constant intervals throughout the profile, and one sample of the mineral substratum was collected. One peat sample was used for laboratory analysis; the second, along with the mineral sample, was stored in a sample library for future reference.

In areas of homogeneous peat where the peat was sampled less frequently, supplemental depth soundings were taken at selected intervals using a

hand-held Davis peat sampler. The peat was classified and its areal extent was determined from observations and the bog appearance on air photos.

Approximately eight hundred observations were made along the traverses. At two hundred and ten selected sites, samples were collected for laboratory analyses.

Representative Raised Bogs

Pine Island Raised Bog in Koochiching County (Figure 7) is representative of many of the raised bogs in the Glacial Lake Agassiz physiographic area. The surficial geology map, used in laying out traverse lines, identifying observation and sample sites, and the base for cross-sections appears on Figure 8. The site descriptions and the laboratory data for the sample sites appear in Appendix B. Appendix A gives the laboratory methods used.

The Arlberg Bog in St. Louis County lies within the Aurora-Alborn clay-till physiographic area (Figure 9). This bog has eight identified raised bogs and they appear to be coalescing. The eight raised bogs within the Arlberg Bog will be included in the phrase "Arlberg Bog". Existing information about this bog was used in selecting traverses and sample sites (8, 21). The MPIP sampled holes that were previously sampled by the IRRRB. The reason for resampling was for data comparison reasons. Also, one cross-section was made, exclusively, from IRRRB data (21).

Figure 10 shows the traverse lines, sample sites, and the surficial geology setting, and Figure 11 shows cross-sections of the Arlberg Bog. Both the MPIP and IRRRB site descriptions and laboratory data for the Arlberg Bog appear in Appendix B.

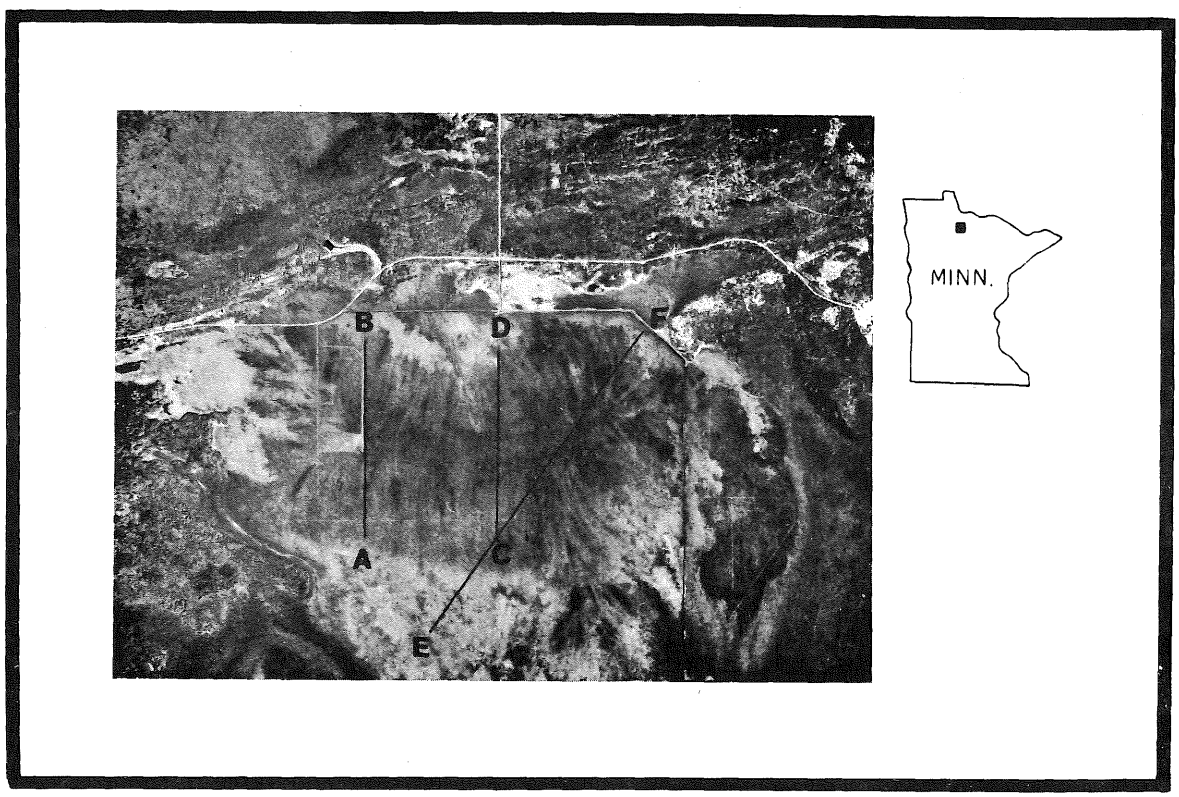


Figure 7. Aerial Photograph and Traverse Lines A-B, C-D, and E-F of Pine Island Raised Bog, Koochiching County, Minnesota (19). Scale: 1 inch equals 1 mile.

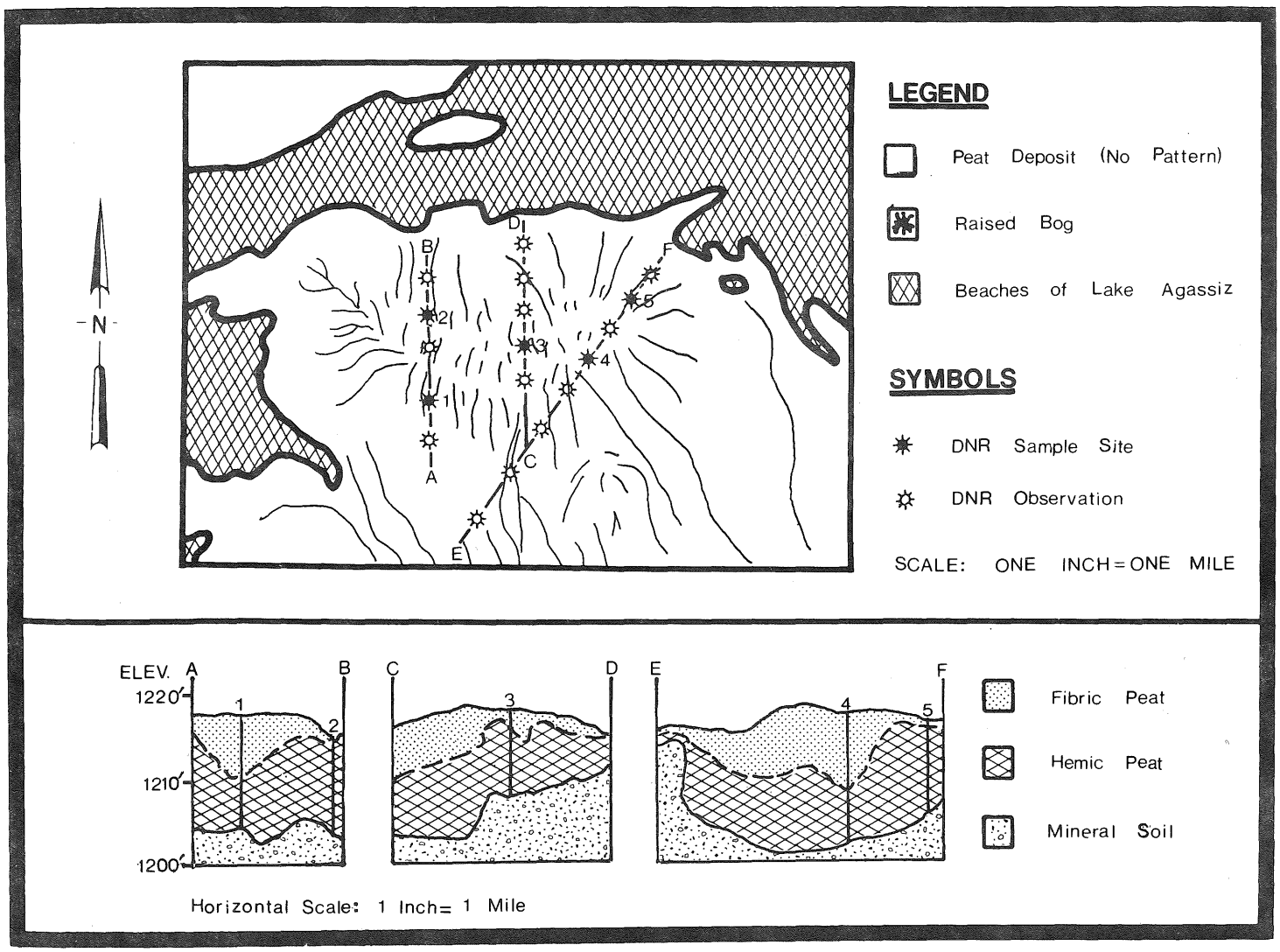


Figure 8. Traverse Locations, Obsevation and Sample Sites, and Cross-Sections for Traverse Lines A-B, C-D, and E-F, Pine Island Raised Bog, Koochiching County, Minnesota. Base map after Eng (5).

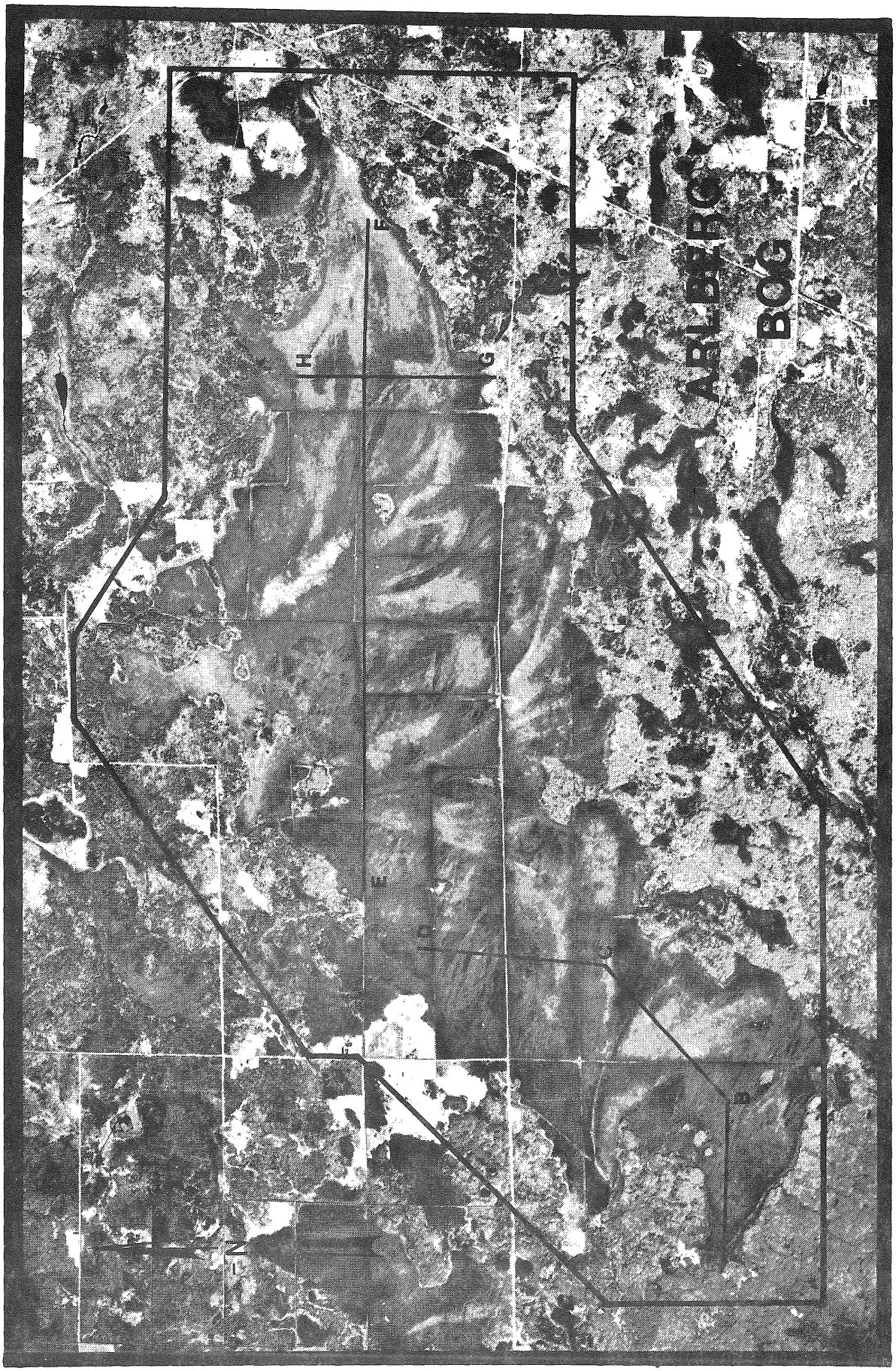


Figure 9. Aerial Photograph and Traverse Lines A-B-C-D, E-F, and G-H of Arlberg Bog, St. Louis County, Minnesota.

