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PEAT IN QUEBEC, ITS ORIGIN, DISTRIBUTION AND UTILIZATION

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GEOLOGICAL REPORT 31

PEAT IN QUEBEC

ITS ORIGIN, DISTRIBUTION, AND UTILIZATION

by

H. Girard

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PEAT IN QUEBEC

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INTRODUCTION

The peat deposits of the Province of Quebec constitute an important natural resource, supplying material for agricultural and industrial purposes. The increasing amount and value of the production of peat within the last decade have served to bring consideration of this product to the foreground.

During the year 1944, sales of Quebec peat totalled 19,477 tons, valued at $363,321, of which 19,033 tons was used for agricultural purposes and 444 tons as fuel. Fifteen operators were engaged in production and the industry provided employment to 423 men.

The major utilization of peat produced in the Province is connected with agriculture. The fibrous character of certain types of peat, especially the incompletely decomposed species of sphagnum mosses (peat moss), has led to their exploitation as an absorbing material (stable bedding, poultry litter) and for improving the physical condition of mineral soils. Although peat moss has found extensive application in Europe for many years, it has been used as yet only to a limited extent in Canada. Its value is being increasingly realized in the United States, and up to the present the bulk of Quebec's output has been exported to that country.

Similarly, the industrial utilization of peat in Canada has been on a very limited scale. Its earliest use here, as in Europe, was as a fuel, and the manufacture of peat fuel in the Province dates back nearly a century. Particularly during the past decade or so, the feasibility of manufacturing air-dried fuel from Quebec peat has been demonstrated by numerous operators, but high cost of production and marketing problems have hindered development of a permanent industry.

In recent years, a steadily increasing amount of peat moss has been sold for insulation and sound-proofing in the local building trade. Other industrial uses have been found for peat in several European countries, as for example in the manufacture of certain kinds of paper, and of antiseptic dressing, wall-boards, waxes, and dye stuffs. For the most part, these are purely local industries but some of them, at least, have possibilities for expansion.

Considerable attention is now being given to the chemical treatment of peat for its possible utilization in various manufactured products. With this in view, the National Research Council of Canada has begun a study of the manufactured products which might be made from peat on a commercial basis.

For several years past, the Quebec Department of Mines has taken an active interest in developing agricultural and fuel products from peat. To promote this development, an Act was passed by the Quebec Legislature in 1940, and revised in 1943, authorizing the government to pay annually a premium on the marketable products of any peat bog in the Province of Quebec. The main objective sought was the production of standardized peat products for agricultural uses and of peat fuel, the latter being especially important because of a current shortage of other domestic fuels.

At the same time, the Department has given technical guidance to operators of peat bogs in the selection of deposits for exploitation and of equipment for producing marketable products from the peat. Under the stimulus of these measures, there has been a very appreciable expansion of the industry in the past few years.

Most people know that peat is decomposed vegetable matter found in bogs, marshes, or swamps, and that it is used in some countries as fuel. Relatively few are aware that peat can be, and is, used for a variety of other purposes. In recent years, however, inquiries addressed to the Department of Mines for information concerning the peat resources of the Province and their possible utilization have become increasingly numerous, and it is evident that there is a wide and growing demand for such information.

The present report has been prepared to meet this demand. It summarizes available data on the distribution and nature of the Quebec peat deposits and gives some accounts of the methods used in working them and of processes for converting the peat into marketable products.

RÉSUMÉ OF PREVIOUS INVESTIGATIONS

In a report (1) published in 1904, R. Chalmers estimated that peat bogs in the settled parts of the Province of Quebec occupy a total area of 500 square miles, their average depth being eight to ten feet. Since that time, geologists and explorers have reported that, in northern Quebec, deposits of peat, as yet unexplored, cover some thousands of square miles.

Many of the more accessible deposits have been surveyed and examined in some detail, and reports on these, accompanied by maps, have been published from time to time by the Mines Branch of the Federal Department of Mines and the Geological Survey of Canada (see Bibliography, p.30).

The Field Husbandry Branch of the Federal Department of Agriculture has published several reports giving the results of surveys of peat areas in the southwestern section of the Province, and similar reports and maps dealing with

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(1) Bulletin on Peat, by R. Chalmers; Geol. Surv. Can., Pub. No.880, 1904.

deposits in the counties of Laprairie, Napierville, St-Jean, Rouville, Chambly, Verchères, St-Hyacinthe, Stanstead, Richmond, Sherbrooke, Compton, and Bellechasse have been issued by the Field Husbandry Branch of the Quebec Department of Agriculture.

The Quebec Department of Mines has undertaken the examination and sampling of numerous peat deposits in the Province. Such examinations have included determination of the extent and depth of the deposits and investigation of the quality and possible uses of the peat. Where conditions appeared favourable for commercial exploitation of the deposit, these investigations have been carried out in considerable detail. This programme of investigation was continued in 1945 with the examination, by Jean-Paul Drolet, of the St-Fabien peat bog.

A list of the peat bogs which have been investigated in the province by the Federal and Provincial Departments of Mines will be found in Appendix B (pp.37-47), together with a map showing the approximate location of the deposits.

ORIGIN, FORMATION, AND STRUCTURE OF PEAT DEPOSITS

A great deal of information has been published on the origin, occurrence, and manner of formation of peat bogs in southeastern Canada. A detailed study of conditions affecting the growth of peat-forming vegetation in the region has been made by Vaino Auer (1). He recognized three types of bog: sphagnum peat bogs, or the ocean type; carex peat bogs, or the continental type; and a transitional type or combination of the two.

A.V. Anrep, in Bulletins 8, 9, and 10 of the Mines Branch, Federal Department of Mines, has described the various kinds of peat found in the principal Quebec deposits. The descriptions are illustrated by photographs of the peat-forming plants from which the peat in the several bogs has been formed.

According to their mode of origin, three types of peat deposits may be distinguished: (1) the filled basin type (low moor), or accumulation of peat in lakes; (2) the built-up or raised type, originating on flat land or on slopes with deficient drainage; and (3) a combination of these, in which a deposit of type 2 is underlain by one of type 1.

The chief peat-forming vegetation consists of pond weeds, water-lilies, and other soft-bodied plants. These grow and accumulate below the water level, in open bodies of water, and, on decomposition, they give rise to a plastic material of colloidal consistency called 'sedimentary peat', which shrinks and hardens on drying. Then comes the growth

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(1) Peat Bogs in Southeastern Canada, by Vaino Auer; Geol. Surv. Can., Mem.162, 1930.

of sedges and reeds, of which the interwoven roots and underground stems form a matted, fibrous type of peat. The rate of accumulation of the plant remains usually exceeds the rate of decomposition, but it varies with fluctuations of the water level. In time, however, the surface of peat accumulation may emerge above the level of ground water and, if sufficiently rich in mineral nutrients, the area of peat will then support trees and shrubs, which form a distinctive woody type of peat. It is not uncommon to find one or more layers of woody peat, with roots, stumps, and branches of trees, in peat deposits of the Province.

Once the formation of peat begins it proceeds at an increasing rate, but, with the gradual exhaustion of soluble mineral salts, trees and shrubs are unable to survive. The next stage is the growth of sphagnum moss. This succession in surface vegetation is a consequence of variations in rainfall, and of the advent of cool and moist climatic conditions, rather than of changes in ground water level. As the thickness of the moss peat increases, the deposit assumes a somewhat convex form, rising in height from the margin to the centre. On that account, the deposit is known as a 'built-up' or 'raised' bog. The St-Ulric bog, shown in plan and vertical cross-section in Map 1, is an excellent example of such a built-up bog. It is evident that formation of the deposit began with vegetation growing in open water in a shallow lake. This gave rise to 'sedimentary' or 'sedge' peat, which, in this bog, rests on blue clay. The sedges were then replaced by a scrubby forest, and this in turn was succeeded by sphagnum mosses. Thus, above the sedge peat are layers of woody peat with intervening peat moss, and the latter, with convex surface, forms the upper part of the bog.

DISTRIBUTION OF PEAT DEPOSITS IN THE PROVINCE OF QUEBEC

On the combined bases of distribution, mode of origin, and general character, the peat deposits in the Province of Quebec may be broadly divided into three major groups:

(1) A belt of deposits forming the surface material of terraces that border the St-Lawrence river from lake St-François to the gulf of St-Lawrence. Conditions favourable for the formation of these bogs were brought about by the post-glacial marine invasion of the St-Lawrence valley. Ponds of stagnant water were formed behind embankments and, when these were no longer reached by tide-water, they commenced to fill with vegetable matter. The 'filled basin peat types' (low moor) predominate in the upper region, west and southwest of the city of Quebec, but, in the lower St-Lawrence region, frequent fogs and cool summers in districts close to the river and gulf promote the development and spreading of sphagnum mosses giving rise to the built-up bogs or so-called highmoor. Exploitation of these deposits in recent years has given rise to a flourishing peat-moss industry.

(2) A large acreage of peat deposits in southwestern Quebec. These are deposits of filled basin type,

formed from vegetation that filled shallow lakes which remained after the retreat of the waters of the Champlain sea. They consist of sedge, reed, and grasses overlying aquatic peat-forming plants.

(3) In the upper region of the Province, above the St-Lawrence lowland. Peat began to form immediately upon the retreat of the Wisconsin ice sheet. Thousands of acres of bog and swamp land owe their origin to surface irregularities caused by glacial erosion and deposition. Depressions in the land surface were occupied by lakes, in some of which peat-forming vegetation grew and accumulated. Such vegetation, however, cannot grow beyond a certain height above the local water table.

INVESTIGATION OF PEAT DEPOSITS

TYPES OF PEAT AND SYSTEM OF CLASSIFICATION

Peat deposits consist, as a rule, of a succession of layers of peaty material, the several layers differing in nature and quality according to the character of the peat-forming vegetation and the extent of its decomposition. Before attempting the commercial development of a bog, therefore, it is essential to determine not only its extent and thickness but also the type and degree of decomposition of the constituent vegetable matter, since the purposes for which the material may be used depend on these latter factors.

A fairly complete knowledge of the types of peat present in a deposit, and of the number and thickness of its several layers can be obtained by investigating one or more vertical cross-sections across the entire bog. This examination, which should include borings from the surface to the bottom of the deposit, can be made by means of a peat sampling instrument, a soil auger, or, more simply, by digging pits and trenches with a spade. Samples are taken at regular intervals of depth, and their physical character and chemical composition determined.

At the time of the sampling, a note should be made of the colour of the peat, both in the natural state and after the water has been squeezed from it. The colour of this water gives a fair indication of the quality of the peat: if clear and colourless, only slight decomposition of the vegetable matter has occurred; if highly coloured and muddy, decomposition has been more or less complete. The latter is true also if the raw peat squeezes out between the fingers when pressed in the hand.

In its investigations of peat bogs, the Quebec Department of Mines uses the methods, and the sampling instrument, adopted by the Soil Survey Division, Bureau of Chemistry and Soils, United States Department of Agriculture, and described in their Bulletin, Instruction for Field Work in Peat and Muck Resources.

According to its texture, peat may be classified as (1) woody, (2) fibrous, or (3) sedimentary. Woody peat

contains coarse, lumpy, partly decomposed woody fragments, irregular to angular in shape, as well as granular material, the coarseness or fineness depending on the degree of decomposition of the original vegetable material. Fibrous peat consists of underground stems and roots of grasslike plants and mosses only slightly humified; it includes various types of peat, which are described later. Sedimentary peat includes all varieties which are more or less colloidal, form a coherent and sticky mass, and shrink greatly and harden in drying.

The end product in the decomposition of the vegetable matter is known as 'muck'. This may be described as follows (1):

"Muck is a secondary, transformed product differing more or less distinctly from the original peat material owing to drainage, weathering, cultivation, or other forces that are predominantly destructive. Much consists of organic residues that develop from the decomposition of peat by micro-organisms under conditions of aeration and lowered or fluctuating water levels. The distinguishing characteristics of muck are the advanced state of decomposition, dark colour, coarse to fine granular texture, friable and permeable structure, and a content of mineral matter not exceeding 65 per cent. The end product of active decomposition is a type of residue or muck that is more or less mineralized, colloidal to amorphous, plastic and sticky when wet and leached of any salts; it shrinks and hardens upon drying".

Though a very large number of plant species are found in peat deposits, the great bulk of all peat material consists of comparatively few species. According as one or other of these predominates, the peat is designated by the appropriate prefix as sphagnum, eriophorum, carex, sedge, reed, or hypnum peat. These are described below.

Sphagnum moss peat (known under the trade name of 'peat moss') consists chiefly of the poorly decomposed stems and leaves derived from several species of sphagnum mosses. Intermixed with these may be a moderate proportion of fibrous tufts from cotton grass (eriophorum) and small amounts of other plants, such as Labrador tea, cranberry, and bog rosemary. The peaty materials are characterized by small columnar lumps and vertical aggregates. A typical sample of spongy, fibrous peat moss is shown in Plate I. This type of peat is light in weight, firbous in texture, yellowish-brown when dry, and has a water absorptive power of 10 to 25 times its own weight. It is acid (ph 3.5 to 5.0), low in nitrogen (about 1 per cent), and contains 12 to 18 per cent cellulose and about 23 per cent hemi-cellulose. The amount of lignin-like complex present varies with the degree of decomposition but is invariably low.

Moss peat is used in this country principally

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(1) Instruction for Field Work in Peat and Muck Resources; Soil Survey Division, Bureau of Chemistry and Soils, United States Department of Agriculture, Bull.1419,1926.

as an absorbing and deodorizing material and for ameliorating the physical condition of soils. It has been used locally as an insulating material in the building trade. The weight per cubic foot of a poorly decomposed peat moss, air-dried, ranges from 7 to 15 pounds, depending on the moisture content and the compactness of the vegetation.

Eriophorum peat is composed essentially of cotton grass, a sedge that occurs also in most sphagnum moss deposits. Residues of this sedge consist of strong · reddish bundles of fibres from the stems, leaves, and roots of the plant, which have a more or less well developed horizontal lamination. This variety of peat is seldom found in thick layers, but a large section of the northeastern part of the Rivière-Ouelle bog shows a four-foot layer of these plant residues. Plate II shows a sheet of fibrous cotton-grass peat excavated from this bog.