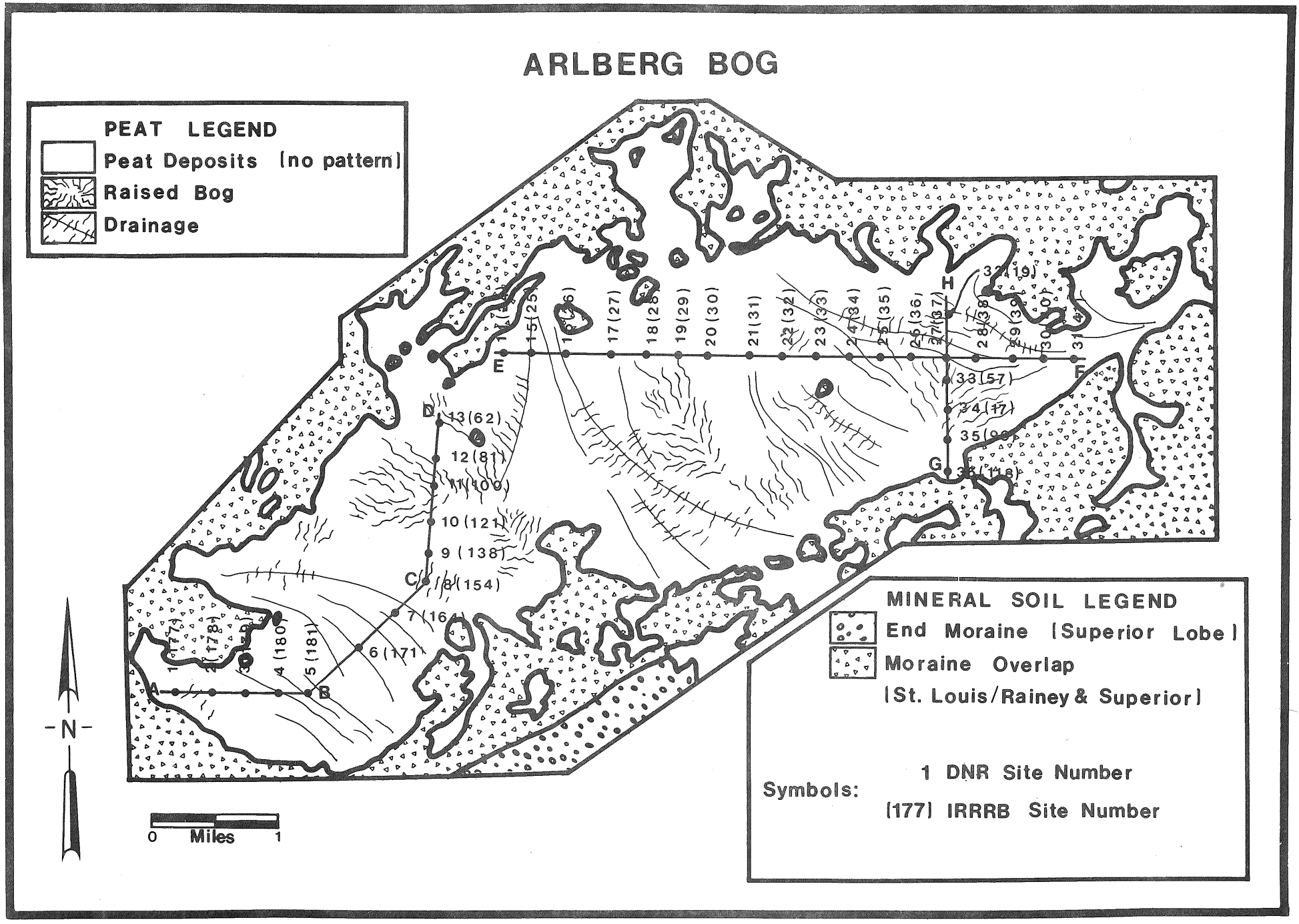


Figure 10. Traverse Lines A-B-C-D, E-F, and G-H and Sample Sites Along the Traverse Lines, Arlberg Bog, St. Louis County, Minnesota.

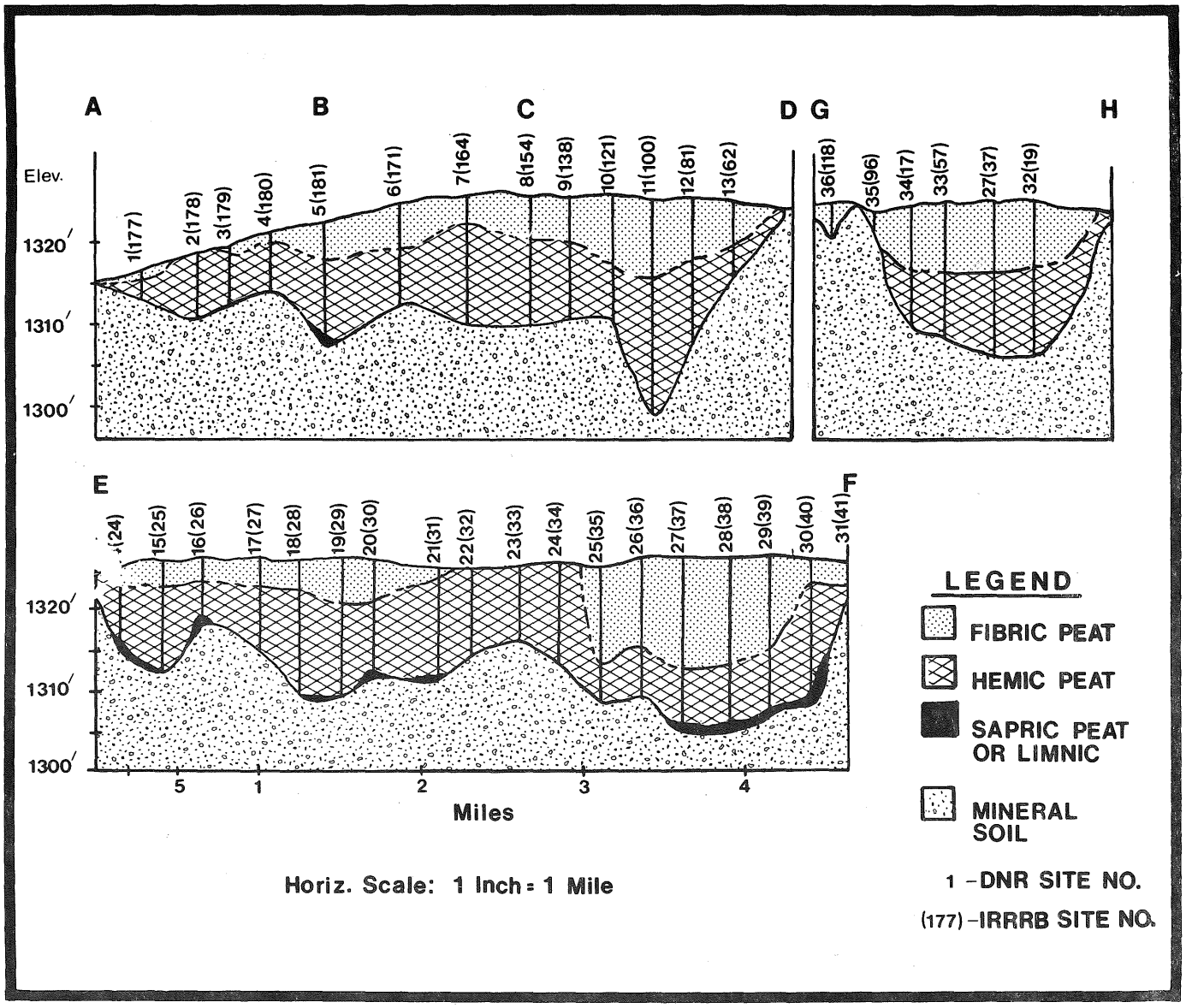


Figure 11. Cross-Sections of Traverses A-B-C-D, E-F, and G-H, Arlberg Bog, St. Louis County, Minnesota.

VII. RESULTS

Through aerial photograph interpretation, field work, laboratory analyses, and synthesis of existing information, the MPIP identified and evaluated two hundred and twenty-four raised bogs (see Distribution of Raised Bogs in Minnesota map in back-cover flap). The map shows the distribution, size, and depth of raised bogs.

On the above mentioned map, there are three fibric (sphagnum) peat categories. They are: 1) <0.6 m (<2 ft), 2) 0-1.5 m ($\sim$0-5 ft), and 3) 1.5- 3.0 m ($\sim$5-10 ft). Depth category 0-1.5 m ($\sim$0-5 ft) overlaps the depth category <0.6 m (<2 ft). At a reconnaissance level of inventory, bogs that were <0.6 m (<2 ft) could be distinquished. However, bogs that were 0-1.5 m ($\sim$0-5 ft) were best identified, categorized, and presented in a 0-1.5 m ($\sim$0-5 ft) category.

Some bogs were immediately adjacent to one another. To maintain spatial location for a map of this scale, sixteen of the <0.6 m (<2 ft), seven of the 0-1.5 m ($\sim$0-5 ft), and four of the 1.5-3.0m ($\sim$5-10 ft) units were combined and mapped as one unit The uncombined figures were used in the following tables.

The majority of raised bogs occur in Glacial Lakes Agassiz, Upham, and Aitkin areas. The remainder are distributed between moraines and till plains adjacent to the glacial lakes areas.

Collected samples were analyzed, in the Hibbing DNR laboratory, for bulk density, pH, water content, and mineral content. The decompositions were approximated in the field and accordingly, the peats were classified as fibric, hemic, and sapric. Laboratory analyses of the Pine Island and Arlberg Bog are in Appendix B. The remaining laboratory analyses will be published as the MPIP completes inventory work on the total resources of an area; *e.g.* Inventory of Peat Resources of SW St. Louis County, Minnesota (24).

The range and average value of four hundred and five analyzed fibric peat samples appear in Table 4. The analyses indicate that Minnesota's fibric peat is of equal quality to that now being sold commercially. The laboratory methods used in the analyses appears in Appendix A.

The depth, number of raised bogs, estimated acreage, average size, and percentage of total Minnesota peatland acreage are given in Table 5. Estimates of tonnage, cubic yards, and bales of Minnesota's fibric peat are given in Table 6.

For a sphagnum peat deposit to be economical, generally it must be five or more feet deep and occupy 100 or more acres. Nearly all of the raised bogs are large enough for a commercial peat harvesting operation. However, the majority of Minnesota's sphagnum moss deposits are 1.5 m (~5 ft) deep or less.

Forty-four raised bogs are estimated to have fibric peat that is 1.5-3.0 m (~5-10 ft) deep. These do have economic value. Also, sphagnum peat deposits less than 1.5 m (~5 ft) deep may have economic value when they occur with deeper peat.

Considering only the deeper peats, they represent 0.36 percent or 25,871 acres of Minnesota's total peat resource. The raised bogs represent a very small proportion of the total Minnesota peat resource and they should be judiciously managed.

Although small in relation to the statewide peat resources, these raised bogs have considerable value. The estimated 3.8×10^7 tons or 6.1×10^8 bales of fibric (sphagnum) peat is approximately two hundred and twenty times the total sphagnum moss peat production in the United States in 1977.

Appendix C gives a county by county breakdown of Tables 5 and 6.

Table 4. Summary of Analyses of Fibric Peat.

	Range	Average
pH	2.8- 4.5	3.8
Mineral Content (%)	4.0- 13.0	7.7
Water Content (%)	850-3000	1800

Table 5. Depth, Number of Raised Bogs, Estimated Acreage, Average Size, and Percentage of Total Minnesota Peatland.

Depth of Fibric Peat	Number of Bogs	Estimated Acres	Average Size (Acres)*	% of Total MN Peatlands**
<0.6 m; 0.3 m av (<2 ft; 1 ft av)	106	53,710	507	0.75
0-1.5 m; 0.75 m av (~0-5 ft; 2.5 ft av)	74	49,581	670	0.69
1.5-3.0 m; 2.25 m av (~5-10 ft; 7.5 ft av)	44	25,871	588	0.36
TOTAL	**224**	**129,162**		**1.80**

* Arithmetic mean.
** Using 7.2 million acres.

Table 6. Estimates of Tonnage, Cubic Yards, and Bales of Minnesota's Fibric Peat.

Depth of Fibric Peat	Estimated Tons*	Estimated Cubic Yards	Estimated Bales**
< 0.6 m; 0.3 m av (< 2 ft; 1 ft av)	1.1×10^7	8.4×10^7	1.7×10^8
0-1.5 m; 0.75 m av (~ 0-5 ft; 2.5 ft av)	2.5×10^7	1.9×10^8	3.9×10^8
1.5-3.0 m; 2.25 m av (~ 5-10 ft; 7.5 ft av)	3.8×10^7	3.1×10^8	6.1×10^8
TOTAL	**7.4×10^7**	**5.8×10^8**	**1.2×10^9**

* Estimated according to 1 acre-foot of peat in place being equivalent to 200 tons of air-dried peat.

** Estimated according to 1 cubic yard of fibric peat in place will yield two standard 6 cubic foot bales.

VIII. SUMMARY

The demand for horticultural peat, especially sphagnum moss peat, has been increasing since the early 1950's. Currently, the United States imports about 65 percent of its consumption of horticultural sphagnum moss peat.

Bogs that contain deposits of sphagnum moss (fibric peat) are commonly called "raised bogs". Sphagnum moss peat has horticultural importance because it has high water content, is acidic, and resists breakdown when used as a soil amendment.

In the lower 48 states, Minnesota has a large proportion of the commercially harvestable sphagnum moss peat deposits. However, there are only two active sphagnum moss peat harvesting operations in the State.

An inventory of the total amount and quality of Minnesota's sphagnum moss deposits has never been done. Presented in this report are the results of an inventory of Minnesota's raised bogs. The inventory was undertaken in conjunction with the ongoing Minnesota Peat Inventory Project (MPIP).

The primary purpose of the raised bog inventory was to present the location, size, quantity, and selected characteristics of sphagnum peat in Minnesota. No attempt was made to evaluate the feasibility of harvesting or social and economic variables.

Through air photo interpretation, field work, and existing information, two hundred and twenty-four raised bogs were identified. Their location, size, and estimated depth are presented on the Distribution of Raised Bogs in Minnesota map (back-cover flap).

Approximately eight hundred observations were made along traverse lines in sixty-one raised bogs. At two hundred and ten selected sites, samples were collected for laboratory analyses. The laboratory analyses confirmed that Minnesota's sphagnum moss (fibric) peat is of equal quality to that now being sold commercially.

Of the two hundred and twenty-four raised bogs, forty-four had estimated depths greater than 1.5 m (~ 5 ft) and were, therefore, considered to have commercial value. The acreage of the forty-four raised bogs is 25,871 or 0.36 percent of the total peatland in Minnesota. Because the raised bogs represent such a small proportion of the total Minnesota peat resource, they should be judiciously managed.

Although small in relation to the statewide peat resources, these raised bogs have considerable value. The estimated 3.8×10^7 tons or 6.1×10^8 bales of fibric (sphagnum) peat is approximately two hundred and twenty times the total sphagnum moss peat production in the United States in 1977. The 3.8×10^7 tons is also approximately seventy-five times the 1977 fibric (sphagnum) peat consumption in the United States.

In conclusion, the commercial sphagnum moss deposits account for only 0.36 percent of the total peatland in Minnesota. However, with regards to state and national sphagnum deposits, they have great potential for development.

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APPENDIX A

LABORATORY METHODS

MPIP LABORATORY METHODS

1. Bulk density (Db)

Bulk density is measured by taking a core of a known volume and oven-drying it to a constant weight (105°C for 24 hours). Calculations are carried out using the formula:

$$\text{Bulk density (g/cm}^3\text{)} = \frac{\text{oven-dry wt. core (g)}}{\text{vol. core (cm}^3\text{)}}$$

2. Water content

Water content is measured by taking approximately 100 g of a saturated peat sample and oven-drying it to a constant weight (105°C for 24 hours). The equation follows:

$$\text{Water content (\%)} = \frac{\text{weight of water (g)}}{\text{over-dry wt. (g)}} \times 100$$

3. pH

The pH of a sample is determined in two solutions: 1) by mixing the organic soil material in a 0.01M $CaCl_2$ solution; and 2) by mixing the organic soil material in deionized water. Lightly pack 15 cc of a peat sample in a 100 cc plastic container. Add 15 ml of a 0.015M $CaCl_2$ solution (final concentration of approximately 0.01M $CaCl_2$). Mix and allow to equilibrate for one hour before measuring with a pH meter Repeat the same process using deionized water.

4. Mineral content

The mineral content of a sample is determined by placing a pulverized sample of oven-dried peat (105°C for 24 hours) in a crucible and heating it at 500°C for thirty minutes. The sample is cooled and weighed. The weight of the ash equals the mineral content. Mineral content is calculated from the following equation:

$$\text{Mineral content (\%)} = \frac{\text{weight of ash (g)}}{\text{oven-dry wt. (g)}} \times 100$$

IRRRB LABORATORY METHODS

Samples collected by the Iron Range Resources and Rehabilitation Board and the University of Minnesota were analyzed at the University. The Soil Science Laboratory used standard peat laboratory methods.

APPENDIX B

PINE ISLAND AND ARLBERG RAISED BOG SITE DESCRIPTIONS AND LABORATORY DATA.

Pine Island Raised Bog, Koochiching County, Minnesota

The MPIP site descriptions include the site number, date, observers, types of vegetation, depths, and classification of peat. These are itemized below along with the laboratory analyses.

In situations where MPIP and IRRRB sampled the same sites, the IRRRB site numbers are in parenthesis. Both descriptions and laboratory results are given.

Site Number: 1
Location: NE1/4 of NE1/4 of SE1/4 of SW1/4, Sec. 27, T.156N., R. 28W.
Vegetation: Black spruce crown cover of about 50 percent; sparse understory consists of Labrador tea and leatherleaf with some swamp laurel and bog rosemary; ground cover consists of mosses, cranberry, and grasses.
Microrelief: 35 cm.
Depth To Water Table: At surface.
Described And Sampled By: T. Malterer, K. Hayner, and B. Balen on September 27, 1978.

Layer	Depth	Sample Depth	Bulk Density	Water Content	pH		Mineral Content
					H_20	$CaCl_2$	
	(cm)	(cm)	(g/cm^3)	(%)			(%)
Fibric	0-240	35- 50	0.06	1820	3.7	3.1	3.1
Hemic	240-416	85-100	0.07	1693	4.0	3.6	4.4
Sapric	416-422	135-150	0.07	1950	5.2	4.4	5.0
Silt	422-431	185-200	0.10	1305	5.7	5.2	10.0
loam		235-250	0.13	1083	5.8	5.4	7.8
Medium	431+	285-300	0.14	999	5.9	5.5	9.5
sand		335-350	0.12	1181	5.5	5.1	9.3

Site Number: 2
Location: NE1/4 of NE1/4 of SE1/4 of NW1/4, Sec. 27, T.156N., R. 28W.
Vegetation: Black spruce crown cover of about 25 percent; lush understory consists of leatherleaf and swamp laurel with Labrador tea, bog rosemary, cotton grass, sedges, and other grasses, ground cover consists of cranberry and mosses.
Microrelief: 40 cm.
Depth To Water Table: At surface.
Described And Sampled By: T. Malterer, K. Hayner, and B. Balen on September 27, 1978.

Layer	Depth	Sample Depth	Bulk Density	Water Content	pH		Mineral Content
					H_20	$CaCl_2$	
	(cm)	(cm)	(g/cm^3)	(%)			(%)
Fibric	0- 50	35- 50	0.05	1744	4.0	3.0	5.8
Hemic	50-353	85-100	0.09	1462	3.7	3.0	3.4
Sapric	353-365	135-150	0.08	1540	4.1	3.4	4.5
Sandy	365-370	185-200	0.09	1514	3.9	3.0	4.3
loam		235-250	0.12	1226	4.7	4.2	9.6
Coarse	370-374	285-300	0.10	1277	5.2	4.7	6.6
and medium sand		335-350	0.11	1276	5.5	5.1	8.5
Sand loam	374+						

Site Number: 3
Location: NE1/4 of NE1/4 of NE1/4 of SE1/4, Sec. 27, T.156N., R. 28W.
Vegetation: Black spruce crown cover of about 90 percent; lush understory consists of Labrador tea with some leatherleaf, swamp laurel, and bog rosemary; ground cover consists of sphagnum and other mosses.
Microrelief: 40 cm.
Depth To Water Table: At surface.
Described And Sampled By: T. Malterer, K. Hayner, and B. Balen on September 27, 1978.

Layer	Depth	Sample Depth	Bulk Density	Water Content	pH		Mineral Content
					H_20	$CaCl_2$	
	(cm)	(cm)	(g/cm^3)	(%)			(%)
Fibric	0- 33	35- 50	0.10	1347	4.1	3.7	10.4
Hemic	33-326	85-100	0.08	1560	5.7	5.3	7.8
Medium	326+	135-150	0.06	1976	6.0	5.6	6.2
sand		185-200	0.06	1912	6.0	5.5	8.3
		235-250	0.09	1343	5.9	5.3	8.2
		285-300	0.12	1195	6.1	5.7	9.8
		306-321	0.15	873	6.1	5.7	11.9

Site Number: 4
Location: SE1/4 of SW1/4 of NE1/4 of SW1/4, Sec. 26, T.156N., R. 28W.
Vegetation: Black spruce crown cover of about 90 percent with scattered tamarack; lush understory consists of Labrador tea with some leatherleaf; ground cover consists of sphagnum mosses, cranberry, and other mosses.
Microrelief: 50 cm.
Depth To Water Table: At surface.
Described And Sampled By: D. Mellem, B. Leuelling, and B. Balen on September 14, 1978.

Layer	Depth	Sample Depth	Bulk Density	Water Content	pH		Mineral Content
					H_20	$CaCl_2$	
	(cm)	(cm)	(g/cm^3)	(%)			(%)
Fibric	0-284	35- 50	0.08	1059	3.7	2.9	7.1
Hemic	284-473	85-100	0.08	1056	3.7	2.9	3.4
Sapric	473-480	135-150	0.07	1256	3.5	2.9	2.1
Fine	480+	185-200	0.07	1173	3.6	3.0	2.6
sand w/		235-250	0.07	1389	3.8	3.2	3.5
pebbles		285-300	0.09	952	4.3	3.7	4.5
		335-350	0.12	780	4.9	4.4	9.7
		385-400	0.11	764	5.0	4.7	6.9
		435-450	0.12	1186	5.2	5.0	7.1
		465-480	0.15	954	4.9	4.7	21.7

Site Number: 5
Location: NE1/4 of NE1/4 of SW1/4 of NE1/4, Sec. 26, T.156N., R. 28W.
Vegetation: Black spruce crown cover of about 90 percent; understory consists mostly of Labrador tea with some leatherleaf, swamp laurel, and bog rosemary; ground cover consists mostly of sphagnum moss, cranberry, and other mosses.
Microrelief: 40 cm.
Depth To Water Table: At surface.
Described And Sampled By: T. Malterer, D. Mellem, B. Leuelling, and B. Balen on September 12, 1978.

Layer	Depth	Sample Depth	Bulk Density	Water Content	pH		Mineral Content
					H_20	$CaCl_2$	
	(cm)	(cm)	(g/cm^3)	(%)			(%)
Hemic	0- 27	35- 50	0.07	1275	3.7	2.9	7.8
Fibric	27-136	85-100	0.07	1255	4.1	3.3	3.8
Hemic	136-379	135-150	0.09	1008	4.1	3.3	5.2
Sapric	379-390	185-200	0.09	944	4.8	4.1	6.3
Medium	390+	235-250	0.08	1037	5.4	5.0	7.2
sand w/		285-300	0.13	696	5.4	5.2	11.2
calcareous		335-350	0.14	668	5.7	5.0	10.6
pebbles		375-390	0.25	335	5.3	4.9	48.3

Arlberg Bog, St. Louis County, Minnesota

Site Number: 1
Location: SW1/4 of SW1/4 of SW1/4 of NW1/4, Sec. 16, T.51N., R.19W.
Vegetation: Black spruce crown cover of about 95 percent; understory consists of leatherleaf and bog rosemary; ground cover consists mostly of sphagnum mosses.
Microrelief: 35 cm.
Depth To Water Table: 85 cm.
Described And Sampled By: D. Olson and J. Atkins on February 14, 1978.

Layer	Depth	Sample Depth	Bulk Density	Water Content	pH		Mineral Content
					H_20	$CaCl_2$	
	(cm)	(cm)	(g/cm^3)	(%)			(%)
Hemic	0-215	35- 50	0.10	764	3.8	3.2	8.5
Silt	215-236	85-100	0.14	538	4.0	3.3	5.6
Silty	236+	135-150	0.29	273	4.4	3.8	5.5
clay		185-200	0.20	381	5.0	4.4	19.1

Site Number: (177)
Location: SW1/4 of SW1/4 of SW1/4 of NW1/4, Sec. 16, T.51N., R.19W.
Vegetation: Thin spruce 1/2" - 4" diameter, 2' - 20' high, leatherleaf and sphagnum moss. Dry hole.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Sphagnum	3.7	4.4	2850
30- 61	1-2	Sphagnum	3.8	6.0	2137
61- 91	2-3	Herbaceous-Decomposed	4.4	30.0	636
91-122	3-4	Herbaceous-Decomposed	5.1	37.6	239
122+	4+	Gray Clay			

Site Number: 2
Location: SW1/4 of SW1/4 of SE1/4 of NW1/4, Sec. 16, T.51N., R.19W.
Vegetation: Black spruce crown cover of about 30 percent; understory consists of leatherleaf, swamp laurel, and bog rosemary; ground cover consists mostly of sphagnum mosses.
Microrelief: 40 cm.
Depth To Water Table: 91 cm.
Described And Sampled By: D. Mellem and T. Malterer on February 14, 1978.

Layer	Depth	Sample Depth	Bulk Density	Water Content	pH		Mineral Content
	(cm)	(cm)	(g/cm³)	(%)	H_2O	$CaCl_2$	(%)
Fibric	0- 25	35- 50	0.16	497	3.6	3.0	12.2
Hemic	25-199	85-100	0.13	652	4.0	3.2	4.7
Sampler	199+	135-150	0.13	703	4.2	3.4	5.1
would not penetrate		185-200	0.16	539	4.6	3.8	6.1

Site Number: (178)
Location: SW1/4 of SW1/4 of SE1/4 of NW1/4, Sec. 16, T.51N., R.19W.
Vegetation: Thin spruce 1/2" - 4" diameter, 2' - 20' high, cotton grass, leatherleaf and some sphagnum moss. Dry hole.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Sphagnum-Herbaceous	3.9	6.9	1024
30- 61	1-2	Sphagnum-Herbaceous	3.9	8.0	1569
61- 91	2-3	Herbaceous-Sphagnum	4.1	4.2	1009
91-122	3-4	Herbaceous	4.3	5.9	1060
122-152	4-5	Herbaceous	4.5	4.7	1011
152-183	5-6	Herbaceous-Decomposed	4.7	15.4	677
183-213	6-7	Herbaceous-Decomposed	5.0	36.2	368
213+	7+	Gray Clay			

Site Number: 3
Location: SW1/4 of SW1/4 of SW1/4 of NE1/4, Sec. 16, T.51N., R.19W.
Vegetation: Black spruce crown cover of about 30 percent; understory consists of leatherleaf, swamp laurel, and bog rosemary; ground cover consists mostly of sphagnum mosses.
Microrelief: 40 cm.
Depth To Water Table: 80 cm.
Described And Sampled By: D. Mellem and T. Malterer on February 14, 1978.

Layer	Depth	Sample Depth	Bulk Density	Water Content	pH		Mineral Content
	(cm)	(cm)	(g/cm³)	(%)	H_2O	$CaCl_2$	(%)
Fibric	0- 30	35- 50	0.10	809	3.8	3.0	8.0
Hemic	30-205	85-100	0.08	1072	4.0	3.2	3.6
Sampler	205+	135-150	0.11	876	4.0	3.2	2.6
would not penetrate		185-200	0.14	631	4.2	3.4	5.5

Site Number: (179)
Location: SW1/4 of SW1/4 of SW1/4 of NE1/4, Sec. 16, T.51N., R.19W.
Vegetation: Thin spruce 1/2" - 3" diameter, 2'- 15' high, scattered tamarack, cotton grass, leatherleaf, and sphagnum moss. Surface water.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Herbaceous-Sphagnum	4.4	17.4	1435
30- 61	1-2	Sphagnum	4.7	4.1	-
61- 91	2-3	Sphagnum	4.3	6.4	1974
91-122	3-4	Herbaceous-Sphagnum	4.4	4.4	1480
122-152	4-5	Herbaceous Partly Decomposed	4.6	14.8	1067
152-183	5-6	Herbaceous	5.2	8.1	1446
183-213	6-7	Herbaceous	5.3	4.8	1484
213+	7+	Gray Clay			

Site Number: 4
Location: SW1/4 of SW1/4 of SE1/4 of NE1/4, Sec. 16, T.51N., R.19W.
Vegetation: Scattered black spruce and tamarack; understory consists of Labrador tea, leatherleaf, swamp laurel, and bog rosemary; ground cover consists mostly of sphagnum mosses.
Microrelief: 35 cm.
Depth To Water Table: 60 cm.
Described And Sampled By: D. Olson and J. Atkins on February 14, 1978.