Reed and sedge peat are characteristic low-moor peats. Depending on the degree of decomposition of the vegetable matter, the colour ranges from reddish through various shades of brown, to black. These types of peat are high in nitrogen (2.0 to 3.5 per cent) and ash (5 to 30 per cent), and they will absorb 3.5 to 8 times their own weight of water. They consist essentially of lignin-like complexes, with a relatively small amount of associated cellulose and hemi-cellulose. The weight per cubic foot of air-dried peat ranges from 20 to 35 pounds, depending on the degree of compactness and the moisture content.

Samples of reed peat and sedge peat show an intricate network of slender roots and rootlets, or felted mass of fibres (radicellate). The fibrous type of sedge peat is illustrated in Plate III. The designation as 'sedge' peat or 'reed' peat depends on the nature of the flattened root-stocks that predominate in the material. Both types are among the most effective of the peat substances for soil improvement and general horticultural purposes.

Hypnum moss peat is derived chiefly from the entire stems and leaves of various species of hypnum mosses and related plants. It belongs to the 'low moor' deposit, and although, in most occurrences, it is intermixed with reed and sedge peat, it often occurs alone in massive strata covering wide areas. An excellent example of a deposit of this kind is the St-Bonaventure (Yamaska county) peat bog, operated by the Quebec Peat Moss Company. A sample of this peat from this bog is shown in Plate IV. The material, which is yellowish-brown to dark in colour, is characterized by rather long, parallel stems of the hypnum mosses. Being brittle when dry, it lacks some of the commercial applications of sphagnum moss peat, but it finds a local market as an agent for soil improvement.

Carex peat consists of remnants of the stems, leaves, and roots of the tall-stemmed sedges of the carex group. The newly-dry peat, drak brown in colour, gradually turns black when exposed to the oxidizing action of the atmosphere. It will absorb from 8 to 13 times its own weight of water.

GENERAL OBSERVATIONS ON THE WINNING AND DRYING OF PEAT

Before attempting the commercial exploitation of a peat deposit, a number of important factors must be taken into account. It is not sufficient to ascertain only the extent acreage, depth, and quality or type of the peat material. Equally important as affecting successful operation are such factors as the location of the deposit, climatic conditions, topography and drainage, depth and nature of overburden, transportation facilities - as nearness to highways, railways, or waterways - and markets.

In general, it may be said that, before any work on a deposit is undertaken, it is advisable to consult a qualified peat technician, and in any case, if it is to be a small-scale operation, it is probable that the best policy is to adopt methods of winning and preparing the peat that have already proved successful elsewhere: otherwise, the result may be failure and fruitless expenditure.

Available Tonnage.-Knowing the extent and depth of peat in a drained deposit, a fair estimate of the quantity available may be obtained by assuming that one cubic yard of the raw peat will furnish 180 to 230 pounds of air-dried commercial peat moss, and a humified peat for fuel purposes is assumed to yield 290 to 350 pounds of air-dried substance. The weight obtained varies depending on the moisture content and the compactness of the vegetable matter.

Dehydration.-A certain percentage of the mechanically held water in peat may be eliminated by exposure to the atmosphere (sun and wind), by pressure, or by artificial heating. Notwithstanding considerable research on the problem, natural atmospheric dehydration remains today, as in the past, the almost universal method employed in preparing peat for fuel and other uses. In Quebec, however, and in most other counties where peat is produced, the season during which such natural drying is possible is short, and, as a consequence, large-scale operation is difficult.

The use of artificial heat for drying has been partially successful in certain instances, but high temperatures reduce the original absorbing capacity of fibrous moss peat and change other important properties. Young or new peat in which the cellular structure is but little broken down by decomposition may be de-watered by artificial heat or mechanical pressure much more readily and to a much greater extent than can older, well-humified peat.

Peat used for fuel purposes has a relatively high content of colloidal residues and products of decomposition. Its physical properties are such that moisture evaporation by artificial drying on mechanical pressure is impracticable. Owing to the presence of these colloids, the moisture content cannot be reduced below 70 per cent even when high pressures are used and sustained for a long time. For more complete data relating to the dehydration of humified peat by artificial heat and mechanical pressure, the reader is referred to the Final Report of the Peat Committee (1).

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(1) Final Report of the Peat Committee: Peat, its Manufacture, and Uses; Mines Branch, Dept. of Mines, Ottawa, 1926, pp.56 and 91.

Drainage.-The first operation in the preparation of an area of peat selected for commercial utilization should be drainage, which is a much more complex problem than that of draining ordinary mineral soils. One of the most remarkable properties of peat is its capacity for retaining water.

Each bog presents its own peculiar drainage problems, but the most economical layout of trenches and ditches usually follows the natural slopes in the shortest line toward the main drainage outlet.

Bogs of the 'raised' type which are operated for moss peat can be drained to the full depth of the deposit. The excavation of a main drain alone is ineffective for commercial operation, since its influence as a drain extends for only a short distance from the sidewalls of the ditch. Additional secondary ditches or working trenches, at intervals of 40 to 60 feet, are necessary for satisfactory operation. In laying out the drainage system for a deposit of this type, advantage should be taken of the natural surface slope. Generally, it is better to have the main drain near the margin of the bog than through its centre, since a drain so located will not have to be so deep as a central drain and therefore will cost less to excavate, and, moreover, the expense of building passageways for transportation over it, necessary if the drain crosses the centre of the bog, is avoided. The drainage system for peat moss operations should be kept at least two years in advance of the requirements for block cutting since it generally takes three to five years before the full effects of drainage are secured.

Peat in an undrained deposit has usually a water content of 90 per cent or more. The effect of drainage may be to reduce the water content by 5 to 6 per cent. This is more important than it may seem at first glance, since, if the water content of peat in a deposit is 92 per cent and this is reduced by draining to 86 per cent, the weight of material to be excavated is only one-half what it was before (1) draining. A further consequence of the drainage is that the compactness of the peat is increased, which reduces subsequent shrinkage. The cut blocks are more firm to handle, and they do not disaggregate in small pieces. Thus the cost of excavating and handling peat blocks is materially influenced by the efficiency of the drainage.

Experience at the Bagotville, Rivière-Ouelle, Rivière-Blanche, and Isle Verte bogs, which have been drained efficiently by main and secondary ditches, has demonstrated that, when raw fibrous peat moss materials are freed of their excess water by drainage, they do not deteriorate in quality after further long exposure to the atmosphere due to the spongy nature of the peat for retaining water.

Map No.2 shows a carefully planned system of drains at the Cacouna Bog of Allied Peat Moss, Limited, in Rivière-du-Loup county. The main ditches are around the edge of the bog. They receive surface water from adjacent level land and also that drained off by the secondary working trenches. These latter are a series of parallel ditches spaced at 50-foot intervals. They divide the bog into separ-

(1) Op. cit.

ate plots, each of sufficient size for the operation of cutting and drying to be carried on during the whole season.

In bogs operated for the production of air-dried peat fuel, the drainage of the deposit should be shallow, lowering the water level only enough to produce a sufficiently firm working surface Overdrainage is to be avoided, since the binding quality and plasticity in pulping is dependent upon a high water content. In this connection, the following paragraphs, reproduced from the Final Report of the Peat Committee, (1), are of interest Speaking of the work carried out at the experimental plant at Alfred, Ontario, the report says (p.151):

"Experience at Alfred, however, clearly demonstrated that the removal of large quantities of water from the raw peat by drainage is not practical The quality of the fuel produced depends on the amount of shrinkage in drying, and to obtain dense, firm blocks of fuel, the macerated peat spread on the field must contain a high percentage of water. Experiments showed that, when the peat slop contained an insufficient amount of water, the peat blocks checked in drying and disintegrated in handling, producing a fuel of inferior quality. The best results were obtained when the peat slop spread on the field had an average water content of about 90 per cent.

"Drainage of the bog to about 87½ per cent water content produces a surface sufficiently firm to carry the machines. Once this object is attained, further drainage can serve no useful purpose, since water must then be added to the peat to produce a peat slop of the proper consistency to yield a fuel of high quality".

METHODS EMPLOYED IN THE PREPARATION OF FIBROUS PEAT PRODUCTS

One of the first steps to be taken before opening a bog is the study of the top surface plants.

A profitable side-line has been developed by some of our operators by the utilization of the top growth of sphagnum moss (live or slightly humified) which, after drying, finds use in plant nurseries as packing material for the shipment of shrubs, trees, and roots, and also in the florist trade.

Not all species of sphagnum moss are of equal value for their absorbing power. The most common species we have are Sphagnum cuspidatum, magellanicum, fuscum, rubrum, and acutifolium.

The Winning of Sphagnum Moss.-The moss is pulled up by means of a digging fork or is cut close to the surface, using, either a special rake consisting of a bar set with long, curved teeth, or a hay-knife. The cut moss is spread on drying racks at the bog or is transported to high ground and spread there. It is turned several times a day to

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(1) Op. cit.

expose the underside to the air, and is then cleaned of roots (see Plate V). Care should be exercised not to crush the moss, since long-fibre material is required by the floral trade. Under normal weather conditions in the summer months, the moss is ready for baling after ten to twelve hour's exposure. The drying should not be carried so far as to cause the moss to become brittle. The material is shipped in lightly pressed bales weighing 20 pounds for the Canadian market and 30 to 36 pounds for export to the United States.

The Winning of Fibrous Peat.-The type and quality of moss peat known in the trade as 'peat moss' and used for agricultural and certain industrial purposes consists of rather incompletely or poorly decomposed stems and leaves from several species of sphagnum moss. The dry, shredded sphagnum moss peat is in demand for use as stable and poultry litter and for various horticultural purposes, due to its high absorbing capacity and light weight. The fibrous peat consisting of hypnum moss, reed, and sedge has a smaller absorptive power. This material finds a rather local market, due to its greater weight and cost of transportation as compared with an equal bulk of sphagnum peat moss. Coarse fibrous reed and sedge peat, when properly shredded, is used for improving mineral soils. It absorbs fertilizer salts better, and persists in the soil much longer, than the organic matter from green crop, straw, or stable manure. It is not as suitable as sphagnum peat moss for stable bedding and litter because of its lower absorptive capacity, its brittleness when dry, and its tendency to break down to a powdery dust.

The winning and preparation of the peat involves:

(1) Cutting the peat into blocks of suitable size with a spade or similar implement

(2) Air-drying

(3) Transportation on the bog

(4) Shredding and baling

Usually, Quebec operators cut the peat into blocks 6 in. by 6 in. by 18 to 20 in. long except in opening a new bog, when the uppermost layers are cut with a thickness of only 3 to 4 inches. For drying, the blocks are stacked in piles. Hence, for satisfactory results, it is necessary to have them of regular shape and uniform size in order that the air may have easy access to all sides of each block. The reason for cutting the blocks of small thickness in the first year of operation is that, owing to the imperfect drainage of the bog at this early stage, standard size blocks take a very long time to dry. This was the experience at the Isle Verte bog when operations commenced in 1936 - the first attempt to utilize moss peat in the Province. Blocks 12 in. by 12. in. by 24 in. long were cut and laid side by side on the surface to dry. After two years' exposure, they still carried too much water to be marketable.

For cutting the peat into blocks, Quebec operators use an ordinary spade. A working trench, 18 inches wide, is cut, vertically and horizontally into blocks of the standard size (see Figure 1). Successive lifts are cut to a depth of 3 to 4 feet, or a total of 6 to 8 lifts. The blocks, as cut, are placed in rows on the ground adjacent to the trend or on racks, depending on the method adapted for drying (Plates VI, VII, and VIII). There they remain throughout the winter. In the spring, when they are sufficiently dry to be handled, they are stacked in chimneys and piles.

Labour for digging the working trench is paid by the hour, but the cutting of blocks is usually done on a contract basis, at the rate of 25 cents per cubic yard. On the average, a cutter will lift blocks totalling 20 cubic yards per day. This hand-cutting of blocks accounts for more than one-third of the total cost of producing the finished peat product.

In an endeavour to reduce production costs, some operators have experimented with mechanical cutters. One of these machines, built by Henri Reid, who operates the St-Anaclet bog in Rimouski county, consists of horizontal and vertical knives fixed beneath the frame of a caterpillar tractor, at the rear of which is a rotary cutter. At first, the machine was run over the entire working area of the bog, but it has now been modified to permit its operation along the working trenches. The distance between the vertical knives is 6 inches and the horizontal knives can be lowered or raised to give the thickness required. Lengthwise, the peat is cut by the rotary knives into blocks 20 inches long or more, depending on the number of knives. Several types of mechanical cutter have been used at peat bogs in various parts of Europe, but records of their performance are not available.

In Quebec, the work of excavating peat begins about mid-summer, when the bog surface has been cleared of dried blocks cut during the previous season, and continues until the required quantity is dug out or until frost sets in. It has been found advisable to leave the cut peat lying on the surface throughout the winter as the frost improves its absorptive quality. Furthermore, this practice offers the advantage of having dried or partially dried material always on hand.

Methods of Air-Drying.-In air-drying operations, the rate of evaporation of the moisture content of the peat depends principally upon the length of the drying season and upon atmospheric conditions, of which wind and temperature are the most important. Summer climatic conditions in the Province of Quebec are favourable for the drying of peat on account of moderate rain-fall, long days, and a comparatively high temperature. Weather conditions in various localities are given in tables published by the Meteorological Service of Canada.

Drying of the cut blocks which have lain at the side of the trenches throughout the winter is effected in

either of two ways: (1) they are stacked in conical heaps, or 'chimneys' (Plates IX and X), or (2) they are lain on trestles or racks, which are stacked in tiers of ten (Figure 2). The peat is left on these drying racks for two to four weeks, according to the state of the weather. During a season, therefore, the same racks may be used four to five times. Provision of trestles naturally involves initial costs which are not incurred where the blocks are simply stacked in chimneys.

In the case of a bog which is in the first stage of development, or not sufficiently drained, it is common practice to pile the blocks around poles stuck in the peat ground. The reason for this is that peat blocks having a high water content shrink very considerably in drying, and a pole is needed to support them in piles. Plate XI shows such a method employed at the St-Anaclet bog, in Rimouski county.