Layer	Depth	Sample Depth	Bulk Density	Water Content	pH		Mineral Content
	(cm)	(cm)	(g/cm³)	(%)	H_20	$CaCl_2$	(%)
Fibric	0- 27	35- 50	0.14	585	3.7	3.0	6.8
Hemic	27- 56	85-100	0.10	882	3.8	3.0	3.7
Fibric	56- 75	135-150	0.09	949	4.2	3.2	5.0
Hemic	75- 95	185-200	0.07	1189	4.4	3.4	3.4
Fibric	95-136	235-250	0.20	407	4.8	3.8	4.8
Hemic	136-438	285-300	0.24	308	5.0	4.2	4.9
Silt	438-444	335-350	0.19	436	5.4	4.6	14.5
Limnic	444-463	385-400	0.19	410	5.7	5.0	12.7
Very fine sand	463+	415-430	0.25	305	5.4	4.8	9.3

Site Number: 5
Location: NW1/4 of NW1/4 of NW1/4 of SW1/4, Sec. 15, T.51N. R.19W.
Vegetation: Scattered black spruce and tamarack; understory consists of Labrador tea, leatherleaf, swamp laurel, and bog rosemary; ground cover consists mostly of sphagnum mosses
Microrelief: 40 cm.
Depth To Water Table: 46 cm.
Described And Sampled By: D. Mellem and J. Atkins on February 13, 1978.

Layer	Depth	Sample Depth	Bulk Density	Water Content	pH		Mineral Content
	(cm)	(cm)	(g/cm³)	(%)	H_20	$CaCl_2$	(%)
Hemic	0- 30	35- 50	0.08	1063	4.0	3.0	3.9
Fibric	30-145	85-100	0.08	1090	4.0	3.2	3.8
Hemic	145-170	135-150	0.09	1023	4.2	3.4	4.2
Fibric	170-180	185-200	0.10	866	4.4	3.6	6.3
Hemic	180-349	235-250	0.12	730	4.6	3.6	6.5
Limnic	349-354	285-300	0.13	709	4.8	4.0	12.7
Coarse sand	354-360	334-349	0.15	637	5.2	4.4	12.6
Silt loam	360+						

Site Number: (180)
Location: SW1/4 of SW1/4 of SE1/4 of NE1/4, Sec. 16, T.51N., R.19W.
Vegetation: Thin spruce 1/2" - 3" diameter, 2' - 20' high, scattered large tamarack, cotton grass, leatherleaf, and sphagnum moss. Dry hole.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Sphagnum	-	13.2	1770
30- 61	1-2	Sphagnum	-	4.3	-
61- 91	2-3	Sphagnum	-	6.9	1926
91-122	3-4	Sphagnum	-	2.7	2843
122-152	4-5	Sphagnum	4.0	2.8	1866
152-183	5-6	Sphagnum-Herbaceous	4.0	5.9	1413
183-213	6-7	Sphagnum-Herbaceous	4.4	7.4	1508
244+	8+	Gray Sandy Clay			

Site Number: (181)
Location: NW1/4 of NW1/4 of NW1/4 of SW1/4, Sec. 15, T.51N., R.19W.
Vegetation: Thin spruce 1/2" - 3" diameter, 2' - 20' high, leatherleaf, cotton grass, and sphagnum moss. A trickle of water at 4 feet.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Sphagnum-Herbaceous	3.7	11.1	1068
30- 61	1-2	Sphagnum	3.7	2.2	2970
61- 91	2-3	Sphagnum	4.0	1.9	3155
91-122	3-4	Sphagnum	4.0	2.1	1551
122-152	4-5	Sphagnum	4.2	2.8	3356
152-183	5-6	Sphagnum	4.3	2.4	2626
183-213	6-7	Sphagnum	4.5	3.3	2522
427+	14+	Gray Clay			

Site Number: 6
Location: NE1/4 of NE1/4 of SW1/4 of NW1/4, Sec. 15, T.51N., R.19W.
Vegetation: Scattered black spruce and tamarack; understory consists of leatherleaf with some swamp laurel and bog rosemary; ground cover consists mostly of sphagnum mosses with some cranberry.
Microrelief: 45 cm.
Depth To Water Table: At surface.
Described And Sampled By: D. Mellem and J. Atkins on February 13, 1978.

Layer	Depth	Sample Depth	Bulk Density	Water Content	pH		Mineral Content
					H_20	$CaCl_2$	
	(cm)	(cm)	(g/cm^3)	(%)			(%)
Fibric	0-150	35- 50	0.12	670	4.0	3.2	7.6
Hemic	150-160	85-100	0.07	1216	4.1	3.3	4.1
Fibric	160-230	135-150	0.07	1226	4.2	3.4	3.8
Hemic	230-316	185-200	0.10	893	4.3	3.6	6.6
Sandy	316+	235-250	0.14	654	4.6	3.8	10.3
clay		285-300	0.13	657	4.8	4.0	6.2

Site Number: 7
Location: SE1/4 of SW1/4 of SE1/4 of SW1/4, Sec. 10, T.51N., R.19W.
Vegetation: Scattered black spruce; understory consists of Labrador tea, leatherleaf, and swamp laurel; ground cover consists mostly of sphagnum mosses.
Microrelief: 51 cm.
Depth To Water Table: At surface.
Described And Sampled By: T. Malterer and J. Atkins on February 15, 1978.

Layer	Depth	Sample Depth	Bulk Density	Water Content	pH		Mineral Content
					H_20	$CaCl_2$	
	(cm)	(cm)	(g/cm^3)	(%)			(%)
Hemic	0-389	35- 50	0.10	882	4.2	3.4	6.3
Sapric	389-392	85-100	0.05	1482	4.7	3.7	4.7
Fine to	392+	135-150	0.10	875	4.6	3.8	4.7
medium		185-200	0.09	935	4.8	3.6	6.6
sand		235-250	0.13	643	5.0	4.1	6.8
		285-300	0.12	698	5.0	4.4	6.3
		335-350	0.12	694	5.4	4.6	10.4
		375-390	0.15	581	5.6	4.9	14.5

Site Number: (171)
Location: NE1/4 of NE1/4 of SW1/4 of NW1/4, Sec. 15, T.51N., R.19W.
Vegetation: Open - a few scattered tamarack 4' - 15' high, cotton grass, leatherleaf, and sphagnum moss. Ankle deep surface water.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Sphagnum-Herbaceous	4.0	6.9	1064
30- 61	1-2	Sphagnum	3.8	5.0	1351
61- 91	2-3	Sphagnum	4.3	4.2	1655
91-122	3-4	Sphagnum	4.3	4.2	2758
122-152	4-5	Sphagnum	4.0	3.0	1658
152-183	5-6	Herbaceous-Sphagnum	4.5	15.9	1603
183-213	6-7	Herbaceous Partly Decomposed	4.6	7.6	1075
366+	12+	Gray Clay			

Site Number: (164)
Location: SE1/4 of SW1/4 of SE1/4 of SW1/4, Sec. 10, T.51N., R.19W.
Vegetation: Spruce 1" - 7" diameter, 5' - 30' high, scattered tamarack, cotton grass, some leatherleaf and sphagnum moss. Surface water flow.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Sphagnum-Herbaceous	3.9	8.8	1556
30- 61	1-2	Sphagnum-Herbaceous	3.8	7.2	1401
61- 91	2-3	Herbaceous	4.4	3.8	1385
91-122	3-4	Herbaceous	4.7	6.6	1417
122-152	4-5	Herbaceous	4.5	4.5	1430
152-183	5-6	Herbaceous	4.6	5.4	1321
183-213	6-7	Herbaceous	4.8	7.2	1312
427+	14+	Gray Clay			

Site Number: 8
Location: NW1/4 of NW1/4 of SW1/4 of SE1/4, Sec. 10, T.51N., R.19W.
Vegetation: Scattered black spruce and tamarack; understory consists mostly of leatherleaf with some swamp laurel and bog rosemary; ground cover consists mostly of sphagnum mosses.
Microrelief: 40 cm.
Depth To Water Table: At surface.
Described And Sampled By: D. Mellem and T. Malterer on February 9, 1978.

Layer	Depth	Sample Depth	Bulk Density	Water Content	pH		Mineral Content
					H_2O	$CaCl_2$	
	(cm)	(cm)	(g/cm^3)	(%)			(%)
Hemic	0-493	35- 50	0.10	820	4.8	3.9	8.2
Limnic	493-510	85-100	0.08	961	4.8	3.8	4.8
Silt and	510+	135-150	0.11	839	4.9	3.9	4.9
fine sand		185-200	0.11	799	5.1	4.2	5.9
		235-250	0.14	635	5.3	4.4	8.0
		285-300	0.12	710	5.5	4.8	7.7
		335-350	0.14	622	5.6	5.0	10.6
		385-400	0.16	517	5.8	5.2	19.8
		435-450	0.15	628	5.8	5.2	6.3
		452-473	0.12	751	5.9	5.2	4.6
		474-489	0.12	811	6.3	5.8	21.6

Site Number: (154)
Location: NW1/4 of NW1/4 of SW1/4 of SE1/4, Sec. 10, T.51N., R.19W.
Vegetation: Thin spruce and tamarack 1" - 5" diameter, 3' - 30' high, cotton grass, leatherleaf, and sphagnum moss. Surface water flow.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Herbaceous-Sphagnum	4.4	7.2	1164
30- 61	1-2	Sphagnum	4.4	5.3	2528
61- 91	2-3	Sphagnum	4.5	4.4	1949
91-122	3-4	Sphagnum	4.5	4.6	2179
122-152	4-5	Herbaceous	4.5	7.9	1212
152-183	5-6	Herbaceous	4.9	7.8	1513
183-213	6-7	Herbaceous	4.5	5.9	1397
427+	14+	Gray Clay			

Site Number: 9 (Not sampled by DNR).

Site Number: (138)
Location: SE1/4 of SE1/4 of SW1/4 of NE1/4, Sec. 10, T.51N., R.19W.
Vegetation: Mostly open - a few scattered tamarack, cotton grass, leatherleaf, and sphagnum moss. Surface water.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Sphagnum-Herbaceous	3.7	7.5	886
30- 61	1-2	Sphagnum	3.9	3.4	1425
61- 91	2-3	Sphagnum	3.8	3.5	1475
91-122	3-4	Sphagnum	3.9	10.5	1498
122-152	4-5	Sphagnum	3.9	3.1	1508
152-183	5-6	Herbaceous-Sphagnum	4.2	3.4	1180
183-213	6-7	Herbaceous Partly Decomposed	4.3	5.6	954
396+	13+	Bottom - Hard			

Site Number: 10 (Not sampled by DNR).

Site Number: (121)
Location: SW1/4 of SW1/4 of NW1/4 of SE1/4, Sec. 10, T.51N., R.19W.
Vegetation: Spruce 1/2" - 5" diameter, 2' - 25' high, scattered large tamarack, leatherleaf, and sphagnum moss. Surface water flow.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Sphagnum	3.4	-	2618
30- 61	1-2	Sphagnum	3.3	7.5	1007
61- 91	2-3	Sphagnum	3.3	2.1	1745
91-122	3-4	Sphagnum	3.4	2.4	1854
122-152	4-5	Sphagnum	3.6	2.6	1446
152-183	5-6	Sphagnum	3.7	3.2	1572
183-213	6-7	Sphagnum	3.5	2.7	1702
427+	14+	Gravel and Rock			

Site Number: 11 (Not sampled by DNR).

Site Number: (100)
Location: SE1/4 of NE1/4 of SW1/4 of SE1/4, Sec. 3, T.51N., R.19W.
Vegetation: Opening - scattered spruce 2' - 8' high (surrounded by large thick spruce), cotton grass, leatherleaf, and sphagnum moss. Surface water.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Sphagnum-Herbaceous	4.0	4.9	1156
30- 61	1-2	Sphagnum	4.1	6.8	1666
61- 91	2-3	Sphagnum	3.8	3.0	2183
91-122	3-4	Sphagnum	3.8	3.2	1333
122-152	4-5	Sphagnum	3.8	2.7	1712
152-183	5-6	Sphagnum	3.8	4.3	1823
183-213	6-7	Sphagnum	4.3	4.5	1910
762+	25+	Gray Clay			

Site Number: 12 (Not sampled by DNR).

Site Number: (81)
Location: NE1/4 of NE1/4 of NW1/4 of SE1/4, Sec. 3, T.51N., R.19W.
Vegetation: Thick spruce 2" - 7" diameter, 10' - 35' high, leatherleaf, Labrador tea, and sphagnum moss. Small surface water flow.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Sphagnum	3.4	4.6	2183
30- 61	1-2	Sphagnum	3.2	3.9	1715
61- 91	2-3	Sphagnum	3.8	2.8	-
91-122	3-4	Sphagnum	3.7	5.5	1780
122-152	4-5	Sphagnum-Herbaceous	4.1	6.6	1452
152-183	5-6	Sphagnum-Herbaceous	4.0	4.6	1340
183-213	6-7	Sphagnum-Herbaceous	4.1	4.9	1615
396+	13+	Gray Clay			

Site Number: 13 (Not sampled by DNR).

Site Number: (62)
Location: SE1/4 of SE1/4 of SE1/4 of NE1/4, Sec. 3, T.51N., R.19W.
Vegetation: Spruce 1" - 6" diameter, 3' - 35' high, leatherleaf, and sphagnum moss. Surface water flow.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Sphagnum	3.6	6.2	1546
30- 61	1-2	Sphagnum	3.5	2.7	1862
61- 91	2-3	Sphagnum	4.1	2.7	1799
91-122	3-4	Sphagnum	4.3	2.2	2437
122-152	4-5	Sphagnum-Herbaceous	4.1	4.0	1495
152-183	5-6	Herbaceous-Decomposed	4.4	10.3	852
183-213	6-7	Herbaceous-Decomposed	4.5	5.5	993
244+	8+	Gray Clay			

Site Number: 14
Location: SW1/4 of SE1/4 of SE1/4 of SW1/4, Sec. 35, T.52N., R.19W.
Vegetation: Black spruce crown cover of about 60 percent; sparse understory consists of Labrador tea, leatherleaf, swamp laurel, and bog rosemary; ground cover consists mostly of sphagnum mosses.
Microrelief: 40 cm.
Depth To Water Table: 70 cm.
Described And Sampled By: D. Olson and T. Malterer on February 21, 1978.

Layer	Depth	Sample Depth	Bulk Density	Water Content	pH		Mineral Content
					H_20	$CaCl_2$	
	(cm)	(cm)	(g/cm^3)	(%)			(%)
Hemic	0- 40	35- 50	0.15	578	3.9	3.0	7.9
Fibric	40- 75	85-100	0.14	612	4.0	3.2	5.2
Hemic	75-264	135-150	0.16	522	4.2	3.4	5.6
Sapric	264-269	185-200	0.13	643	4.6	3.6	6.2
Silt	269+	235-250	0.21	433	4.8	4.0	15.2

Site Number: 15
Location: NE1/4 of SE1/4 of SE1/4 of SW1/4, Sec. 35, T.52N., R.19W.
Vegetation: Black spruce crown cover of about 20 percent; sparse understory consists of Labrador tea, leatherleaf, swamp laurel, and bog rosemary; ground cover consists mostly of sphagnum mosses.
Microrelief: 50 cm.
Depth To Water Table: 90 cm.
Described And Sampled By: D. Mellem and J. Atkins on February 22, 1978.

Layer	Depth	Sample Depth	Bulk Density	Water Content	pH		Mineral Content
					H_20	$CaCl_2$	
	(cm)	(cm)	(g/cm^3)	(%)			(%)
Fibric	0- 45	45- 60	0.15	555	3.8	3.0	7.8
Hemic	45- 60	85-100	0.14	606	4.0	3.2	10.7
Fibric	60- 70	135-150	0.15	645	4.6	3.7	7.8
Hemic	70-365	185-200	0.13	695	5.1	4.2	7.9
Hemic with silt particles	365-375	235-250	0.14	667	5.0	4.6	13.2
		285-300	0.16	561	5.6	5.0	13.2
		335-350	0.14	644	5.8	5.2	8.7
Silt	375+						

Site Number (24)
Location: SW1/4 of SE1/4 of SE1/4 of SW1/4, Sec. 35, T.52N., R.19W.
Vegetation: Spruce 2" - 9" diameter, 10' - 50' high, Labrador tea, cotton grass, and sphagnum moss.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Sphagnum	3.7	5.4	1747
30- 61	1-2	Herbaceous Partly Decomposed	4.0	6.0	1177
61- 91	2-3	Herbaceous Partly Decomposed	4.2	4.6	898
91-122	3-4	Herbaceous Partly Decomposed	4.1	8.1	1217
122-152	4-5	Herbaceous Partly Decomposed	4.8	13.5	996
152-183	5-6	Herbaceous Partly Decomposed	4.8	9.8	1157
183-213	6-7	Herbaceous	5.2	6.4	1295
396+	13+	Gray Sandy Clay			

Site Number: (25)
Location: NE1/4 of SE1/4 of SE1/4 of SW1/4, Sec. 35, T.52N., R.19W.
Vegetation: Thin spruce 1" - 4" diameter, 3' - 20' high, leatherleaf, Labrador tea, and sphagnum moss. Small surface water flow.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Sphagnum-Herbaceous	3.7	9.8	925
30- 61	1-2	Sphagnum	3.8	2.5	1937
61- 91	2-3	Sphagnum-Herbaceous	4.0	4.5	1228
91-122	3-4	Sphagnum-Herbaceous	4.4	3.3	1414
122-152	4-5	Herbaceous Partly Decomposed	4.5	7.0	1044
152-183	5-6	Herbaceous-Sphagnum	4.7	5.8	1256
183-213	6-7	Herbaceous-Sphagnum	4.9	7.4	1156
732+	24+	Gray Clay			

Site Number: 16
Location: NE1/4 of SE1/4 of SW1/4 of SE1/4, Sec. 35, T.52N., R.19W.
Vegetation: Scattered black spruce and tamarack; understory consists mostly of leatherleaf, swamp laurel, and bog rosemary; ground cover consists mostly of sphagnum mosses.
Microrelief: 30 cm.
Depth To Water Table: 30 cm.
Described And Sampled By: T. Malterer and J. Atkins on February 23, 1978.

Layer	Depth	Sample Depth	Bulk Density	Water Content	pH		Mineral Content
					H_20	$CaCl_2$	
	(cm)	(cm)	(g/cm^3)	(%)			(%)
Fibric	0- 35	35- 50	0.16	524	4.2	3.8	9.3
Hemic	35-175	85-100	0.16	539	5.0	4.2	6.3
Sapric	175-180	135-150	0.16	593	5.0	4.2	6.8
Medium and coarse sand	180+						

Site Number: 17
Location: NE1/4 of SW1/4 of SW1/4 of SW1/4, Sec. 36, T.52N., R.19W.
Vegetation: Scattered black spruce and tamarack; understory consists of leatherleaf, swamp laurel, and bog rosemary; ground cover consists mostly of sphagnum mosses.
Microrelief: 35 cm.
Depth To Water Table: 30 cm.
Described And Sampled By: D. Olson and T. Malterer on February 22, 1978.

Layer	Depth	Sample Depth	Bulk Density	Water Content	pH		Mineral Content
					H_20	$CaCl_2$	
	(cm)	(cm)	(g/cm^3)	(%)			(%)
Hemic	0- 37	35- 50	0.12	725	4.0	3.0	4.2
Fibric	37- 65	85-100	0.14	614	3.8	3.0	3.7
Hemic	65-250	135-150	0.16	598	4.0	3.2	5.4
Silt	250-265	185-200	0.15	608	4.2	3.4	5.0
Fine sand and silt	265+	235-250	0.17	524	4.6	3.7	9.3

Site Number: (26)
Location: NE1/4 of SE1/4 of SW1/4 of SE1/4, Sec. 35, T.52N., R.19W.
Vegetation: A few scattered spruce 1" - 5" diameter, 4' - 25' high, 2' - 3' bog birch, leatherleaf, and sphagnum moss. Trickle of surface water.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Herbaceous Partly Decomposed	4.7	17.8	866
30- 61	1-2	Herbaceous Partly Decomposed	5.0	11.4	1022
61- 91	2-3	Herbaceous Partly Decomposed	5.2	10.9	1652
91-122	3-4	Herbaceous Partly Decomposed	5.1	9.6	1109
122+	4+	Gray Clay			

Site Number: (27)
Location: NE1/4 of SW1/4 of SW1/4 of SW1/4, Sec. 36, T.52N., R.19W.
Vegetation: Thin spruce and tamarack 1/2" - 10" diameter, 2' - 5' high, and cotton grass. A trickle of surface water.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Sphagnum	3.9	6.5	1766
30- 61	1-2	Sphagnum	4.1	4.0	1256
61- 91	2-3	Sphagnum	4.3	3.6	1603
91-122	3-4	Herbaceous Partly Decomposed	4.3	7.8	1033
122-152	4-5	Herbaceous-Sphagnum	5.1	9.5	1499
152-183	5-6	Herbaceous-Sphagnum	5.2	8.5	1277
183-213	6-7	Herbaceous Partly Decomposed	5.3	18.7	977
518+	17+	Rock			

Site Number: 18
Location: NE1/4 of SW1/4 of SE1/4 of SW1/4, Sec. 36, T.52N., R.19W.
Vegetation: Black spruce crown cover of about 50 percent; understory consists of leatherleaf, swamp laurel, and bog rosemary; ground cover consists mostly of sphagnum mosses.
Microrelief: 40 cm.
Depth To Water Table: 30 cm.
Described And Sampled By: D. Olson and D. Mellem on January 23, 1978.

Layer	Depth	Sample Depth	Bulk Density	Water Content	pH H_2O	pH $CaCl_2$	Mineral Content
	(cm)	(cm)	(g/cm^3)	(%)			(%)
Hemic	0- 55	40- 55	0.15	577	3.8	3.2	10.9
Fibric	55-110	85-100	0.10	956	4.0	3.2	4.1
Hemic	110-255	135-150	0.10	848	4.4	3.4	7.6
Fibric	255-280	185-200	0.12	753	4.6	3.8	8.8
Hemic	280-423	235-250	0.14	686	4.8	4.1	6.4
Fibric	423-448	285-300	0.13	706	5.1	4.2	8.4
Hemic	448-458	335-350	0.16	580	5.2	4.4	14.0
Limnic	458-468	385-400	0.13	678	5.2	4.6	5.5
Silt and very fine sand	468-476	435-450	0.13	811	5.6	4.6	4.0
Silt	476+						

Site Number: 19
Location: NE1/4 of SW1/4 of SW1/4 of SE1/4, Sec. 36, T.52N., R.19W.
Vegetation: Scattered black spruce and tamarack; understory consists of Labrador tea, leatherleaf, swamp laurel, and bog rosemary; ground cover consists mostly of sphagnum mosses.
Microrelief: 35 cm.
Depth To Water Table: 30 cm.
Described And Sampled By: D. Olson and D. Mellem on February 23, 1978.

Layer	Depth	Sample Depth	Bulk Density	Water Content	pH H_2O	pH $CaCl_2$	Mineral Content
	(cm)	(cm)	(g/cm^3)	(%)			(%)
Fibric	0- 20	45- 60	0.11	818	3.6	3.0	8.5
Hemic	20- 70	85-100	0.08	1032	3.9	3.0	5.9
Fibric	70-130	135-150	0.14	696	4.2	3.3	4.1
Hemic	130-464	185-200	0.11	826	4.4	3.5	4.6
Limnic	464-476	235-250	0.13	721	4.7	3.8	7.3
Coarse sand and pebbles	476-478	285-300	0.13	681	4.8	4.1	6.8
		335-350	0.12	816	5.0	4.2	6.7
		385-400	0.10	938	5.1	4.4	7.9
Silt loam and small pebbles	478+	448-463	-	633	5.1	4.6	34.9

Site Number: (28)
Location: NE1/4 of SW1/4 of SE1/4 of SW1/4, Sec. 36, T.52N., R.19W.
Vegetation: Thin spruce 1/2" - 5" diameter, 2' - 25' high, scattered large tamarack, leatherleaf, and sphagnum moss. A trickle of surface water.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Sphagnum	3.2	5.5	1527
30- 61	1-2	Sphagnum	4.0	2.4	1695
61- 91	2-3	Sphagnum	4.2	2.9	2342
91-122	3-4	Sphagnum	4.3	2.8	1394
122-152	4-5	Herbaceous Partly Decomposed	4.1	8.0	941
152-183	5-6	Herbaceous	4.5	5.0	1606
183-213	6-7	Herbaceous	4.5	7.3	1228
274+	9+	Gray Clay and Rock			

Site Number: (29)
Location: NE1/4 of SW1/4 of SW1/4 of SE1/4, Sec. 36, T.52N., R.19W.
Vegetation: Thin spruce 1/2" - 2" diameter, 2' - 12' high, scattered large tamarack, cotton grass, leatherleaf, and sphagnum moss. A trickle of surface water.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Herbaceous-Sphagnum	4.0	9.8	991
30- 61	1-2	Sphagnum	4.2	4.8	1993
61- 91	2-3	Sphagnum	4.3	3.5	2190
91-122	3-4	Sphagnum	3.8	3.0	2636
122-152	4-5	Herbaceous-Sphagnum	4.3	3.1	1458
152-183	5-6	Herbaceous	4.7	4.0	1265
183-213	6-7	Herbaceous	4.6	7.4	1227
579+	19+	Gray Clay			

Site Number: 20
Location: NE1/4 of SW1/4 of SE1/4 of SE1/4, Sec. 36, T.52N., R.19W.
Vegetation: Black spruce crown cover of about 30 percent with scattered tamarack; understory consists of Labrador tea with some leatherleaf and swamp laurel; ground cover consists mostly of sphagnum mosses.
Microrelief: 40 cm.
Depth To Water Table: 40 cm.
Described And Sampled By: T. Malterer and J. Atkins on February 23, 1978.

Layer	Depth	Sample Depth	Bulk Density	Water Content	pH		Mineral Content
					H_20	$CaCl_2$	
	(cm)	(cm)	(g/cm³)	(%)			(%)
Fibric	0-130	35- 50	0.11	847	3.8	3.0	5.2
Hemic	130-397	85-100	0.09	940	3.8	3.0	3.4
Sapric	397-401	135-150	0.13	717	4.0	3.2	3.4
Coarse	401+	185-200	0.09	936	4.4	3.5	4.2
sand and		235-250	0.13	709	4.4	3.8	6.2
medium		285-300	0.12	739	4.6	4.0	8.4
sand		335-350	0.15	649	4.8	4.1	11.8
		385-400	0.18	483	5.0	4.3	9.7

Site Number: 21
Location: SW1/4 of NE1/4 of SW1/4 of SW1/4, Sec. 31, T.52N., R.18W.
Vegetation: Scattered black spruce and tamarack; understory consists of leatherleaf with some swamp laurel and bog rosemary; ground cover consists mostly of sphagnum mosses.
Microrelief: 40 cm.
Depth To Water Table: 40 cm.
Described And Sampled By: T. Malterer and J. Atkins on February 23, 1978.