Storing of Dry Peat Blocks.-Depending on the locality and its climate, the air-dried peat is left standing in stacks on the drying field, or it is stored in small sheds on the bog. A large storage shed is usually built also near the factory. In Quebec, however, climatic conditions are such that it has been found practicable to dispense with the storage sheds in the field. The air-dried blocks are stacked in piles arranged with their length in the direction of the prevailing winds and thus also of beating rains, as shown in Plate XII. These blocks retain their 'air-dried' condition all winter and until they are used the next season. The melting of the snow and the heavy rains in springtime have no effect on the moisture content, because the peat material remains frozen until later in the spring, due to its poor heat conductivity.

Transportation.-Transportation of the air-dried peat blocks over the bog presents serious difficulty, due to yielding surface, soft spots, and depressions. Means of transporting the material are by (a) basket, (b) conveyor, (c) horse and cart, (d) railway, or (e) tractor.

Baskets, with a capacity of one cubic yard, are used for carrying the air-dried blocks from the conical heaps to the large stacks or to the cars. In large-scale operations, this work is done by a conveyor, which is moved on rails or caterpillar tracks. Portable mechanical loaders and conveyors are also used for stacking blocks in the drying field.

Where the distance to the factory is short and the quantity of material to be transported is too small to warrant the use of mechanical haulage, horse-drawn trucks are used. The bog must first be sufficiently drained to support the weight of the loaded truck.

The tractor has become a very useful and, indeed, essential piece of equipment for transportation over peat bogs. The old method of transportation over fixed rails (Plate XIII) caused loss of time and added to labour costs since it involved constant pulling up and relaying of track as the digging operations moved forward over the bog.

There can be no question as to the desirability of using caterpillar traction (Plate XIV). An automobile adapted to caterpillar traction has been used successfully by one Quebec operator. It has more speed than the ordinary tractor for haulage over relatively great distance.

Shredding and Baling Factory.-Peat moss was first manufactured in Quebec in 1936, at the plant of Insulation, Limited, Isle-Verte, Rivière-du-Loup county. Since then, ten large plants and five of smaller size have been erected in the Province. In addition to the deposits in active production, a number of others are in various stages of development.

Following is a list of the principal operations, with location of the bog they work:

Allied Peat Moss,Limited, Cacouna, Rivière-du-Loup county
Bourque, Clovis, St-Marc-des-Carrières, Portneuf county
Excel Peat,Limited, Ile-aux-Coudres, Charlevoix county
Lambert, F.X., Rivière-Ouelle, Kamouraska county
La Tourbière St-Fabien Incorporée, St-Fabien, Rimouski county
Maple Leaf Company, St-Antonin, Rivière-du-Loup county
Murphy, Patrick, St-Lambert, Lévis county
Perfect Peat Products Company, Rivière-du-Loup, Rivière-du-Loup county
Premier Peat Moss, Limited, Isle-Verte, Rivière-du-Loup county
Quebec Peat Moss Company, St-Bonaventure, Yamaska county
Reid, Henri, St-Anaclet, Rimouski county
Roy, Louis, St-Ulric, Matane county
Roy, Roméo, St-Ulric, Matane county
Saguenay Peat Moss, Limited, Bagotville, Chicoutimi county
Senneterre Peat Moss Mines, Limited, Senneterre, Abitibi county
Trump Peat Moss, Limited, Rivière-du-Loup, Rivière-du-Loup county
Waterville Moss & Peat Mines, Waterville, Compton county

The equipment of a factory consists of the following units:

One shredder, with mechanical feeder
One Bucket elevator or pneumatic conveyor
One screening unit, either rotary or shaking
Two or more baling presses

The following brief descriptions of two modern Quebec plants will serve to illustrate the manufacturing processes.

Excel Peat, Limited, started production in 1943, using peat from the Isle-aux-Coudres bog, located on an

island in the St-Lawrence river, sixty miles below Quebec city. Diagrammatic plans and elevations of the factory are shown in Figure 3. The air-dried peat blocks are transported to the factory on cars hauled by a tractor, and are dumped into a hopper. From the hopper, they are conveyed by a feeder, driven by chain and sprocket, to the top of a shredder, into which they are discharged. In this machine, the blocks are broken up and the peat emerges as light, shredded material. A bucket elevator, fitted with sheet metal containers or cups, 30 inches wide and 8 inches deep, carries this to a shaking screen at the top of the building. The screen is a wooden frame, 5 feet wide by 20 feet long, covered with wire cloth. It is set with an inclination toward the discharge end and is mounted on flexible supports. The products are separated on the screen: (1) material up to ¼-inch, suitable for horticultural purposes; (2) medium coarse, for use as poultry litter; and (3) coarse, up to 3 inches, for use as stable bedding. From the screen, the material is dropped through a wooden chute and is pressed into bales by hand-presses, built locally. The finished products are packed in boxes made of thin wood and bound with wire, or in cardboard boxes.

Canada Peat, Limited, uses a suction process for transportation and classification of the shredded peat. The material discharged from the shredder, which has a capacity for hauling 160 pounds of air-dried peat moss per minute, is drawn through the pipehood of a suction fan into a collector, where coarse material is dropped and passes through the discharge pipe into a rotary hexagonal screen; it is then classified and falls through chutes to the presses. The short fibres and dust escape through the top of the collector to be blown by the fan into a cyclone collector. The latter effects a separation of the very short fibres and the dust. The plant is equipped with two electric presses, each with a capacity to produce 250 bales per day of 8 hours. The bales are 20 in. by 20 in. by 40 in. long and contain about 20 bushels of loose peat. The plant is electrically operated and most of the machines have their own individual motor.

Details of Factory Equipment.-In the manufacture of fibrous peat products, the desintegration of the air-dried peat blocks is effected by a shredder. On account of the excessive production of fine material, the single-roll machine, provided with numerous teeth fixed on the roller in oblique lines or screw-wise and rolling against a fixed plate provided with counter-teeth, is not used in the newer factories. The shredder constructed of two rolls is apparently the most satisfactory machine for fiberizing. These two rolls, made in ring sections, either of cast iron or cast steel, are equipped with teeth. They revolve at different speeds in opposite directions. Rolls made of sawblades separated from one another by intervening rings are also used. These are usually made in local foundries. By means of adjusting bolts and nuts on the bearing of the slower running roll, the distance between the rolls can be regulated for production, as desired, of coarse, medium, or fine litter (Figure 5). This is important since, if it were not possible to regulate the fineness of the products, the manufacture might accumulate large stocks of grades that were not immediately marketable. In the fall, for example, the

demand is chiefly for peat litter of a granulation between ¼ inch and 3 inches, and, by suitably adjusting the distance between the rolls, it is possible to obtain a product containing from 70 to 80 per cent of such material. Similarly in the spring, when finely granulated peat is in demand, the rolls can be adjusted to yield a product containing 60 to 65 per cent fine material. To complete the reduction of the coarse material, a secondary grinder is needed.

A shredder of lighter construction, consisting of two cylinders with shredding teeth inserted in the shell revolving at different speed and rotating in opposite direction, is used by small producers. This machine, which costs much less than rolls, is similar to the shredder used on the farm.

After shredding, the material passes to a screen, which makes, usually, three products: fine, medium, and coarse. Fibrized peat being light and bulky, it has been found unsatisfactory to have the material passing through the screen fall into bins, as it piles up unto arched heaps and does not run readily, even if the partitions between the bins are metal lined. Instead of bins, therefore, chutes or funnels are provided and the material falls down these directly to presses. By means of an arrangement of fly valves at the tops of the chutes, each grade of material is made to fall into a separate press.

In most modern plants, a rotating hexagonal screen has displaced the vibrating screen for separating the shredded peat into grades. It is of large diameter, from 6 to 8 feet, varying in length from 12 to 18 feet, and the panels, which are removable, are covered with wire screen with 1-5/8-inch and 3/8-inch openings. As regards both performance and costs, it has been found that this type of screen is superior to the vibrating screen. It makes three products, the oversize used for stable litter, the medium for poultry litter and the fine, for horticultural uses. These go to separate presses.

The presses used for baling are vertical, either of the up-stroke or down-stroke type, and they are operated manually or by motor power. They open front and back, which permits covering and tying the bale while under full compression. The shredded, fibrous peat is reduced to one-third of its original volume. While in the press, the bale is covered with a wrapping of burlap, paper, or veneer, and secured with 6 to 10 slats of wood and bound with iron wire. In the Quebec plants, the peat is usually packed in lightweight wooden boxes or in paper containers.

Marketing, Value, and Production Cost.-The sale unit for fibrous agricultural peat is the bale, which contains 12 cubic feet or 20 bushels of loose material. The moisture content ranges from 20 to 35 per cent and the average weight is 120 to 160 pounds. Half-bales, which contain 5 to 6 cubic feet of material and weigh 60 to 80 pounds, are also marketed.

As will be noted, the bale, as marketed today, is not closely standardized in weight, size, or peat content. This should be remedied, not only for statistical purposes but because, for efficient marketing in a competitive and

largely foreign market, standardization is imperative. Emphasis must be placed also on standard of quality. It is important that producers and dealers who do their own marketing devote time and study to what the market demands in order to keep the industry on a sound and expanding basis. The attached specifications (see page 32) set up by the U.S. Procurement Division of the Treasury Department to meet the steadily increasing demands of the U.S. federal agencies and the well-established dealers, are concerned with a description of the characteristics of the type of peat to be procured. Our producers should familiarize themselves with these specifications, since, at present, nine-tenths of our output is sold for consumption in the United States.

Before the war, both Canada and the United States were largely dependent on imports from Germany, Holland, Denmark, and Norway for this commodity. The strong position of the German and Swedish interests made it difficult for Canadian sources of supply to start producing and enter in competition, although the demand for agricultural peat was steadily growing in the United States.

With regard to the possibilities of expanding Canada's peat industry, H.A. Leverin, in a publication issued by the Federal Bureau of Mines, writes as follows:

"A certain demand for peat moss exists in Canada and is increasing, but a much wider market could be developed once the public is educated to its many uses and the beneficial results to be derived therefrom. As a parallel case, Sweden may be cited, which has developed a very large peat moss industry with a yearly production of somewhat over four million bales. Industrially, Sweden and Canada are comparable because the industries of both countries are based mainly on the same natural resources, water power, forest products, and minerals, supported by agriculture on a large scale. Sweden's population is somewhat more than half that of Canada's, yet, of her production of peat moss of over four million bales, she exported only 600,000 bales; the large remainder was absorbed for home consumption. With Canada's vastly greater output of industrial and agricultural products and the potential market for export to the United States, there would appear to be no limit in sight for the expansion of the Canadian peat moss industry for many years to come. Even to maintain the same output of peat moss as Sweden, four million bales per annum, would mean forty plants, each of 100,000 bales capacity, employing 8,000 to 9,000 workers for eight months in the year. Of these, an appreciable number of men would have employment all the year round in the baling factory and on the field for the transportation of the dried peat sods to the baling plant. Labour in a peat moss plant is employed for an appreciably longer time than in most seasonal labour. Furthermore, a peat moss factory is self-contained, and all equipment and machinery can be obtained from Canadian machine shops and building trade".

During 1945, the market price per bale of peat, as paid to producers by brokers and wholesale dealers, averaged $1.40, f.o.b. shipping points. Production costs per bale are estimated to be as follows, based on a normal production:

Excavating (cutting blocks)	$0.25
Stacking and storing or drying on racks	0.12
Loading and transportation of peat blocks to the factory	0.03
Shredding and baling	0.08
Container	0.35
General expenses and repairs	0.04
Depreciation, interest, administration	0.12
	$0.99

Labour is the largest cost item. Wages paid to workmen employed in the industry are governed by an ordinance of the Minimum Wage Commission, which fixes a minimum rate of wage depending on the classification of the work.

RECLAMATION OF PEAT LANDS FOR AGRICULTURAL USE

Although somewhat outside the scope of this report, reference may be made here to the reclamation of peat lands for agricultural use, a matter that has not yet received much attention in the Province. It is true that extensive drainage operations have been carried out on some of the large peat areas, but these have not been reclaimed by any suitable treatment to convert them into valuable productive crop areas. Such reclamation is a highly specialized undertaking, requiring expert knowledge of the nature of peat soils, lack of which has on many occasions led to disappointment and failure.

For the present, reclamation of the marginal portions of peat deposits is recommended rather than the high-cost drainage of large peat areas. These marginal portions consist usually of decomposed peat, they have a high content of mineral matter, and the ground water generally contains soluble mineral salts of value to growing crops. Peat material of this type is not suitable for the production of litter or fuel and should therefore be considered with special regard to its possible agricultural development.

The practice of reclaiming bog land for cultivation by setting fires should be discontinued. During a dry season, fires which get beyond control often overrun large areas of the bog and destroy a natural resource which, otherwise, might have been of extreme value.

The acidity of peat soils makes them especially valuable for cranberry culture and the raising of blueberries. For some years past there has been a small output of cranberries from a plantation farm in Villeroy, Lotbinière county. There seems to be opportunity for the expansion of this culture.

INDUSTRIAL UTILIZATION OF PEAT

Peat Fuel Industry.-Hand-cutting of peat has been practised in the Province of Quebec for many years by local residents digging their own fuel supply. Plate XV

shows peat fuel made by this method at St-Isidore. This form of peat fuel is scarcely suitable for the outside market on account of its weak cohesion, low calorific value, and high absortive power after drying.

For over a generation, numerous attempts have been made to produce peat fuel in the Province on an industrial scale. A great variety of methods have been tried and have proved commercially unsuccessful. The last venture was near St-Hyacinthe, where a plant with a capacity of 240 tons a day was erected for the manufacture of peat fuel by the hydro-peat process. The high cost of the equipment, and the sales resistance encountered in introducing the new product, obliged the Company to discontinue operation in 1935.

Lately, British interests have been negotiating with the Federal and Provincial governments to obtain subsidies for the establishment in Canada of a factory for the production of pressed, briquetted peat as a domestic fuel, using the Peco-Gram process. The cost of such a factory having an estimated capacity of 50,000 tons a year was to be approximately one million dollars.