Layer	Depth	Sample Depth	Bulk Density	Water Content	pH		Mineral Content
					H_20	$CaCl_2$	
	(cm)	(cm)	(g/cm³)	(%)			(%)
Fibric	0- 40	35- 50	0.13	608	4.0	3.2	6.3
Hemic	40-405	85-100	0.13	662	4.2	3.4	5.2
Limnic	405-415	135-150	0.10	883	4.6	3.7	5.6
Medium	415-418	185-200	0.13	677	4.8	3.9	7.9
sand		235-250	0.10	831	5.0	4.2	5.7
Silt	418+	285-300	0.13	681	5.2	4.4	12.2
		335-350	0.14	623	5.4	4.8	15.9
		385-400	0.16	579	5.6	5.0	13.5

Site Number: (30)
Location: NE1/4 of SW1/4 of SE1/4 of SE1/4, Sec. 36, T.52N., R.19W.
Vegetation: Thin spruce 1/2" - 6" diameter, 2'- 30' high, scattered large tamarack, Labrador tea, leatherleaf, and sphagnum moss. Dry hole.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Herbaceous-Sphagnum	3.7	7.9	897
30- 61	1-2	Sphagnum-Herbaceous	3.8	4.2	1361
61- 91	2-3	Sphagnum	4.1	3.2	1692
91-122	3-4	Herbaceous-Sphagnum	4.2	3.9	1149
122-152	4-5	Herbaceous Partly Decomposed	4.4	4.6	998
152-183	5-6	Herbaceous Partly Decomposed	4.7	6.9	1007
183-213	6-7	Herbaceous Partly Decomposed	4.5	5.5	1021
518+	17+	Gray Clay			

Site Number: (31)
Location: SW1/4 of NE1/4 of SW1/4 of SW1/4, Sec. 31, T.52N., R.18W.
Vegetation: Open - a few scattered tamarack, white pine, and spruce, 2' - 3' bog birch, leatherleaf, and sphagnum moss. Dry hole.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Herbaceous Partly Decomposed	4.0	7.2	1075
30- 61	1-2	Herbaceous-Sphagnum	4.0	6.9	1240
61- 91	2-3	Herbaceous-Sphagnum	3.8	4.2	1128
91-122	3-4	Herbaceous-Sphagnum	4.3	3.3	1166
122-152	4-5	Herbaceous	4.6	4.7	1458
152-183	5-6	Herbaceous Partly Decomposed	4.6	7.6	1012
183-213	6-7	Herbaceous Partly Decomposed	5.0	6.2	931
427+	14+	Gray Clay			

Site Number: 22
Location: SW1/4 of NE1/4 of SE1/4 of SW1/4, Sec. 31, T.52N., R.18W.
Vegetation: Scattered black spruce and tamarack; understory consists mostly of leatherleaf and some bog birch; ground cover consists mostly of sphagnum mosses with some grasses.
Microrelief: 20 cm.
Depth To Water Table: 35 cm.
Described And Sampled By: D. Olson and T. Malterer on March 8, 1978.

Layer	Depth	Sample Depth	Bulk Density	Water Content	pH		Mineral Content
					H_2O	$CaCl_2$	
	(cm)	(cm)	(g/cm^3)	(%)			(%)
Hemic	0-331	35- 50	0.11	677	3.9	3.2	6.8
Silt	331-344	85-100	0.11	794	4.0	3.2	3.6
Clay	344+	135-150	0.10	896	4.2	3.5	4.2
loam		185-200	0.12	754	4.6	3.8	7.6
		235-250	0.12	775	4.6	3.8	4.8
		285-300	0.13	688	4.9	4.0	15.6
		315-330	0.16	542	5.0	4.2	26.7

Site Number: (32)
Location: SW1/4 of NE1/4 of SE1/4 of SW1/4, Sec. 31, T.52N., R.18W.
Vegetation: Open - a few scattered tamarack, scattered 2' bog birch, leatherleaf, and sphagnum moss. Dry hole.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Sphagnum	3.7	7.0	1130
30- 61	1-2	Sphagnum	3.8	4.3	1381
61- 91	2-3	Sphagnum	3.7	3.4	1584
91-122	3-4	Sphagnum	3.9	3.6	1877
122-152	4-5	Sphagnum-Herbaceous	3.9	6.8	1100
152-183	5-6	Sphagnum-Herbaceous	4.1	3.4	1435
183-213	6-7	Herbaceous-Sphagnum	4.2	6.7	1108
274+	9+	Gray Clay			

Site Number: 23
Location: SW1/4 of NE1/4 of SW1/4 of SE1/4, Sec. 31, T.52N., R.18W.
Vegetation: Scattered black spruce; understory consists of leatherleaf and sedges; ground cover consists mostly of sphagnum mosses.
Microrelief: 30 cm.
Depth To Water Table: 40 cm.
Described And Sampled By: D. Olson and T. Malterer on March 8, 1978.

Layer	Depth	Sample Depth	Bulk Density	Water Content	pH		Mineral Content
					H_2O	$CaCl_2$	
	(cm)	(cm)	(g/cm^3)	(%)			(%)
Hemic	0-280	35- 50	0.15	552	4.3	3.5	8.5
Silt	280+	85-100	0.10	899	4.2	3.5	3.7
		135-150	0.11	853	4.3	3.5	5.6
		185-200	0.13	679	4.3	3.5	7.7
		235-250	0.13	713	4.5	3.8	4.5
		260-275	0.16	592	4.8	4.1	16.0

Site Number: (33)
Location: SW1/4 of NE1/4 of SW1/4 of SE1/4, Sec. 31, T.52N., R.18W.
Vegetation: Open - cotton grass, leatherleaf, and sphagnum moss. Dry hole.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Sphagnum	4.0	3.5	1694
30- 61	1-2	Sphagnum-Herbaceous	4.4	6.4	990
61- 91	2-3	Sphagnum	4.4	4.0	1470
91-122	3-4	Herbaceous Partly Decomposed	4.3	7.5	1048
122-152	4-5	Herbaceous	4.4	3.6	1213
152-183	5-6	Herbaceous Partly Decomposed	4.4	7.4	793
183-213	6-7	Herbaceous	4.7	6.2	1211
305+	10+	Gray Clay			

Site Number: 24
Location: SW1/4 of NE1/4 of SE1/4 of SE1/4, Sec. 31, T.52N., R.18W.
Vegetation: Scattered black spruce, tamarack, and white pine; understory consists of Labrador tea and leatherleaf; ground cover consists mostly of sphagnum mosses.
Microrelief: 30 cm.
Depth To Water Table: 40 cm.
Described And Sampled By: D. Olson and T. Malterer on March 8, 1978.

Layer	Depth	Sample Depth	Bulk Density	Water Content	pH		Mineral Content
					H_2O	$CaCl_2$	
	(cm)	(cm)	(g/cm³)	(%)			(%)
Hemic	0-338	35- 50	0.09	985	3.8	3.1	6.3
Silt	338+	85-100	0.11	834	4.0	3.2	2.9
loam		135-150	0.11	895	4.2	3.2	2.8
		185-200	0.08	1152	4.4	3.4	2.8
		235-250	0.15	612	4.7	3.6	8.2
		285-300	0.14	655	4.8	4.1	7.2

Site Number: 25
Location: SE1/4 of NE1/4 of SW1/4 of SW1/4, Sec. 32, T.52N., R.18W.
Vegetation: Black spruce crown cover of about 50 percent with scattered tamarack; understory consists of Labrador tea, leatherleaf, and bog rosemary; ground cover consists mostly of sphagnum mosses.
Microrelief: 20 cm.
Depth To Water Table: 30 cm.
Described And Sampled By: D. Olson and T. Malterer on March 8, 1978.

Layer	Depth	Sample Depth	Bulk Density	Water Content	pH		Mineral Content
					H_2O	$CaCl_2$	
	(cm)	(cm)	(g/cm³)	(%)			(%)
Hemic	0-505	35- 50	0.07	1149	4.0	3.1	7.2
Sampler	505+	85-100	0.08	1067	4.1	3.2	3.8
would		135-150	0.07	1210	4.2	3.3	2.7
not		185-200	0.06	1502	4.3	3.4	3.8
penetrate		235-250	0.07	1320	4.7	3.6	3.6
		285-300	0.11	820	4.8	4.0	5.9
		335-350	0.10	926	5.2	4.4	6.4
		385-400	0.11	830	5.4	4.6	7.2
		435-450	0.13	704	5.6	5.0	10.9
		485-500	0.20	402	5.8	5.3	30.2

Site Number: (34)
Location: SW1/4 of NE1/4 of SE1/4 of SE1/4, Sec. 31, T.52N., R.18W.
Vegetation: Open - cranberry, leatherleaf, Labrador tea, and sphagnum moss. Dry hole.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Sphagnum-Herbaceous	3.9	8.1	969
30- 61	1-2	Sphagnum	4.1	2.2	2104
61- 91	2-3	Sphagnum	4.2	2.6	1036
91-122	3-4	Sphagnum	4.3	3.3	1705
122-152	4-5	Sphagnum-Herbaceous	4.2	7.5	1092
152-183	5-6	Sphagnum	4.6	2.4	2004
183-213	6-7	Sphagnum	4.5	4.7	1795
305+	10+	Gray Clay			

Site Number: (35)
Location: SE1/4 of NE1/4 of SW1/4 of SW1/4, Sec. 32, T.52N., R.18W.
Vegetation: Thin spruce 1/2" - 3" diameter, 2' - 20' high, scattered large tamarack, Labrador tea, some leatherleaf, and sphagnum moss. Small surface water flow.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Sphagnum	3.7	8.7	-
30- 61	1-2	Sphagnum	4.1	8.5	-
61- 91	2-3	Sphagnum	3.8	3.7	-
91-122	3-4	Sphagnum	4.2	8.2	3472
122-152	4-5	Sphagnum	4.4	-	2438
152-183	5-6	Sphagnum-Herbaceous	4.4	-	1159
183-213	6-7	Sphagnum	4.5	6.7	2991
388+	16+	Gray Fine Sand			

Site Number: 26
Location: SW1/4 of NE1/4 of SE1/4 of SW1/4, Sec. 32, T.52N., R.18W.
Vegetation: Scattered black spruce and tamarack; understory consists of Labrador tea, leatherleaf, swamp laurel, and bog rosemary; ground cover consists mostly of sphagnum mosses.
Microrelief: 50 cm.
Depth To Water Table: 25 cm.
Described And Sampled By: D. Mellem and D. Olson on March 7, 1978.

Layer	Depth	Sample Depth	Bulk Density	Water Content	pH		Mineral Content
					H_20	$CaCl_2$	
	(cm)	(cm)	(g/cm³)	(%)			(%)
Hemic	0- 80	35- 50	0.14	650	4.0	3.2	8.6
Fibric	80-135	85-100	0.08	1099	4.2	3.2	2.8
Hemic	135-215	135-150	0.08	1302	4.4	3.4	2.4
Fibric	215-280	185-200	0.09	1064	4.2	3.3	2.4
Hemic	280-466	235-250	0.09	1104	4.4	3.5	2.8
Limnic	466-470	285-300	0.12	731	4.4	3.6	6.2
Medium	470+	335-350	0.10	906	4.6	3.6	5.5
fine		385-400	0.12	750	4.6	3.9	10.3
sand		435-450	0.15	621	4.6	4.1	11.0

Site Number: 27
Location: NE1/4 of SE1/4 of SW1/4 of SE1/4, Sec. 32, T.52N., R.18 W.
Vegetation: Black spruce crown cover of about 90 percent with scattered tamarack; understory consists of Labrador tea, leatherleaf, swamp laurel, and bog rosemary; ground cover consists mostly of sphagnum mosses with some grasses.
Microrelief: 20 cm.
Depth To Water Table: 20 cm.
Described And Sampled By: D. Olson and D. Mellem on March 6, 1978.

Layer	Depth	Sample Depth	Bulk Density	Water Content	pH		Mineral Content
					H_20	$CaCl_2$	
	(cm)	(cm)	(g/cm³)	(%)			(%)
Fibric	0- 53	38- 53	0.06	1217	4.1	3.2	8.5
Hemic	53-110	85-100	0.06	1389	4.0	3.0	10.9
Fibric	110-265	135-150	0.07	1229	4.0	3.1	4.3
Hemic	265-308	185-200	0.06	1418	4.0	3.1	3.8
Fibric	308-322	235-250	0.08	1089	4.2	3.2	3.8
Hemic	322-617	285-300	0.07	1158	4.2	3.4	6.6
Medium	617-624	335-350	0.09	1028	4.4	3.5	5.2
sand		385-400	0.12	726	4.6	3.7	8.9
Silt	624+	435-450	0.11	812	4.7	3.9	5.4
loam		485-500	0.12	711	4.9	4.2	10.5
		535-550	0.16	602	5.0	4.5	12.9
		585-600	0.15	610	5.3	4.6	11.8

Site Number: (36)
Location: SW1/4 of NE1/4 of SE1/4 of SW1/4, Sec. 32, T.52N., R.18W.
Vegetation: Small opening - surrounded by 8' - 20' spruce, cotton grass, leatherleaf, and sphagnum moss. Surface water.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Sphagnum	3.7	6.2	3960
30- 61	1-2	Sphagnum-Herbaceous	3.9	-	976
61- 91	2-3	Sphagnum	3.9	-	-
91-122	3-4	Sphagnum	4.0	4.1	3364
122-152	4-5	Sphagnum	4.4	-	2140
152-183	5-6	Sphagnum	4.1	-	1912
183-213	6-7	Sphagnum	4.3	-	-
488+	16+	Gray Fine Sand			

Site Number: (37)
Location: NE1/4 of SE1/4 of SW1/4 of SE1/4, Sec. 32, T.52N., R.18W.
Vegetation: Spruce 1" - 6" diameter, 4' - 40' high, leatherleaf and sphagnum moss. Dry hole.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Sphagnum	2.9	3.1	2317
30- 61	1-2	Sphagnum	3.5	4.0	2845
61- 91	2-3	Sphagnum	-	2.6	2458
91-122	3-4	Sphagnum	-	2.7	3401
122-152	4-5	Sphagnum	-	2.3	2277
152-183	5-6	Sphagnum	-	7.4	2345
183-213	6-7	Sphagnum	-	3.4	2330
549+	18+	Gray Coarse Sand			

Site Number: 28
Location: SE1/4 of SE1/4 of SE1/4 of SE1/4, Sec. 32, T.52N., R.18W.
Vegetation: Scattered black spruce and tamarack; understory consists of Labrador tea, leatherleaf, swamp laurel, and bog rosemary; ground cover consists mostly of sphagnum mosses.
Microrelief: 35 cm.
Depth To Water Table: 10 cm.
Described And Sampled By: T. Malterer and J. Atkins on March 1, 1978.