The "Quebec Type" Peat-Forming Machine

In view of the difficulties incidental to the large-scale manufacture of peat fuel, the Quebec Department of Mines, in 1942, commenced investigations which resulted in the development of a peat-forming machine of simple construction and requiring a minimum of equipment. Early in 1943, expecting a shortage of wood-fuel, the Emergency Coal Production Board announced that financial assistance might be made available to small enterprises for the production of peat fuel, provided a local market was existing within a reasonable distance of the bog. To encourage this development, the government loaned the peat-forming machine to peat operators.

The design of the "Quebec-type" peat-forming machine, developed by the writer was governed largely by that of a similar machine in successful use in Europe and described in the "Handbook on the Winning and Utilization of Peat", by A. Hausding. The component parts, such as knives, forming pieces, and cutting contrivances, on the nature of which the output of the machine depends, both in quantity and in quality, are fully described in Section V of that Handbook.

Briefly, the machine consists of two screw conveyors of split-pattern intermeshing worms, one right-handed and the other left-handed, 12 inches in diameter and 40 inches long, enclosed in a cast iron shell provided with a feeding hopper at one end and a delivery spout (mouthpiece) at the other (Figure 6). This unit is mounted on a wooden frame and driven by a stationary engine or is installed on the chassis of an automobile that has been stripped down to the framework behind the front seat. In the latter case, which is the installation generally in use, a wooden pulley is keyed on the extension of the motor shaft. The power is

transmitted by belt-drive to line-shafting installed at the side of the frame above the running board. Chain-and-sprocket drive transmits the power from the line-shaft to the macerator and elevator gear. Hinged to the hopper is a light chain-feed conveyor, 12 feet long, which can be raised or lowered into the excavation as desired. The delivery spout consists of a triple forming piece, 3 in. by 3 in. It is divided into separate sections by knife-like intermediate walls, which are fixed on a rotating spindle and can be tilted out through slits in the upper wall (Plate XVI). In operation, therefore, three parallel streams of peat pulp, in cross-section 3 in. by 3 in. and half an inch apart, are extruded and received on wooded pallets made of laths, 3 feet long and 1 foot wide. These pallets are supported on a light stationary conveyor made up of wooden rollers, 3 inches in diameter and 12 inches long, spaced 10 inches apart, and held together in a frame. An automatic sod-cutter stands over a small chain-conveyor, 6 feet in length, which is attached to the end of the roller way. The peat bands emerging from the mouthpieces are cut into pieces of the desired length by the rotating knife, which is set in motion by the forward movement of the peat band.

In actual operation, the peat is excavated by hand, using either a shovel or fork, according to the nature of the material, and shovelled on to the conveyor, which carried it to the hopper of the machine. After passing through the machine, the macerated peat is extruded on to wooden pallets, as already mentioned. These pallets are then carried away by hand and either built up into racks or transported to the drying area by means which will be described later. When the peat within shovelling distance of the machine has all been excavated, the countershaft drive is disconnected and the machine put in gear and driven under its own power to the next working position, where the macerator is again connected up and operations resumed.

Drying Boards.-The drying board on which the issuing peat bands are received is made of nine laths, 36 to 39 inches long. Three laths are used for the framework, to which the other six are fixed with 1-inch nails. In operation, the first drying board is pushed underneath the macerator from the side, until the issuing peat bands begin to rest on it. Before the end of one board reaches the mouthpieces, the workman places a second board immediately behind it and pushes the new board until it is caught and dragged forward by the peat bands.

Methods Adopted for Carrying Out Operations.-Although the devising of a cheap and rapid mode of transporting the pulped peat to the drying area, and the fuel to storage or point of shipment, may at first appear a simple matter, it is really a difficult one. Inefficient methods of handling the raw and manufactured peat, and of picking it up and transporting it from the drying field, may easily ruin an otherwise profitable operation. The problems involved in selecting proper equipment for these operations vary a good deal with the characteristics of the bog, local rates of wages, locality, etc. For this reason, it was left to the initiative of the operators themselves to use such contrivances as they might find satisfactory.

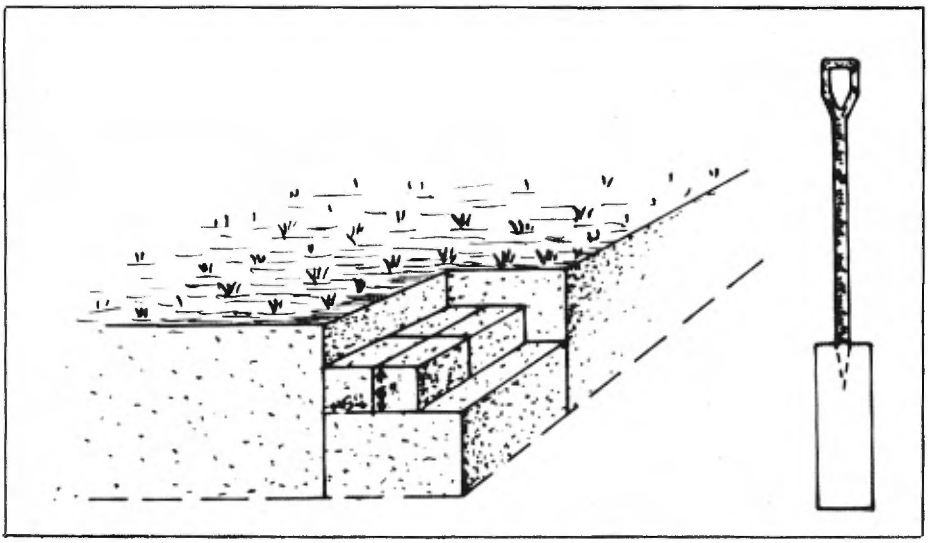


Figure 1.—Diagram showing method of excavating peat moss blocks and type of spade used for hand-cutting.

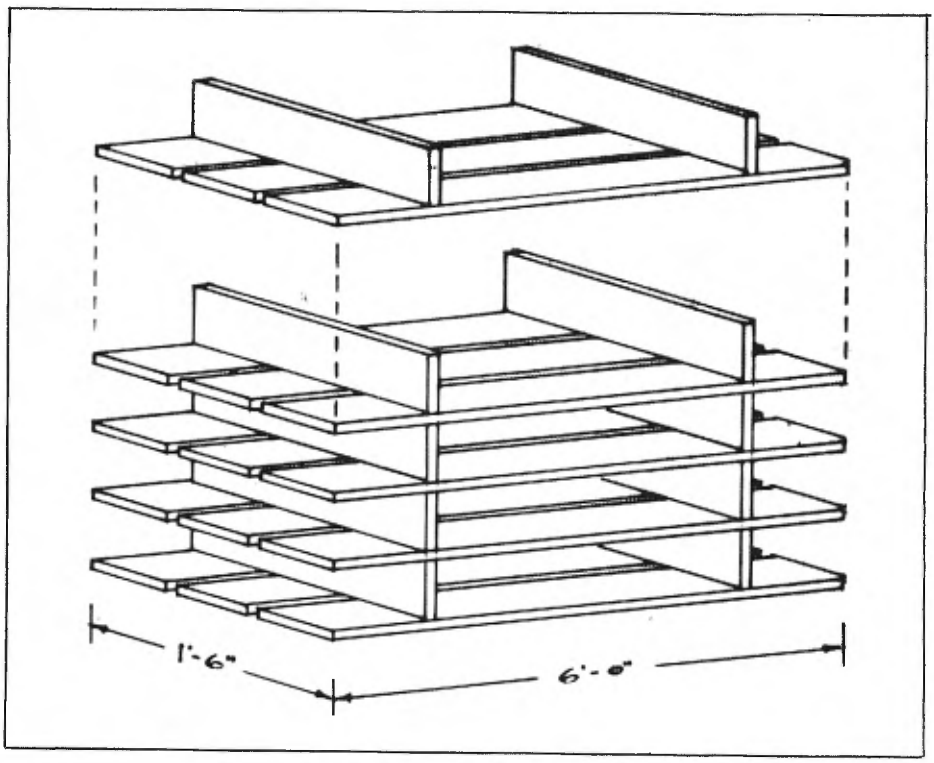


Figure 2.—Drying rack for the air-drying of peat moss blocks.

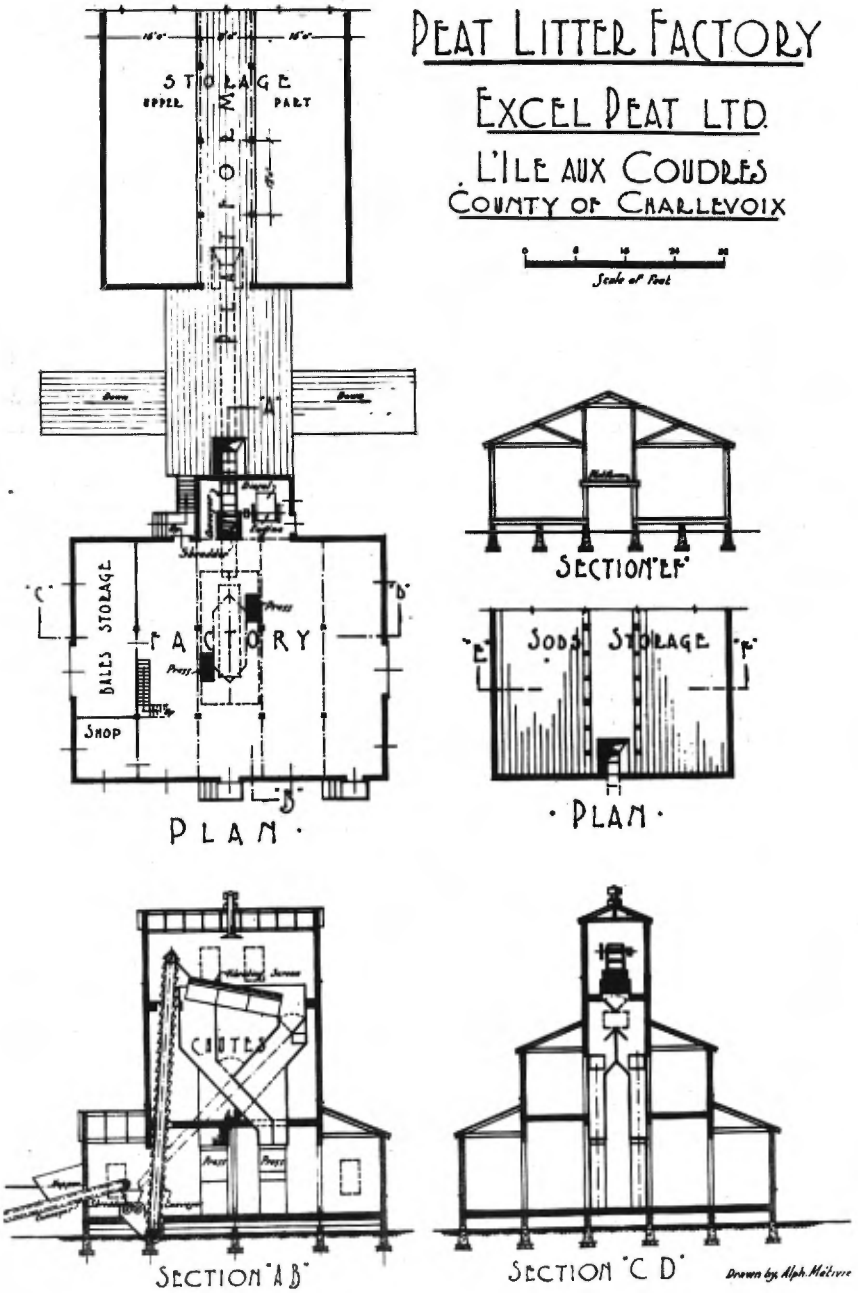


Figure 3.—Peat moss factory of Excel Peat, Limited, Ile-aux-Coudres, Charlevoix county.

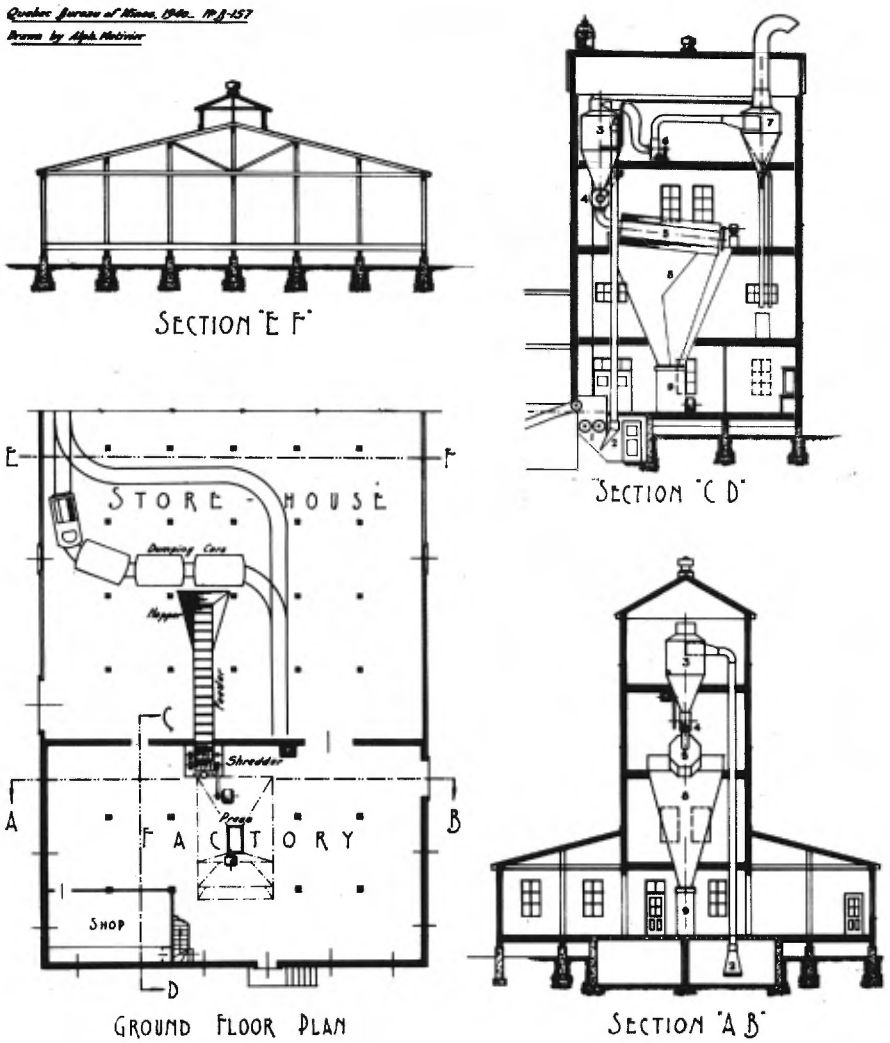
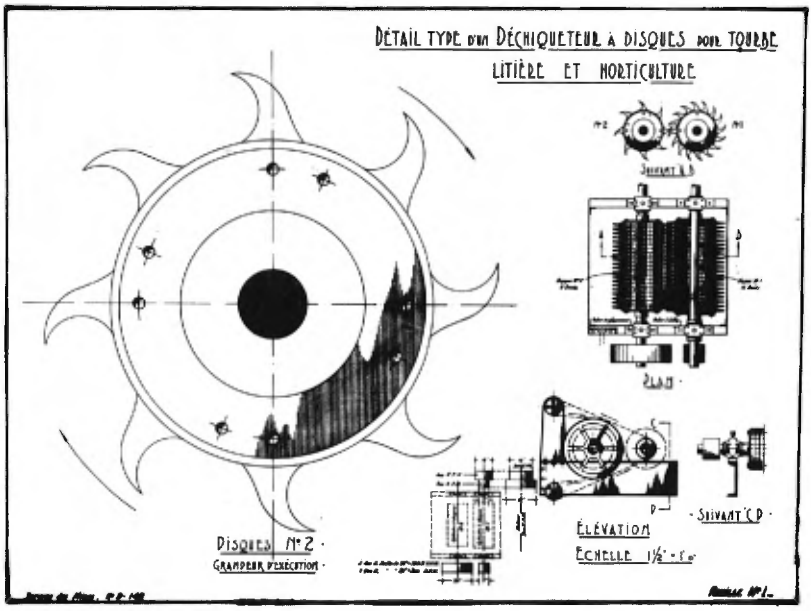