Layer	Depth	Sample Depth	Bulk Density	Water Content	pH		Mineral Content
					H_2O	$CaCl_2$	
	(cm)	(cm)	(g/cm^3)	(%)			(%)
Fibric	0- 45	35- 50	0.05	1675	4.2	3.2	6.0
Hemic	45-600	85-100	0.06	1485	4.2	3.1	2.7
Sapric	600-614	135-150	0.05	1641	4.2	3.1	2.3
Silt	614+	185-200	0.08	1178	4.0	3.2	3.8
loam		235-250	0.07	1325	4.3	3.3	2.4
		285-300	0.07	1163	3.4	4.4	2.8
		335-350	0.09	974	4.5	3.8	4.2
		385-400	0.10	906	4.8	3.9	5.4
		435-450	0.10	838	4.9	4.1	5.7
		485-500	0.12	716	4.9	4.2	12.7
		535-550	0.15	621	5.0	4.3	14.4
		585-600	0.16	548	4.6	5.1	25.7

Site Number: 29
Location: SE1/4 of SE1/4 of SW1/4 of SW1/4, Sec. 33, T.52N., R. 18W.
Vegetation: Scattered tamarack and black spruce; ground cover consists mostly of sphagnum mosses with sedges.
Microrelief: 35-45 cm.
Depth To Water Table: 10 cm.
Described And Sampled By: T. Malterer and J. Atkins on March 1, 1978.

Layer	Depth	Sample Depth	Bulk Density	Water Content	pH		Mineral Content
					H_2O	$CaCl_2$	
	(cm)	(cm)	(g/cm^3)	(%)			(%)
Fibric	0-190	35- 50	0.03	2357	4.2	3.2	4.5
Hemic	190-500	85-100	0.07	1220	3.9	3.1	7.4
Sapric	500-505	135-150	0.10	904	3.8	3.0	5.8
Medium	505+	185-200	0.08	1026	3.8	3.0	4.8
sand		235-250	0.09	1099	4.0	3.2	3.3
		285-300	0.08	1074	4.0	3.2	3.5
		335-350	0.13	715	4.0	3.2	12.6
		385-400	0.11	797	4.1	3.3	10.4
		435-450	0.14	670	4.2	3.4	20.0
		485-500	0.14	604	4.4	3.8	24.8

Site Number: (38)
Location: SE1/4 of SE1/4 of SE1/4 of SE1/4, Sec. 32, T.52N., R.18W.
Vegetation: Open - scattered tamarack and spruce 1/2" - 3" diameter, 2' - 15' high, cotton grass, and sphagnum moss. Ankle deep surface water.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Sphagnum	-	4.3	2011
30- 61	1-2	Sphagnum	-	6.7	1725
61- 91	2-3	Sphagnum	-	2.7	2894
91-122	3-4	Sphagnum	-	2.4	2090
122-152	4-5	Sphagnum	-	4.2	2214
152-183	5-6	Sphagnum	-	3.9	2765
183-213	6-7	Sphagnum	-	2.4	2256
549+	18+	Gray Clay			

Site Number: (39)
Location: SE1/4 of SE1/4 of SW1/4 of SW1/4, Sec. 33, T.52N., R.18W.
Vegetation: Open - a few scattered small tamarack, cotton grass and sphagnum moss. Ankle deep surface water.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Sphagnum	-	3.5	2754
30- 61	1-2	Sphagnum	3.9	4.1	1423
61- 91	2-3	Sphagnum	3.8	2.9	1540
91-122	3-4	Sphagnum	4.0	2.3	2885
122-152	4-5	Sphagnum	3.9	6.1	2167
152-183	5-6	Sphagnum	4.4	2.0	2606
183-213	6-7	Sphagnum	4.3	3.1	2260
488+	16+	Gray Clay			

Site Number: 30
Location: SE1/4 of SE1/4 of SE1/4 of SW1/4, Sec. 33, T.52N., R.18W.
Vegetation: Scattered tamarack and black spruce; ground cover consists mostly of sphagnum mosses with sedges.
Microrelief: 35 cm.
Depth To Water Table: 10 cm.
Described And Sampled By: T. Malterer and J. Atkins on March 1, 1978.

Layer	Depth	Sample Depth	Bulk Density	Water Content	pH H_2O	pH $CaCl_2$	Mineral Content
	(cm)	(cm)	(g/cm^3)	(%)			(%)
Fibric	0- 40	35- 50	0.05	1882	14.2	3.3	6.8
Hemic	40-180	85-100	0.09	1006	4.0	3.1	5.3
with		135-150	0.06	1400	4.1	3.2	2.7
20-30%		185-200	0.06	1273	4.0	3.4	2.6
fibric		235-250	0.09	1021	4.3	3.5	3.8
laminae		285-300	0.12	730	4.4	3.5	6.6
Hemic	180-500	335-350	0.11	823	4.4	3.6	5.4
Sapric	500-502	385-400	0.11	836	4.7	3.8	11.6
Coarse	502+	435-450	0.13	733	4.7	4.0	12.4
and fine		485-500	0.15	542	4.8	4.2	15.4
sand							

Site Number: 31
Location: SE1/4 of SE1/4 of SW1/4 of SE1/4, Sec. 33, T.52N., R.18W.
Vegetation: Scattered tamarack and black spruce; ground cover consists mostly of sphagnum mosses with sedges.
Microrelief: 35 cm.
Depth To Water Table: 15 cm.
Described And Sampled By: T. Malterer and J. Atkins on March 1, 1978.

Layer	Depth	Sample Depth	Bulk Density	Water Content	pH H_2O	pH $CaCl_2$	Mineral Content
	(cm)	(cm)	(g/cm^3)	(%)			(%)
Fibric	0- 30	35- 50	0.07	1274	4.1	3.2	4.6
Hemic	30-137	85-100	0.12	703	3.8	3.1	7.0
Sapric	137-141	120-135	0.14	603	4.2	3.4	13.1
Fine	141+						
sand							

Site Number: (40)
Location: SE1/4 of SE1/4 of SE1/4 of SW1/4, Sec. 33, T.52N., R.18W.
Vegetation: Open - a few scattered small tamarack, cotton grass, and sphagnum moss. Ankle deep surface water.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Sphagnum	4.1	4.6	1702
30- 61	1-2	Sphagnum	3.7	7.4	1188
61- 91	2-3	Sphagnum	3.7	3.9	1284
91-122	3-4	Sphagnum	4.0	3.2	1504
122-152	4-5	Sphagnum	4.0	2.7	2970
152-183	5-6	Sphagnum	4.2	3.0	2300
183-213	6-7	Sphagnum	4.0	3.7	1728
488+	16+	Gray Clay			

Site Number: (41)
Location: SE1/4 of SE1/4 of SW1/4 of SE1/4, Sec. 33, T.52N., R.18W.
Vegetation: Open - a few scattered small tamarack, cotton grass, leatherleaf, and sphagnum moss. Ankle deep surface water.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Sphagnum	4.2	4.4	2704
30- 61	1-2	Sphagnum-Herbaceous	4.2	7.6	1011
61- 91	2-3	Sphagnum-Herbaceous	4.2	3.3	1038
91-122	3-4	Sphagnum	3.9	2.9	1800
122-152	4-5	Sphagnum	4.1	3.3	1579
152-183	5-6	Sphagnum	4.0	3.5	1480
183-213	6-7	Herbaceous-Sphagnum	4.5	7.6	1283
457+	15+	Gray Clay			

Site Number: 32 (Not sampled by DNR).

Site Number: (19)
Location: SE1/4 of NE1/4 of NW1/4 of SE1/4, Sec. 32, T.52N., R.18W.
Vegetation: Open - scattered small tamarack and spruce, cotton grass, leatherleaf, and sphagnum moss. Surface water flow.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Sphagnum	4.2	5.3	2443
30- 61	1-2	Sphagnum	3.9	5.6	1496
61- 91	2-3	Sphagnum	3.9	2.9	1958
91-122	3-4	Sphagnum	3.9	2.8	1609
122-152	4-5	Sphagnum	4.1	2.7	1425
152-183	5-6	Sphagnum	4.0	3.7	1625
183-213	6-7	Sphagnum-Herbaceous	3.9	2.5	1105
549+	18+	Gray Clay			

Site Number: 33 (Not sampled by DNR).

Site Number: (57)
Location: NE1/4 of SE1/4 of SW1/4 of SE1/4, Sec. 32, T.51N., R.18W.
Vegetation: Spruce 1" - 6" diameter, 4' - 40' high, leatherleaf, and sphagnum moss. Dry hole.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Sphagnum	2.9	3.1	2317
30- 61	1-2	Sphagnum	3.5	4.0	2845
61- 91	2-3	Sphagnum	-	2.6	2458
91-122	3-4	Sphagnum	-	2.7	3401
122-152	4-5	Sphagnum	-	2.3	2277
152-183	5-6	Sphagnum	-	7.4	2345
183-213	6-7	Sphagnum	-	3.4	2330
549+	18+	Gray Coarse Sand			

Site Number: 34 (Not sampled by DNR).

Site Number: (77)
Location: SE1/4 of NE1/4 of NW1/4 of NE1/4, Sec. 5, T.51N., R.18W.
Vegetation: Spruce 1" - 6" diameter, 3' - 35' high, leatherleaf, Labrador tea, and sphagnum moss. Surface water.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Sphagnum	3.5	4.3	2070
30- 61	1-2	Sphagnum	3.4	3.6	2363
61- 91	2-3	Sphagnum	3.8	4.3	3421
91-122	3-4	Sphagnum	3.8	4.5	3732
122-152	4-5	Sphagnum	3.6	3.4	2182
152-183	5-6	Sphagnum	3.8	5.0	1382
183-213	6-7	Sphagnum	3.7	3.7	2318
457+	15+	Gray Clay			

Site Number: 35 (Not sampled by DNR).

Site Number: (96)
Location: SE1/4 of NE1/4 of SW1/4 of NE1/4, Sec. 5, T.51N., R.18W.
Vegetation: Open - scattered small spruce and tamarack, cotton grass, cranberry, and sphagnum moss. Ankle deep surface water.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Sphagnum	3.9	6.0	3422
30- 61	1-2	Sphagnum	3.9	3.6	2998
61- 91	2-3	Sphagnum	3.9	3.8	-
91-122	3-4	Sphagnum-Herbaceous	3.7	6.2	1100
122-152	4-5	Sphagnum	4.0	3.9	2040
152-183	5-6	Sphagnum	3.8	4.1	2757
183-213	6-7	Sphagnum	3.9	4.0	2359
457+	15+	Gray Clay			

Site Number: 36 (Not sampled by DNR).

Site Number: (118)
Location: SE1/4 of NE1/4 of SW1/4 of SE1/4, Sec. 5, T.52N., R18W.
Vegetation: Spruce 2" - 6" diameter, 10' - 35' high, scattered tamarack, Labrador tea, and sphagnum moss. Surface water flow.

Depth (cm)	Depth (ft)	Description (Peat Type)	pH	Ash (Mineral) Content %	Water Holding Capacity % (Water Content %)
0- 30	0-1	Herbaceous	4.8	7.8	1310
30- 61	1-2	Herbaceous	4.2	6.2	1793
60- 91	2-3	Herbaceous	5.0	6.0	1217
91-122	3-4	Herbaceous Partly Decomposed	4.8	11.8	613
122+	4+	Gray Clay			

APPENDIX C

COUNTY BY COUNTY BREAKDOWN OF TABLES 5 AND 6

Depth of Fibric Peat	Number of Bogs	Estimated Acreage	Average Size (Ac)[1]	% of Total MN Peatlands[2]	Estimated Tons[3]	Estimated Cubic Yards	Estimated Bales[4]
AITKIN COUNTY							
< 0.6 m; 0.3 m av (< 2 ft; 1 ft av)	15	10,130	675	0.14	2.0×10^6	1.6×10^7	3.2×10^7
0-1.5 m; 0.75 m av (~ 0-5 ft; 2.5 ft av)	3	2,760	920	0.04	1.4×10^6	1.1×10^7	2.2×10^7
1.5-3.0 m; 2.25 m av (~ 5-10 ft; 7.5 ft av)	0	0	0	0.00	0	0	0
County Total	18	12,890		0.18	3.4×10^6	2.7×10^7	5.4×10^7
BELTRAMI COUNTY							
< 0.6 m; 0.3 m av (< 2 ft; 1 ft av)	2	1,690	845	0.02	3.4×10^5	2.7×10^6	5.4×10^6
0-1.5 m; 0.75 m av (~ 0-5 ft; 2.5 ft av)	3	2,780	927	0.04	1.4×10^6	1.1×10^7	2.2×10^7
1.5-3.0 m; 2.25 m av (~ 5-10 ft; 7.5 ft av)	2	2,600	1,300	0.04	3.9×10^6	3.1×10^7	6.2×10^7
County Total	7	7,070		0.10	5.6×10^6	4.5×10^7	8.9×10^7
CARLTON COUNTY							
< 0.6 m; 0.3 m av (< 2 ft; 1 ft av)	2	620	310	< 0.01	1.2×10^5	9.6×10^5	1.9×10^6
0-1.5 m; 0.75 m av (~ 0-5 ft; 2.5 ft av)	7	2,381	340	0.03	1.2×10^6	9.6×10^6	1.9×10^7
1.5-3.0 m; 2.25 m av (~ 5-10 ft; 7.5 ft av)	9	3,376	375	0.05	5.1×10^6	4.1×10^7	8.2×10^7
County Total	18	6,377		0.09	6.4×10^6	5.2×10^7	1.0×10^8
CASS COUNTY							
< 0.6 m; 0.3 m av (< 2 ft; 1 ft av)	1	100	100	< 0.01	2.0×10^4	1.6×10^5	3.2×10^5
0-1.5 m; 0.75 m av (~ 0-5 ft; 2.5 ft av)	2	920	460	0.01	4.6×10^5	3.7×10^6	7.4×10^6
1.5-3.0 m; 2.25 m av (~ 5-10 ft; 7.5 ft av)	1	490	490	0.01	7.4×10^5	5.9×10^6	1.2×10^7
County Total	4	1,510		0.02	1.2×10^6	9.8×10^6	2.0×10^7

[1] Arithmetic mean.