Figure 4.—Peat litter factory of Canada Peat, Limited, at Rivière-du-Loup.



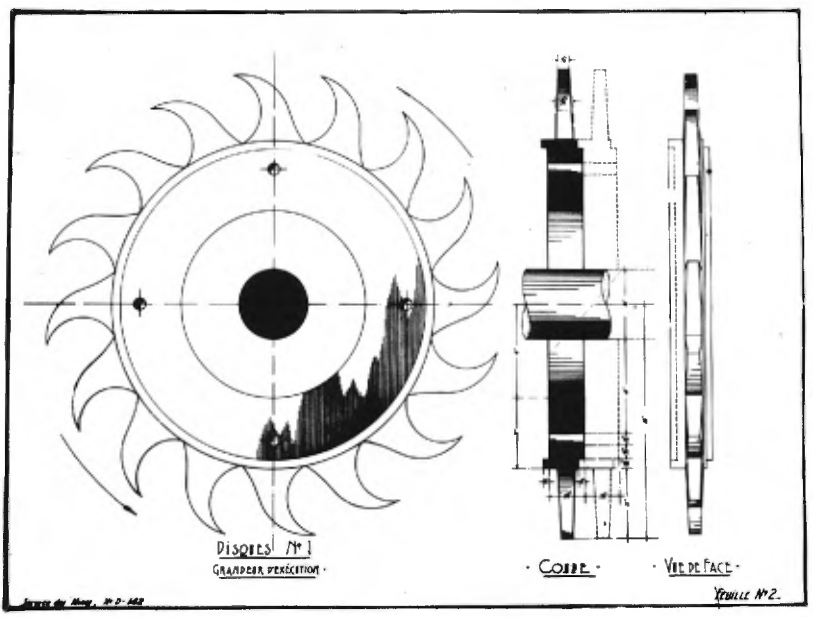


Figure 5.—Detail of ring sections of the two-roll shredder.

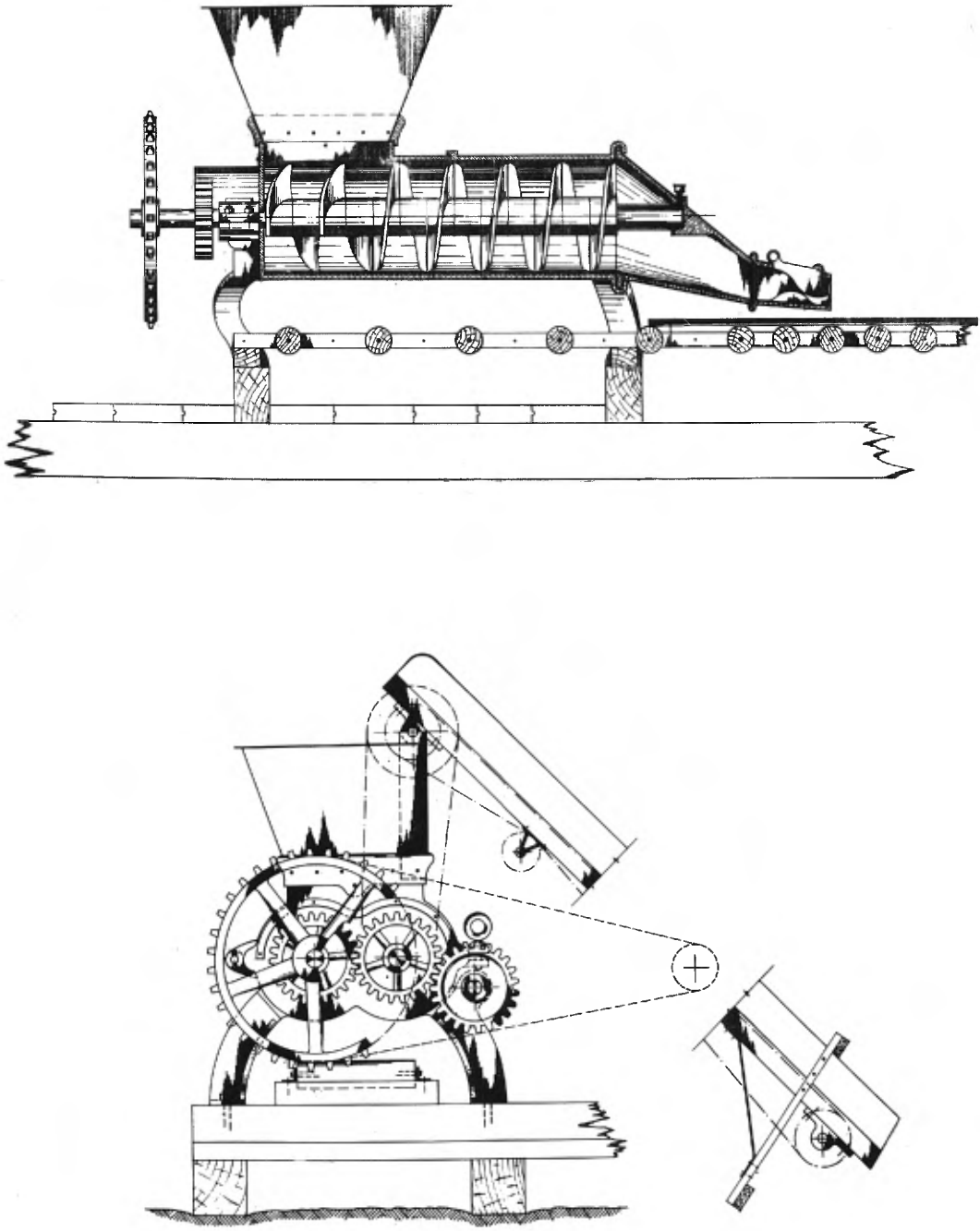


Figure 6.—The "Quebec Type" peat-forming machine.

Plate I—Fibrous sphagnum-moss peat.

Plate II—Large sheet of fibrous cotton-grass peat (eriophorum).

Plate III—Reed and sedge peat.

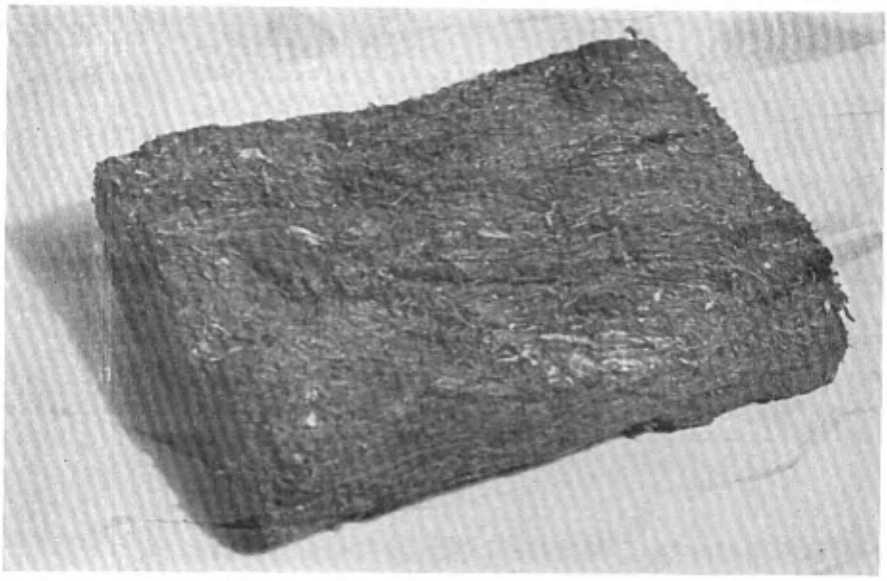


Plate IV.—Hypnum moss peat.

Plate V—The cleaning and drying of floral sphagnum moss spread on drying rack.

Plate VI—Method of cutting peat blocks at Rivière-du-Loup bog of Canada Peat, Limited.

Plate VII—Building of drying racks at Canada Peat, Limited, Rivière-du-Loup bog.

Plate VIII—Peat blocks placed in rows on edge of working trench. Premier Peat Moss, Limited, Isle-Verte bog.

Plate IX—Piling peat blocks into conical heaps. Premier Peat Moss, Limited, Isle-Verte bog.

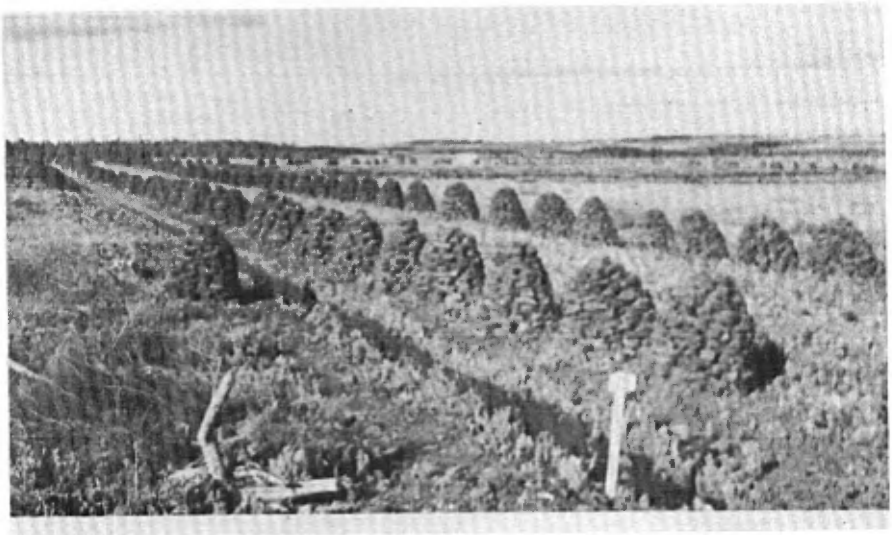
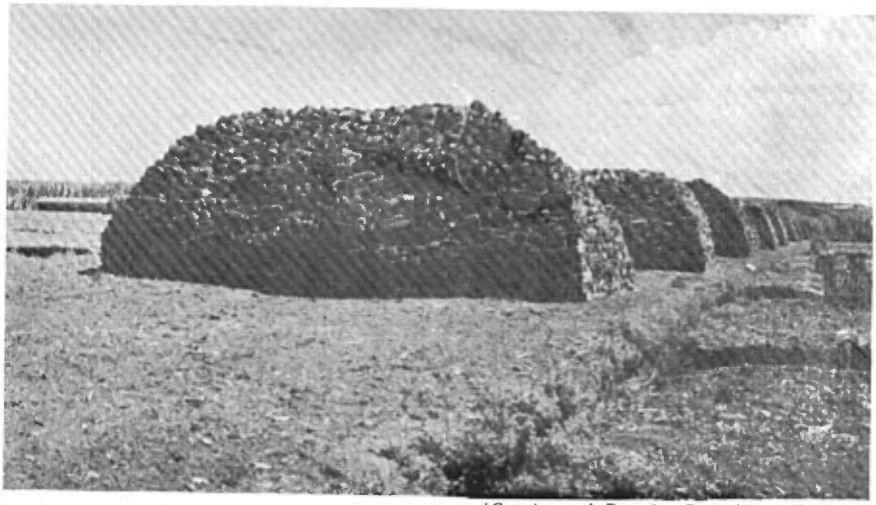


Plate X—Conical heaps on surface of bog. Allied Peat Moss, Limited, Cacouna bog.

Plate XI—Method of drying peat blocks at the St-Anaclet bog, operated by Henri Reid.



(Courtesy of Premier Peat Moss, Limited)

Plate XII—Peat blocks stored in piles (stacks) on surface of bog. Premier Peat Moss, Limited, Isle-Verte bog.