[2] Using 7.2 million acres.

[3] Estimated according to 1 acre-foot of peat in place being equivalent to 200 tons of air-dried peat.

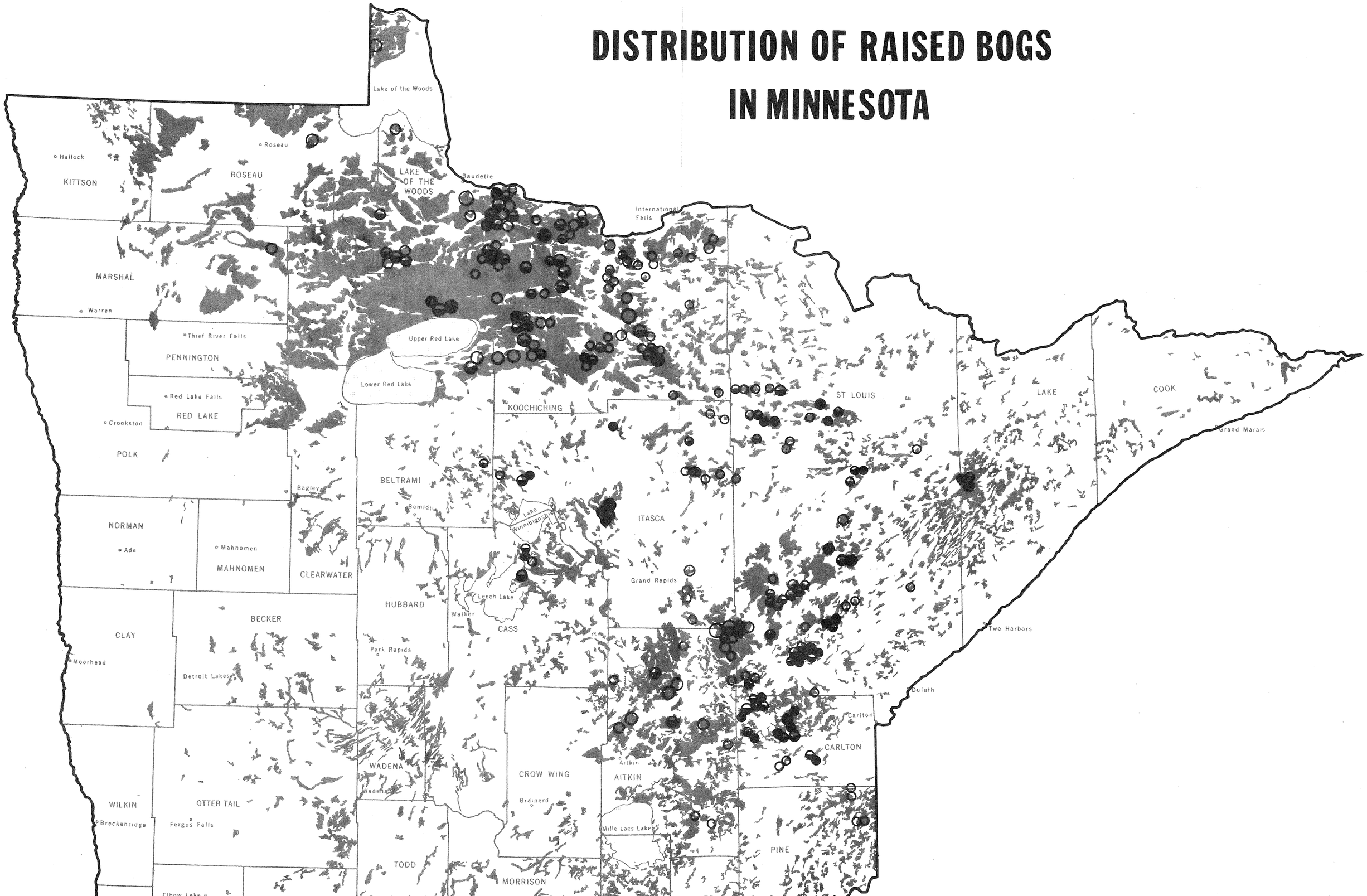
[4] Estimated according to 1 cubic yard of fibric peat in place will yield two standard 6 cubic foot bales.

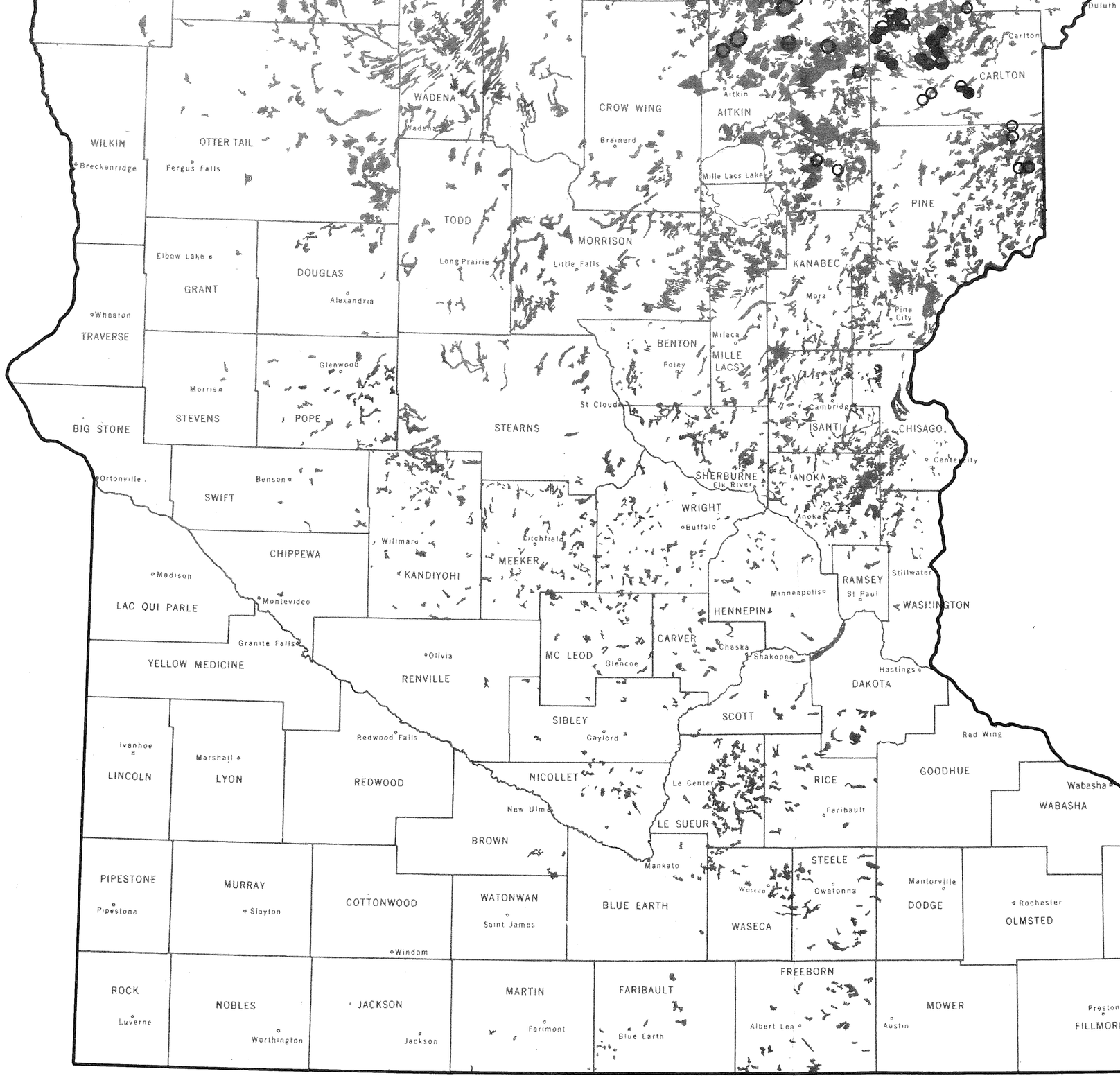
Depth of Fibric Peat	Number of Bogs	Estimated Acreage	Average Size (Ac)[1]	% of Total MN Peatlands[2]	Estimated Tons[3]	Estimated Cubic Yards	Estimated Bales[4]
ITASCA COUNTY							
< 0.6 m; 0.3 m av (< 2 ft; 1 ft av)	10	2,350	235	0.03	4.7×10^5	3.7×10^6	7.4×10^6
0-1.5 m; 0.75 m av (~ 0-5 ft; 2.5 ft av)	4	1,850	463	0.03	9.3×10^5	7.4×10^6	1.5×10^7
1.5-3.0 m; 2.25 m av (~ 5-10 ft; 7.5 ft av)	6	4,110	685	0.06	6.2×10^6	4.9×10^7	9.8×10^7
County Total	20	8,310		0.12	7.6×10^6	6.0×10^7	1.2×10^8
KOOCHICHING COUNTY							
< 0.6 m; 0.3 m av (< 2 ft; 1 ft av)	44	24,020	546	0.33	4.8×10^6	3.8×10^7	7.6×10^7
0-1.5 m; 0.75 m av (~ 0-5 ft; 2.5 ft av)	25	26,160	1,046	0.36	1.3×10^7	1.0×10^8	2.0×10^8
1.5-3.0 m; 2.25 m av (~ 5-10 ft; 7.5 ft av)	9	8,230	914	0.11	1.2×10^7	9.6×10^7	1.9×10^8
County Total	78	58,410		0.80	3.0×10^7	2.3×10^8	4.7×10^8
LAKE COUNTY							
< 0.6 m; 0.3 m av (< 2 ft; 1 ft av)	0	0	0	0.00	0	0	0
0-1.5 m; 0.75 m av (~ 0-5 ft; 2.5 ft av)	1	240	240	< 0.01	1.2×10^5	9.6×10^5	1.9×10^6
1.5-3.0 m; 2.25 m av (~ 5-10 ft; 7.5 ft av)	2	1,230	615	0.02	1.8×10^6	1.4×10^7	2.8×10^7
County Total	3	1,470		0.02	1.9×10^6	1.5×10^7	3.0×10^7
LAKE OF THE WOODS COUNTY							
< 0.6 m; 0.3 m av (< 2 ft; 1 ft av)	7	6,710	959	0.09	1.3×10^6	1.0×10^7	2.0×10^7
0-1.5 m; 0.75 m av (~ 0-5 ft; 2.5 ft av)	5	3,665	733	0.05	1.8×10^6	1.4×10^7	2.8×10^7
1.5-3.0 m; 2.25 m av (~ 5-10 ft; 7.5 ft av)	1	300	300	< 0.01	4.5×10^5	3.7×10^6	7.4×10^6
County Total	13	10,675		0.14	3.6×10^6	2.8×10^7	5.5×10^7
MARSHALL COUNTY							
< 0.6 m; 0.3 m av (< 2 ft; 1 ft av)	1	1,210	1,210	0.02	2.4×10^5	1.9×10^6	3.8×10^6
0-1.5 m; 0.75 m av (~ 0-5 ft; 2.5 ft av)	0	0	0	0.00	0	0	0
1.5-3.0 m; 2.25 m av (~ 5-10 ft; 7.5 ft av)	0	0	0	0.00	0	0	0
County Total	1	1,210		0.02	2.4×10^5	1.9×10^6	3.8×10^6

Depth of Fibric Peat	Number of Bogs	Estimated Acreage	Average Size (Ac)[1]	% of Total MN Peatlands[2]	Estimated Tons[3]	Estimated Cubic Yards	Estimated Bales[4]
PINE COUNTY							
< 0.6 m; 0.3 m av (< 2 ft; 1 ft av)	**4**	**345**	86	< 0.01	6.9×10^4	5.5×10^5	1.1×10^6
0-1.5 m; 0.75 m av (~ 0-5 ft; 2.5 ft av)	**0**	**0**	0	0.00	0	0	0
1.5-3.0 m; 2.25 m av (~ 5-10 ft; 7.5 ft av)	**0**	**0**	0	0.00	0	0	0
County Total	**4**	**345**		< 0.01	6.9×10^4	5.5×10^5	1.1×10^6
ROSEAU COUNTY							
< 0.6 m; 0.3 m av (< 2 ft; 1 ft av)	1	960	960	0.01	1.9×10^5	1.5×10^6	3.0×10^6
0-1.5 m; 0.75 m av (~ 0-5 ft; 2.5 ft av)	0	0	0	0.00	0	0	0
1.5-3.0 m; 2.25 m av (~ 5-10 ft; 7.5 ft av)	0	0	0	0.00	0	0	0
County Total	1	960		0.01	1.9×10^5	1.5×10^6	3.0×10^6
ST. LOUIS COUNTY							
< 0.6 m; 0.3 m av (< 2 ft; 1 ft av)	19	5,575	293	0.08	1.1×10^6	8.8×10^6	1.8×10^7
0-1.5 m; 0.75 m av (~ 0-5 ft; 2.5 ft av)	24	8,825	368	0.12	4.4×10^6	3.5×10^7	7.0×10^7
1.5-3.0 m; 2.25 m av (~ 5-10 ft; 7.5 ft av)	14	5,535	395	0.08	8.3×10^6	6.6×10^7	1.3×10^8
County Total	57	19,935		0.28	1.4×10^7	1.1×10^8	2.2×10^8

NOTES

DISTRIBUTION OF RAISED BOGS IN MINNESOTA





LEGEND

ESTIMATED ACREAGE	ESTIMATED DEPTH OF SPHAGNUM Meters	Feet
0-500	0-0.6	0-2
500-1000	0-1.5	0-5
1000-2000	1.5-3.0	5-10
2000-3000		

Scale: 1 inch = approximately 16.0 miles

MAY, 1979

PEAT INVENTORY PROJECT
MINERALS DIVISION
MINNESOTA DEPARTMENT OF NATURAL RESOURCES

Funded By:
Legislative Commission on Minnesota Resources