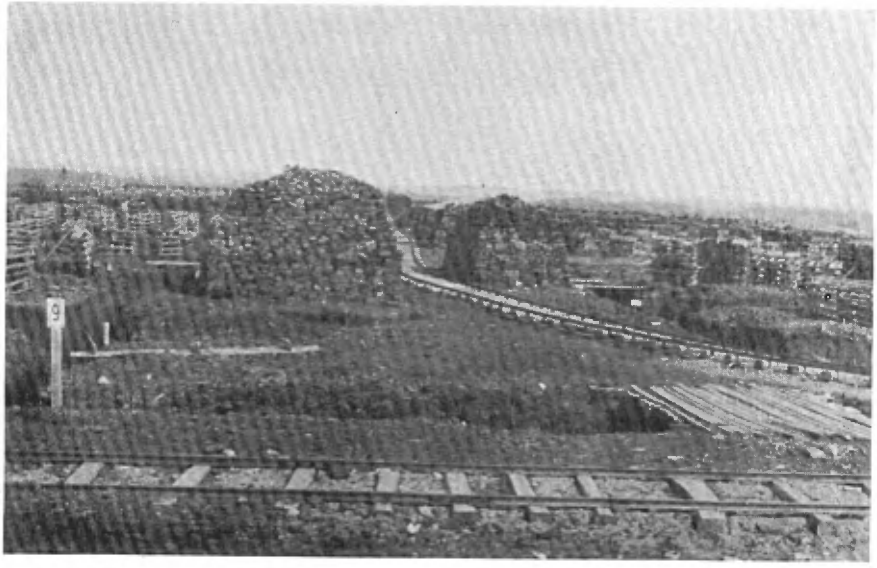


Plate XIII—Method of transportation on peat bog. Premier Peat Moss, Limited, Isle-Verte bog.

Plate XIV—Caterpillar tractor for transportation over peat bog. St-Anaclet bog, operated by Henri Reid.

Plate XV—Hand-cutting of peat fuel blocks at St-Isidore.

Plate XVI—"Quebec Type" peat fuel machine in operation at St-Lambert, Lévis county.

Plate XVII—Caterpillar tractor used in spreading and harvesting peat fuel.

Plate XVIII—Stack of dry peat fuel on ground. Saint-Jean peat bog, Lévis county.

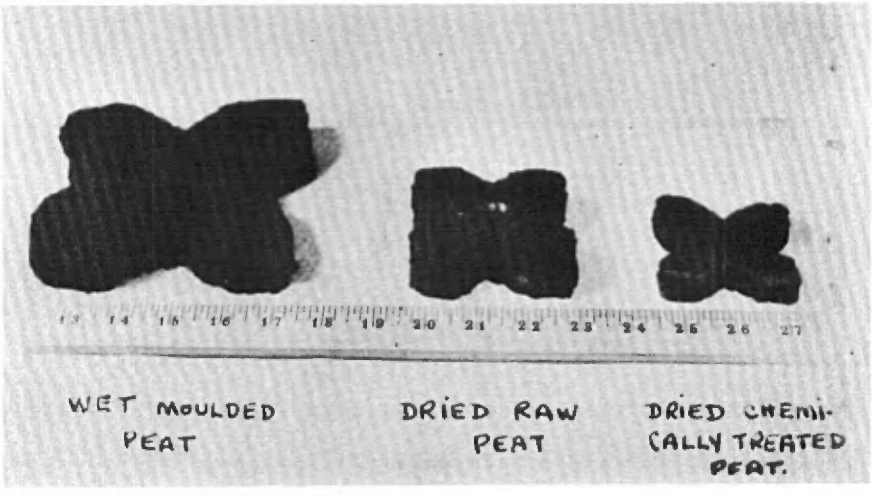


Plate XIX—Showing relative size of blocks of (1) wet moulded peat; (2) dried raw peat; and (3) chemically treated peat.

Actually, four different methods have been used or experimented with by Quebec operators for handling the peat after cutting:

(1) Drying on wooden boards stacked in racks

(2) Drying on boards carried by hand and set on surface of bog

(3) Same as (2), but boards transported by tractor

(4) Drying on surface of the bog by using a chain conveyor for carrying the boards to the drying area

Method No.1.-As a result of the first year's experience with the peat-forming machine, it would appear that method No.1 is uneconomic in both capital expenditure and labour cost. In this method, which was adopted by a few operators, drying boards loaded with the pulped peat are carried by hand to racks, on which they are stacked in tiers of ten. The racks are moved forward over the bog as the machine advances, so the loaded boards do not have to be carried far. It was found, however, that two men were required just for handling the boards. Another serious disadvantage was that the moulded peat sods were slow in drying when two or more rows of stacks were built up adjacent to one another.

Working with this system, the labour requirement was two men digging peat, one feeding the drying boards to the machine, two carrying the drying boards to racks, two building up the racks, and one general helper, or a total of 8 men.

Calculations at one plant at the end of the season indicated that operating costs amounted to approximately $8.00 a ton. The high cost was in part due to the frequent breaking down of the automobile engine - an old one - used for power.

Method No.2.-In this method, the loaded boards are taken from the peat machine, carried by hand, and deposited in rows on the surface nearby. To serve one machine during the season 12,000 to 15,000 drying boards are required.

This system has the advantage of requiring a minimum of equipment and only unskilled labour. For experimental work and initial development of a bog, it proved superior to any of the other methods. Using a peat machine with a capacity of one ton of air-dried peat per hour and drying boards 3 feet square, the number of boards required per hour is 300, which, spread on the surface, occupy an area of 900 square feet. The main problem was to find a method of spreading these boards with as short a carrying distance as possible. This was effected by moving the peat machine about 15 feet ahead every twenty minutes. The machine can be moved easily over the bog on two-inch planks placed under the wheels.

The pulped peat cakes have to remain on the drying boards for three or four days in good weather before they are sufficiently stiff to be turned over, and they are not

removed from the boards until they are quite dry and ready to harvest - hence the very large number of boards required for the season's operation.

The labour required for attending the machine is two men for shovelling peat, one in charge of the drying boards, and three for spreading the boards on the surface of the bog, a total of six men. The estimated production cost, based on work for a period of 30 days, was $6.50 a ton.

Method No.3.-This was found to be the most efficient method for commercial production on a small scale. It was adopted by one producer, who used a caterpillar tractor for spreading and harvesting the peat. The drying boards, loaded with pulped peat, were carried over the bog surface on a sled, 5 feet wide by 20 feet long, on which a trestle was built, accommodating 100 drying boards. The tractor hauled the loaded sleds to the drying field and later in the season hauled empties for picking up the dry fuel and conveying it to storage (Plates XVII and XVIII).

Working with one peat machine, the production cost based on operations in 1945, is estimated at $5.00 a ton.

The tractor used in this operation, a 30 h.p. International, hauls a train of two or three loaded sleds at a time and makes the round trip between the peat machine and drying ground in 5 to 8 minutes. It could take care of the output of three peat machines. With this method of working, the peat machine is mounted on skids and provided with a 10 h.p. stationary engine as a source of power.

Method No.4.-In order to minimize as much as possible the manual labour involved in handling the output from the peat machine, one producer used a chain conveyor 120 feet long, made in detachable 20-foot sections so that it could be moved easily over the bog. It was connected with, and operated by, the peat-machine motor. As this conveyor was in operation for only a short period, late in the season, it is not possible to express a final opinion as to its possible merits. Much would depend on the speed with which it can be adjusted and moved over the surface of the bog. Also, it is doubtful if this type of equipment would be efficient for conveying the fuel from the drying field to the point of storage.

Conclusions.-The most important item in the consideration of any method of producing peat fuel is the unit cost of such fuel delivered and ready for consumption. Obviously, the production cost will be lower for a large-scale than for a small-scale operation, as the large producer can afford to employ every mechanical material-handling device that can be advantageously adapted to the recovery of peat, and the most modern and efficient equipment for moving and handling large quantities of material. Conversely, it is equally true that, unless the operation is on a moderately large scale, the investment in such special equipment is uneconomic and not justified. The present position is that peat fuel, being a new and untried fuel so far as Quebec is concerned, has a rather limited market. Until the demand arises for larger output, no large-scale operation is economically possible.

It was hoped that the experimental work carried out in 1943 with the peat-forming machine would lead to the establishment of a successful, though of necessity small-scale, peat-fuel industry for domestic purposes. However, production declined in 1944, due chiefly to the shortage of labour and to the fact that the production of other peat products was more profitable for the operators.

One of the great difficulties in widening the market for air-dried peat fuel for domestic purposes is that in Quebec, as already mentioned, and in Canada generally, peat is an almost unknown and untried fuel. Without reasonable assurance that their output can be marketed, producers naturally will not risk building up supplies of peat fuel by operating in the early part of the season, when drying conditions are most favourable. As far as can be judged, the probability is that air-dried peat fuel will not be extensively produced in this country so long as an abundant supply of wood can be had in normal times for the cutting. The manufacture of a denser peat fuel product which would be easier and less bulky to handle would doubtless assist in encouraging the use of peat as a household fuel. It is known that the addition of various coagulants during the macerating operation improves the fuel product, rendering it denser, harder, and coal-like in appearance. C.W. Davis, attached to the National Research Council, Ottawa, has recently investigated the effect on the drying qualities of wet peat produced by a mild chemical treatment, during maceration, with a solution containing either 1 per cent NH_4OH (ammonia) or 2 per cent $Na_2CO_3.H_2O$ (washing soda) with or without $\frac{1}{8}$ per cent ferrous sulphate on the dried weight of peat material. This treatment yields a rather denser, and also stronger product than does raw peat pulp. Plate XIX shows the relative sizes of, from left to right, wet moulded peat, dried raw peat, and dried chemically-treated peat.

The results of tests carried out at the fuel-testing station of the Mines Branch, Department of Mines, Ottawa, show that peat with a 20 per cent moisture content is a good fuel, can be handled readily, burns with a long flame, yields little ash, and does not clinker. Owing to its low ash content, it can be used in certain types of blast furnace as a reducing agent, in place of coke or coal. As may be seen from the figures given in the accompanying table (page 29), peat, when properly used, has a fuel value of about $9.00 a ton when compared with hardwood or coal, whereas its market price is only $8.00 a ton.

Utilization of Peat Fuel for Production of Power, Charcoal, and Various By-Products

Peat fuel can be used satisfactorily and economically (1) for generating steam power, by burning under boilers in specially designed furnaces in which the combustion chambers have large, step grates to accommodate the blocks of fuel peat; (2) for production of charcoal and a variety of gaseous and other products by carbonization; and for production of producer-gas with or without the recovery of by-products such as light oils, tar, and ammonia. The products

of carbonization comprise various condensable gases, wax and bitumens, charcoal, and crude alcohol, acetic acid, acetone, ammonia, and other compounds. At low temperatures, charcoal is the main product; at high temperatures, gases may equal or exceed charcoal in importance.

An alternative to the burning of peat under steam boilers, for generation of electric energy in turbo-generators, is to have the combustion take place in a gas producer and use the gas generated in a gas engine or in a gas-fired steam boiler, which in turn works a turbo-generator.

In Europe, large quantities of fuel peat are produced and consumed every year. In Germany particularly, several large electric power plants are conveniently situated on peat deposits to take advantage of the fuel peat available in the adjacent areas.

The use of peat for industrial purposes has probably been developed on a larger scale in Russia than in any other country. Notably, in one process, they have converted the water, the big liability of the peat bogs, into an asset by designing a peat-fired gas generator which produces a gaseous fuel product that is partly producer gas and partly water-gas. In several large plants, this gas is burned to generate steam. The Russian practice and operations are worthy of most careful study and consideration by Quebec producers.

OTHER INDUSTRIAL USES OF PEAT

Heat Insulation and Sound-Proofing.-In Quebec, peat moss is used locally in the building trade as an insulating material and for sound-proofing. While not fireproof, it does not easily ignite and, by impregnation with certain chemicals, it can be made resistant to water and to fire.

Wallboard.-An interesting possibility now being investigated in the laboratory of the Quebec Department of Mines is the utilization of peat for making a special type of wallboard. Experiments have shown that by submitting a mixture of peat and ground mica to heat and pressure, a resin-banded material is obtained which is both waterproof and fireproof. 'Low-moor' peats of the reed and sedge types are the most effective for this purpose as they consist largely of lignin-like complexes, the material employed by nature to cement the individual fibres together in wood.

Filler.-Peat has been used, or its use has been suggested, in the production of a great variety of materials in which it is present chiefly as a filler, as in linoleum, paper, and wallboard.

Products Obtained by Chemical Treatment.-Chemical research has shown or indicated that peat can be converted into a variety of industrial products, and investigations to that end were commenced some time ago in the laboratories of the National Research Council, in Ottawa. Peat consists of organic complexes including fats and waxes, cellulose and hemi-cellulose, lignins and their derivatives, and a variety of other carbohydrates. Several processes have been worked out and patented for converting the cellulose into suger from this producing alcohol.

TABLE I.-Comparison of Coal, Wood, and Peat as Sources of Domestic Fuel

	Measuring Unit	Weight	Storage Bulk	Calorific Power*			Price	
				B.t.u. Per lb.	Relative Value	Measuring Unit	Per Ton	Per B.t.u.
Pennsylvania anthracite ..	1 ton	2,000 lb.	37 p.c.	12,900	1,808	$16.50 per ton	$16.50	0.00127
Average hardwood dried to 25% moisture.	1 cord	4,000 lb.	128 p.c.	6,500	956	17.40 per cord	$ 8.70	0.00134
Peat fuel air dried to 25% moisture	1 ton	2,000 lb.	62 p.c.	6,800	1,000	8.00 per ton	$ 8.00	0.00118

*The gross heating value given above is for standard fuels on the market.

The price set by the War Prices and Trade Board for hardwood is $17.40 in Quebec city for a cord of 128 cubic feet (4 x 4 x 8 feet) cut in foot length and split. Two tons of peat fuel would be equal in heating value to a little more than a cord of wood.

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APPENDIX A

TREASURY DEPARTMENT

PROCUREMENT DIVISION

SPECIFICATION FOR PEAT

(Moss, Reed, and Sedge)

A.-APPLICABLE SPECIFICATIONS

A-1.-There are no other specifications applicable to this specification.

B.-TYPES AND CLASSES

B-1.-Peat shall be furnished in the following types and classes, as specified in the invitation for bids:

Type I. Moss peat (See note H-2)
Class A. Horticultural grade (fine shreds)
Class B. Poultry litter (medium shreds)
Class C. Stable bedding (coarse shreds)

Type II. Reed much or sedge muck

Type III. Reed peat or sedge peat
Class A. Acid grade
Class B. Nearly neutral grade

C.-MATERIAL

C-1.-See detail requirements.

D.-GENERAL REQUIREMENTS

D-1.-See detail requirements.

E.-DETAIL REQUIREMENTS

E-1.-Type 1. - Moss peat shall be the poorly decomposed (fibrous or cellular) stems and leaves of any of several species of Sphagnum mosses. Its texture may vary from porous-fibrous to spongy-fibrous, and it shall be either crumbly or compact but fairly elastic and substantially homogeneous. It shall be free from decomposed colloidal residue, wood, sulphur, and iron, and shall be brown in colour, tinted grey, yellow, or red.

E-1a.-Acidity.- The PH value shall be not less than 3.5 and not greater than 5.5.

E-1b.-Moisture content.- Peat shall be furnished in air-dry condition, and shall contain not more than 35 per cent moisture, by weight.

E-1c.-Water-Holding Capacity.- Shall be not less than 1,100 per cent, by weight, on an oven-dry basis.

NOTE.-Where the highest grade of moss peat (type 1) is not required, the purchaser may find satisfactory a grade containing up to 2 per cent of foreign matter, such as twigs and cotton grass. In this event, it should be so specified in the invitation for bids.

E-1d.-Coarseness Classification of Shreds.-Peat shall be furnished in three classes of coarseness, as specified in the invitation for bids.

E-1d(1).-Class A. (Horticultural Grade).- Shall be finely shredded material, suitable for horticultural purposes. Particles shall vary in size from dust up to the size of wheat bran.

E-1d(2).-Class B, (Poultry Litter).- Shall be medium shredded, suitable for use as poultry litter. It shall be coarser than Class A and lumpy. Individual pieces may be as large as walnuts.

E-1d(3).-Class C. (Stable Bedding).- Shall be coarsely shredded, suitable for use as stable bedding. It shall be coarser than classes A and B and may contain larger lumps.

E-2.-Type II.-Reed muck or sedge muck shall be finely divided plant débris in a fairly advanced state of decomposition (peat humus). It shall be furnished in granular form, of uniform composition and size, free from hard lumps. It shall be low in wood, sulphur, and iron content, and shall be dark brown to black in colour.

E-2a.-Acidity.- The PH value shall be not less than 5.0 and not more than 7.5.

E-2b.-Moisture Content.- Shall be not more than 55 per cent, by weight.

E-2c.-Water-Holding Capacity.- Shall be not less than 100 per cent, by weight, on an oven-dry basis.

E-2d.-Ash.- Shall be not more than 15 per cent.

E-3.-Type III.- Reed peat or sedge peat shall be the moderately decomposed stems and roots or rushes, coarse grasses, sedges, reeds, canes, and similar plants. It shall be coarse or finely fibrous, and brown in colour. It shall be low in wood, decomposed colloidal residue, sulphur, and iron content. It shall have either a definitely acid reaction (Class A) or be slightly acid to slightly alkaline (Class B), as specified in the invitation for bids.

E-3a.-Acidity:

E-3a(1).-Class A.- Shall have a PH value not lower than 4.5 and not greater than 5.5.

E-3a(2).-Class B.- Shall have a PH value not lower than 5.5 and not greater than 7.5.

E-3b.-Moisture Content.- Shall be not more than 50 per cent by weight.

E-3c.-Water-Holding Capacity.- Shall be not less than 350 per cent, by weight, on an oven-dry basis.

E-3d.-Ash.- Shall be not more than 10 per cent.

F.-METHODS OF SAMPLING, INSPECTION, AND TEST

F-1.-Sampling.- A representative composite sample shall be taken from each delivery, sealed in a glass container, and submitted to the laboratory for test. The test specimens shall be taken from the interior for the packages sampled.

F-2.-Tests:

F-2a.-Moisture Content (see also note H-2).-Place a 5- to 10-gram sample in a tared covered vessel and weigh to the nearest milligram. Record. Remove the cover and heat the vessel and contents at 105° to 110°C. to constant weight. Before each weighting, cool the vessel and contents in a desiccator. Compute the per cent of moisture, based on the oven-dry weight. (Note: This oven-dried material may be used for the ash determination).

F-2b.-Ash.- Carefully ignite at dull red heat to constant weight either the dried material used in the determination of moisture content or a new weighed sample of approximately 5 grams of oven-dry material. Compute the per cent of ash, based on the oven-dry weight.

F-2c.-Acidity.- Determine the PH value by any convenient approved method for determining hydrogenation on concentration. In preparing the solution for this test use distilled water and sample approximately in the ratio of 4 to 1, respectively, by weight, permitting the material to soak for 30 minutes at a temperature of 20° to 30°C. Determine the PH value at approximately 25°C.

F-2d.-Water-Holding Capacity.-Place an unweighed sample of 25 to 50 grams, taken from the centre of the composite sample, in a tared covered container having a wire screen bottom of approximately 25 meshes to the linear inch. Immerse in water at room temperature (20° to 30°C) for 18 to 24 hours. Remove the container with sample from the water and allow to drain for 1 hour while supported on glass rods under a bell-jar. Carefully wipe the excess water from the outside of the container and weight. Heat in an oven at 105° to 110°C. to constant weight; before weighing, cool the container and contents in a desiccator. From

the difference in weight between the saturated sample and the oven-dry sample, compute the per cent of absorbed water, based on the oven-dry weight. (Caution: It is important that the sample shall not have been subjected to partial preliminary drying, as dried or partially dried peat or muck may not re-absorb water to its original absorbing capacity).

F-2e.-The purchaser reserves the right to make any additional tests to determine compliance with this specification.

G.-PACKAGING, PACKING, AND MARKING FOR SHIPMENT

G-1.-Packaging.- Unless otherwise specified, commercial packages are acceptable under this specification.

G-2.-Packing.- Unless otherwise specified, the subject commodity shall be delivered in standard commercial containers, so constructed as to insure acceptance by common or other carriers, for safe transportation, at the lowest rate, to the point of delivery.

G-3.-Marking:

G-3a.-Issue Packages.- Unless otherwise specified, each package shall be marked with the name of the manufacturer.

G-3b.-Shipping Containers.- Unless otherwise specified, shipping containers shall be marked with the name of the material and the quantity contained therein, as defined by the contract or order under which the shipment is made, the name of the contractor, and the number of the contract or order.

H.-NOTES

H-1.- Purchasers should exercise any desired options offered herein, and should specify the types and classes required.

H-2.- Type I, moss peat, is generally designated by the trade as "peat moss".

H-3.-The various types of peat specified herein commonly have a water-absorbing capacity greatly in excess of the minimum specified. The following limits are characteristic of the respective types:

Moss peat	1,100	to 2,000	per cent
Reed muck or sedge muck	100	to 350	per cent
Reed peat or sedge peat	350	to 800	per cent

H-4.-Peat having a higher moisture-content than is permitted by this specification, but otherwise, meeting specification requirements, may be considered acceptable by the inspector at an appropriate deduction from contract price.

H-5.-It is believed that this specification adequately describes the characteristics necessary to secure the desired material, and that normally no samples will be necessary prior to award to determine compliance with the specification. If for any particular purpose samples are desired, they should be specifically asked for in the invitation for bids, and the particular purpose to be served by the bid sample should be definitely stated, the specification to apply in all other respects.

H-6.-Copies of this specification may be obtained, without cost, upon application to the Procurement Division, Treasury Department, Washington, D.C.

NOTICE.-When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied, the said drawings, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

Approved for the Director of Procurement
May 19, 1942
N.F. HARRIMAN
Technical Assistant to the Director.

APPENDIX B

LIST OF PEAT BOGS INVESTIGATED IN THE PROVINCE OF QUEBEC

(See Map No.3)

1.-Breakeyville Bog

Area: 950 acres
East half lots 394 to 416, Ste-Hélène parish, Breakeyville; east half lots 1 to 6, St-Augustin conc., St-Lambert parish, Lauzon; lots 515 to 524, and south part lots 510 to 514, Bellaire conc., East, N.W. part lots 435 to 445, central part lots 446 to 449, S.E. part lots 450 to 454, Beauséjour conc., St-Jean Chrysostome parish, seigniory of Lauzon, Lévis county.

Geol. Surv. Can., Summ. Rept., Pt.D, 1922, (Pub.No.1983).

2.-Cacouna Bog

Area: 845 acres
Lots 185 to 228, range II, about 1,500 feet each side of Intercolonial railway, St-Georges-de-Cacouna parish; south part of lots 61 to 72, range III, about 2,000 feet from the railway, St-Arsène parish, Leparc seigniory, Temiscouata county.

"Investigation of the Peat Bogs of Canada", 1911-1912, page 16, Geol. Surv., Canada, Pub. No.1892.

3.-Conrobert Bog

Area: 2,000 acres
Two and a half miles east from Conrobert station, Canadian Pacific railway, approximately same distance to Angeline station on Central Vermont railroad line. L'Ange Gardien parish, Rouville county.

Mines Branch, Dept. of Mines, Canada, Map No.463.

4.-Clair Bog

Area: 2,600 acres
Lots 603 and 604, North Rivière Boyer conc., St-Charles-Borromée parish, Livaudière and Beaumont seigniories, Bellechasse county.

Geol. Surv., Canada, Pub. No.1892.

5.- Farnham Bog

Area: 5,100 acres
Lots 410 to 426, 2nd double range of Murray North side, and lots 380 to 390, 2nd double range of Murray South side, Ste-Brigide parish, Monnoir seigniory, Iberville county. Lots 362 to 376, Rang du Lac conc., lots 351 to 361, des Woods range, lots 507 to 531, Onzième conc., Ste-Sabine parish, Missisquoi county.

Mines Branch, Dept. of Mines, Canada, Map No.462.

6.-St-Blaise Bog

Area: 4,200 acres
Lot 243, S.W. conc., 2nd Grande Ligne, De Lery seigniory, two miles southwest of Girard station, St-Blaise and St-Valentin parishes, St-Jean county.

"Organic Soils of Southwestern Quebec". Dept. of Agriculture, Canada, 1936.

7.-Holton Bog

Area: 6,181 acres
Lots 2 to 6, 3rd range of Clergé, lots E, F, and 1 to 3, 2nd range of Clergé, parish and township of Hemingford, Huntingdon county.

Lots 12 to 42, 53 to 88, and 96 to 99, ranges I, II, and III of Williamstown; lots 953, 954, 957 to 958, and 1025 to 1029, Ruisseau Norton conc.; lots 1030 to 1125, and 1193 to 1215, ranges I, II and III of Edwardstown, St-Chrysostome parish, Chateauguay county.

Lots 151 to 167, St-Michel parish; lots 490 to 501, 452 to 489, 387, 394 to 397, and 403 to 407, St-Patrice parish, Napierville county.

"Investigation of the Peat Bogs of Canada" 1913-14; Mines Branch, Dept. of Mines, Canada, Map No.368.

8.-Ile-Verte Bog

Area: 800 acres
Lots 73 to 96, St-Jean-Baptiste de l'Ile-Verte parish, conc. I, seigniory of l'Ile-Verte, Rivière-du-Loup county.

Geol. Surv., Canada, Pub. No.1894.

9.-Lanoraie Bog

Area: 7,500 acres
Lots 540 to 555, and lots 557 to 563; Riv. St-Joseph conc. N.W.; N.W. and S.E. Ruisseau St-Joseph conc. entirely; lots 660 to 667 Riv. du Petit Bois conc.; lots 850 to 858, S.E. St-Henri conc., N.W. 1st and 2nd conc. of St-Henri entirely, St-Joseph de Lanoraie parish; lots 440 to 456, $\frac{3}{4}$ S, 457 to 459 and central part 480 to 500, N.W. du Point du Jour conc., Berthier county.

Lots $\frac{1}{2}$S. 97 to 106, S.E. Riv. L'Assomption conc.; N.W. du lac Romer conc. entirely; N.E. $\frac{1}{2}$ of N.W. $\frac{1}{2}$, Coteau Jaune conc. entirely, less lots 228 to 247, $\frac{1}{2}$ S.E. all those lots 250, 251 and $\frac{1}{2}$ S.E. of part of lots 256 to 327, located to S.-E. of C.P.R. Bras Sud-Ouest conc.; lots 379 to 386, St-Thomas parish, Joliette county.

"Investigation of the Peat Bogs of Canada" 1911-1912; Mines Branch, Dept. of Mines, Canada, Map No.271.

10.-Large Tea Field Bog

Area: 5,268 acres
Lots 9 to 17, range II; lots 9 to 34, range III; lots 15 to 28, range IV; lots 18 to 20, range V; occupying part of parishes of St-Anicet, Ste-Barbe and Godmanchester, Godmanchester township, Huntingdon county.

"Investigation of the Peat Bogs of Canada" 1911-1912; Mines Branch, Dept. of Mines, Map No.269.

11.-L'Assomption Bog

Area: 1,565 acres
Lots 315 to 352A, 3rd conc., St-Paul L'Ermite parish; lots 16 to 28, St-Charles conc., L'Epiphanie parish; ½ N.W. lots 491 to 510, La Presqu'Ile conc. L'Assomption parish, L'Assomption county.

"Investigation of the Peat Bogs of Canada" 1913-1914, Mines Branch, Dept. of Mines, Canada, Map No.366.

12.-LeParc Bog

Area: 614 acres
Lots 1004, 1006, 1008 and 1010, range II, municipality of Rivière-du-Loup; lots 137 to 152 located to south of Intercolonial railway, range II, Cacouna parish, LeParc seigniory, Temiscouata county.

"Investigation of the Peat Bogs of Canada" 1911-1912; Mines Branch, Dept. of Mines, Canada, Map No.275.

13.-Little Tea Field Bog

Area: 4,190 acres
Lots 8 to 34, range I; lots 18 to 32, range II, N.W. Godmanchester township, occupying part of St-Anicet and Ste-Barbe parishes, Huntingdon county.

"Investigation of the Peat Bogs of Canada" 1911-1912; Mines Branch, Dept. of Mines, Canada, Map No.270.

14.-Napierville Bog

Area: 8,000 acres
Lots 703 to 708, range 9, St-Cyprien, de Lery parish; lot 114, Gore of Sherrington, St-Patrice parish; lots 19, 20, Vide de Steward, de Lery seigniory, Napierville county.

"Que. Bur. Mines, Ann. Rept., 1917, p.74.

15.-Pont Rouge Bog

Area: 425 acres
Neuville parish, Portneuf county.

Que. Bur. Mines, Ann. Rept., 1917, p.75.

16.-Rivière-du-Loup Bog

Area: 7,220 acres
Lots 1013 to 1040 and lots 1041 to 1077 and lots 1079 to 1089, ranges III, IV, ½ S.E., municipality of Rivière-du-Loup; lots 26 to 37, St-Modeste parish; lots 335 to 342, range IV, St-Arsène parish; lots 1 to 2, range N.E., Témiscouata road; lots 1 to 2, range S.W., Témiscouata road; lots 29 to 31, range I, ½ N. Whitworth township, St-Antonin parish, Terrebois, Rivière-du-Loup and LeParc seigniories, Rivière-du-Loup county.

"Investigation of the Peat Bogs of Canada" 1911-1912; Mines Branch, Dept. of Mines, Canada, Map No.273.

17.-Rivière-Ouelle Bog

Area: 4,521 acres
Lots 382 to 386, Rivière-Ouelle parish; lot 385, St-Denis de la Bouteillerie parish, Kamouraska county.

"Investigation of the Peat Bogs of Canada" 1911-1912; Mines Branch, Dept. of Mines, Map No.277.

18.-Sagamite Bog

Area: 340 acres
Lots 535 to 540, N.E. conc., Notre-Dame des Laurentides parish; lots 30 and 31, range VII, St-Dunstan-du-Lac Beauport parish, Quebec county.

Geol. Surv. Can., Summ. Rept., Pt.D, 1922, p.13.

19.-St-Anaclet Bog

Area: 3,250 acres
Lots 5 to 51, 2nd range, St-Anaclet parish; lots 44, 46, 48, 50 and 54, central part, ½ S.E. 37 to 43, ¾ S.E. 25 to 35, ¼ S.E., 1 to 21, range I, St-Germain de Rimouski parish; ¾ S.E. 150 to 158, ½ S.E. 148 and 149, ½ N.W. of ½ S.E. of 99 to 146 and ½ S.E. 67 to 98, range I, Ste-Luce parish, north part of lots 182 to 188, range II, Ste-Luce parish, seigniory of Lessard and Lepage-Thivierge, Rimouski county.

Geol. Surv., Canada, Pub. No.1896.

20.-St-Arsène Bog

Area: 2,160 acres
Lots 67 to 89, south part, range I, lot 243 and south part 244 to 247, range II, Cacouna parish; lots 30 to 48, 4, 5, 6, 10 to 14, 16, 19, 21 to 29 and lots 17 and 18 entirely, range II, St-Arsène parish, Leparc and Lachenaie seigniory, Témiscouata county.

Geol. Surv., Canada, Pub. No.1895.

21.-St-Denis Bog

Area: 315 acres
Lots 20 to 66, Rivière-Ouelle parish, Petite Anse conc., Kamouraska county.

"Investigation of the Peat Bogs of Canada" 1911-1912; Mines Branch, Dept. of Mines, Canada, Map No.276.

22.-St-Hyacinthe Bog

Area: 3,890 acres
Lots 20 to 28, Ste-Françoise conc., Notre-Dame-de-St-Hyacinthe parish; lots 281 to 292, range St-Dominique S.W., St-Hyacinthe-le-Confesseur parish; St-Hyacinthe county.

Lots 200 to 211, range VI; lots 75 to 84, range VII; lots 394 to 531, range St-Dominique S.W.; lots 212 to 290, range St-Dominique N.E.; lots 36 to 118, range St-François N.E.; N.E. part lots 145 to 177, range St-François S.W.; Bagot county.

"Investigation of the Peat Bogs of Canada", 1911-12; Mines Branch, Dept. of Mines, Map No.272.

23.-St-Isidore Bog

Area: 1,231 acres
Lots 24 to 28 and 35 to 41, 1st conc. St-Urbain parish, Chateauguay county.

Lots 115 to 132, N.W. conc., lots 133 to 168, S.E. county, St-Isidore parish, Laprairie county.

Lots 60 to 96, Ste-Thérèse conc., St-Rémi parish, Napierville county.

"Investigation of the Peat Bogs of Canada" 1913-14; Mines Branch, Dept. of Mines, Canada, Map No.367.

24.-St-Jean Bog

Area: 270 acres
Lots 314 to 318, ½ N.E., St-Augustin conc., Ste-Hélène de Breakeyville parish; lots 275 to 288, S.E. extremity, Beaulieu No. 1 conc.; lots 308 to 313, ½ N.W., Beaulieu No. 2 conc., St-Jean Chrysostome parish, Lauzon seigniory, Lévis county.

Geol. Surv. Can., Summ. Rept., Pt.D, 1922, p.16.

25.-St-Joseph Bog

Area: 1,400 acres
Lots 452 and 453 and adjoining part, St-Joseph de la Pointe de Lévis parish, Lauzon, La Martinière, Livaudière, and Vincennes seigniories, Lévis county.

Geol. Surv. Can., Summ. Rept., Pub. No.1893.

26.-Ste-Thérèse Bog

Area: 1,070 acres
Lots 826 to 829, Ste-Hélène de Blainville parish, Terrebonne county.

Geol. Surv. Can., Sum. Rept., Pt.D, 1922, p.16.

27.-Chicoutimi Bog

Area: 2,748 acres
Lots 9 to 22, range S.W. of Sydenham road and lots 474 to 480, range III; lots 464 to 473, range II; lots 413 to 422, range I; lots 399 to 410, range I, S.W.; lots 1 to 9, range II, S.W. Bagot township, Chicoutimi county.

Geol. Surv. Can., Sum. Rept., Pt.C, 1926, Fig.9.

28.-Henryville Bog

Area: 1,350 acres
Range I, Henryville parish, Noyan seigniory, two miles south of Henryville station, Iberville county.

Geol. Surv. Can., Sum. Rept., Pt.C, 1926, Fig.10.

29.-Escoumains Bog

Area: 1,200 acres
Lots 1 to 8, range II, lots 1 to 12, range III, Bergeronnes township; lots 1 to 8, range I, Escoumains township, Saguenay county.

Que. Bur. Mines, Ann. Rept., Pt.D, 1929.

30.-St-Luc Bog

Area: 6,200 acres
Lots 9 to 35, Pays Brulé range; lots 70 to 100 S.E. de la Rivière Champlain, St-Luc de Champlain parish; lots 488 to 522, Côté S.E. St-Malo, Cap-de-la-Madeleine parish, Champlain county.

31.-St-Ulric Bog

Area: 625 acres
Lots 18 to 21, range II; lots 1 to 7, range III, St-Ulric de Rivière Blanche parish, Matane county.

Survey and Investigation, Quebec Dept. of Mines.

32.-Dosquet Bog

St-Joseph S.W. and N.E. ranges, Ste-Croix seigniory, (to southeast of Dosquet village), Lotbinière county.

Investigation, Que, Dept. of Mines.

33.-Yamaska Bog

Area: 1,200 acres
Lots 282 to 292, 227 to 237, range IV, Upton township, Drummond county.

Investigation, Que. Dept. of Mines.

34.-Orford Bog

Range IV, Orford township, (4 miles south of Brompton village), Sherbrooke county.

Information, Que. Dept. of Agriculture.

35.-Lacolle Bog

Area: 3,600 acres
Lots 791 to 796 and 679 to 692, 693 to 723, range St-André, St-Bernard of Lacolle parish, St-Jean county.

"Organic Soils of Southwestern Quebec", Dept. of Agriculture, Canada.

36.-Nicolet Bog

Area: 1,280 acres
Range 7, St-Eulalie parish, Aston township, Nicolet and Arthabaska counties.

Information, Que. Dept. of Agriculture.

37.-Bagot Bog

Area: 2,000 acres
Between villages of St-Liboire, St-Nazaire, and Ste-Hélène, Bagot county.

Information, Que. Dept. of Agriculture.

38.-St-Zénon du Lac Humqui Bog

Lots 8 to 12, range VII, Pinault township, Matapédia county.

Information, Que. Dept. of Agriculture.

39.-St-Fabien Bog

Area: 550 acres
Lots 60 to 73, range I, St-Fabien parish; lots 14 to 17, range I, St-Siméon parish, Rimouski county.

Survey and Investigation, Que. Dept. of Mines, 1945.

40.-St-Eugène de Ladrière Bog

Area: 350 acres
Lots 568 to 578, range IV, municipality of St-Fabien, Rimouski county.

Information, Que. Dept. of Agriculture.

41.-St-Octave de Métis Bog

Area: 500 acres
Municipality of St-Octave de Métis, Matane county.

Information, Que. Dept. of Agriculture.

42.-St-Nicéphore Bog

Ranges 2, 3, 4, 5, and 6, Dalmas township, Roberval county.

Information, Que. Dept. of Agriculture.

43.-Péribonka Bog

Ranges 2,3,4,5 and 6, Dalmas township, Roberval county.

Information, Que. Dept. of Agriculture.

44.-Mistassini Bog

Area: 3,200 acres
Ranges 4, 5, and 6, Racine township, Roberval county.

Information, Que. Dept. of Agriculture.

45.-St-Ignace Bog

Area: 1,200 acres
Range I, Montmagny and St-Ignace parishes, Rivière-du-Sud seigniory, Montmagny county.

Information, Que. Dept. of Agriculture.

46.-Hébertville Bog

Area: 2,000 acres
Ranges I and II, Labarre township, Lac St-Jean and Chicoutimi counties.

Investigation, Que. Dept. of Mines.

47.-Bourget Bog

Lots 30 to 41, ranges 4 and 5; lots 17 to 14, range West, Bourget township, Chicoutimi county.

Information, Que. Dept. of Agriculture.

48.-Waterville Bog

Area: 640 acres
Range du Brûlé, Compton township, Compton county.

Investigation, Que. Dept. of Mines.

49.-Ormstown Bog

Area: 1,000 acres
Range du Rocher, Chateauguay county.

Information, Que. Dept. of Agriculture.

50.-Garnier Bog

Taché township, (three miles from village of l'Ascension).
Information, Que. Dept. of Agriculture.

51.-Sicotte Bog

Area: 1,280 acres
Lots 10 to 40, range III, Sicotte township, Gatineau county.

Information, Que. Dept. of Agriculture.

52.-Grenier Bog

Area: 250 to 400 acres
Lots 26 and 27, range VII, Eaton township, Compton county.

Investigation, Que. Dept. of Mines.

53.-Pointe-aux-Outardes Bog

Area: 3,840 acres
Lots 23 to 37, range Pointe-aux-Outardes, Manicouagan township, Saguenay county.

Investigation, Que. Dept. of Mines.

54.-Ile-aux-Coudres Bog

Area: 640 acres
Lots 135 to 192, range de la Baleine, St-Louis de l'Ile-aux-Coudres parish, Charlevoix county.

Investigation, Que. Dept. of Mines.

55.-St-Marc Bog

Lot 26, St-Alban parish, Deschambault seigniory, 1 mile north of St-Marc-des-Carrières village conc., Portneuf county.

Investigation, Que. Dept. of Mines.

56.-Taché Township Bog

Area: 1,200 acres
Ranges 7 and 8, Taché township, Chicoutimi county.

Investigation, Que. Dept. of Mines.

57.-Nelson Township Bog

Lots 28 to 35, range IV, Nelson township, Megantic county.

Investigation, Que. Dept. of Mines.

58.-Taillon Township Bog

Area: 800 acres
Lots 1 to 12, ranges X and XI, Taillon township, Lac-St-Jean county.

Investigation, Que. Dept. of Mines.

59.-St-Bruno Bog

Area: 220 acres
Lots 12, 13, 14, 15, range IX, Labarre township, Lac St-Jean county.

Investigation, Que. Dept. of Mines.

60.-Betsiamites Bog

Blocks H, I, J, Betsiamites township; one mile north of Betsiamites river, Saguenay county.

Investigation, Que. Dept. of Mines.

61.-Bulstrode Bog

Lot 20, ranges V and VI, Bulstrode township, Arthabaska county.

Investigation, Que. Dept. of Mines.

62.-Senneterre Bog

Lots 53 to 56, ranges V and VI, Senneterre township, Abitibi county.

Investigation, Que. Dept. of Mines.

63.-Fortierville Bog

Lots 687 and 688, south part, Ste-Philomène de Fortierville parish, Deschaillons seigniory, Lotbinière county.

Investigation, Que. Dept. of Mines.

64.-St-Michel de Sherrington Bog

Lots 432 and 433, Sherrington parish, Sherrington township, Napierville and Laprairie counties.

Investigation, Que. Dept. of Mines.

65.-Simard Township Bog

Lots 10 to 20, range VI, Simard township, Chicoutimi county.

Investigation, Que. Dept. of Mines.

66.-Raguenau Township Bog

Lots 29 to 32, range I, Raguenau township, Saguenay county.

Investigation, Que. Dept. of Mines.

67.-Bourlamaque Township Bog

Block 20, Bourlamaque township, Abitibi county.

Investigation, Que. Dept. of Mines.

68.-Lac à la Tortue Bog

Lots 8 and 9, range VII, Radmor township, Laviolette county.

Investigation, Que. Dept. of Mines.

69.-St-Bernard Bog

Lots 314 to 319, range Iberville, St-Lambert de Lauzon parish, Lévis county.

Investigation, Que. Dept. of Mines.

70.-St-Henri Bog

Lots 622 to 628, Jean Guérin conc., St-Henri parish, Lévis county.

Investigation, Que. Dept. of Mines.

71.-Garthby Bog

Lots 58 to 63, Garthby township, Wolfe county.

Investigation, Que. Dept. of Mines.

72.-Grondines Bog

Range IV, Grondines parish, Portneuf county.

Investigation, Que. Dept. of Mines.

73.-Wendover Bog

Lots 4 to 9, range XIII, Wendover township, Drummond county.

Investigation, Que. Dept. of Mines.

74.-Tring Township Bog

Ranges II and III, Tring township, Beauce county.

Investigation, Que. Dept. of Mines.

75.-St-Hilarion Bog

Lots 1 and 2, range VI; lots 4A, 4, and 5, range V, St-Hilarion parish, Settrington township, Charlevoix county.

Investigation, Que. Dept. of Mines.

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