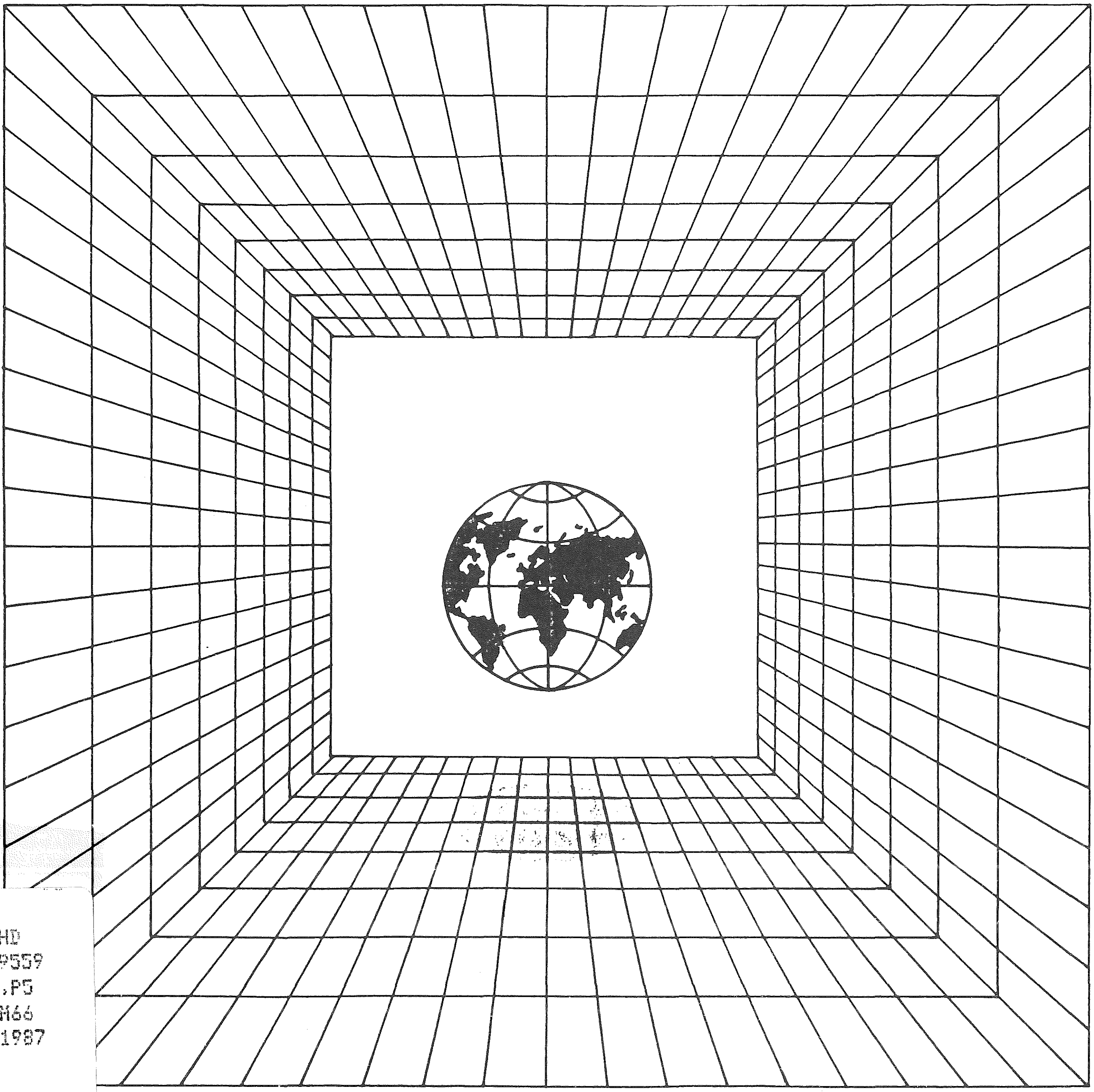
PEATREX Ltd

VAPO OY / EKONO Oy

MINNESOTA DEPARTMENT
OF NATURAL RESOURCES,
Division of Minerals

Planning of Milled Peat Production Systems at Two Sites in Northern Minnesota

February 1987



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Horticultural Peat

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March , 1987

Mr. Joseph N. Alexander, Commissioner
Minnesota Department of Natural Resources
500 Lafayette Rd.
St. Paul
Minnesota, 55146
U.S.A.

Dear Commissioner Alexander,

Peatrex Ltd., the Minnesota subsidiary of Vapo Oy, is pleased to present you with the final report of the fuel peat production study. As you requested, we evaluated two production sites = one near Hibbing to supply the local utility, and a second near International Falls to supply Boise Cascade. The technical work was completed in Finland using techniques and models which are commonly used to evaluate new production sites.

We believe there exists a real economic basis for further effort on fuel peat at both of these locations. In both cases the results show that the delivered cost of fuel peat, if the financing can be arranged as assumed in calculations and if long term contract can be achieved with the customers (10 years), should be the same as the price of Western coal. The companies, Vapo Oy and Ekono Engineering, are prepared to move this work forward and to enter into serious negotiation with potential customers based on the data contained in the report.

We believe this study is a significant step in the creation of a fuel peat industry in Minnesota. We would be pleased to be a part of any future efforts.

Sincerely yours,

PEATREX, LTD.

Matti Hilli
President

KP

PLANNING OF MILLED PEAT PRODUCTION SYSTEMS
AT TWO SITES IN NORTHERN MINNESOTA

MINNESOTA DEPARTMENT OF NATURAL RESOURCES
Division of Minerals

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PEAT REPORT OUTLINE

EXECUTIVE SUMMARY

The state of Minnesota has sought to stimulate economic growth through the development of its peat resources. Since July 1983 the Department of Natural Resources, working through its peat development program has tested peat in many existing boilers. The work conducted prior to this report has shown that the use of sod peat may be technically feasible in most cases but does not demonstrate an economic advantage for the consumer. However, another form of fuel peat, milled peat, is cheaper to produce and is clearly competitive with the prices paid by some consumers for western coal and natural gas.

Peatrex Limited, its parent firm Vapo Oy, and EKONO Oy, experts in the design and operation of milled peat facilities, were selected by the state os Minnesota to submit a comprehensive report assessing the feasibility of milled peat production near Hibbing and International Falls, Minnesota. Both technical and economic evaluations were conducted.

The potential consumers, the Hibbing Public Utility and Boise Cascade Inc. were identified. Each of these consumers appears to be well positioned to convert to peat combustion within the next three to four years. The Hibbing Public Utility is currently engaged in a five-year program to upgrade their boilers. This program calls for rebuilding two existing boilers by 1989 and installing a new boiler in 1990 - 1991. Similar upgrades are planned by Boise Cascade for its plant in International Falls. Company policy has directed the plant to become indenpendent of imported fuels by 1991. One of their existing boilers may be rebuilt to accomplish this.

In January, 1986, the Department of Natural Resources peat inventory staff began to examine all peat resources near Hibbing and International Falls. Two sites, the Riley Peatland near Hibbing, and the Littlefork Peatland near International Falls, were selected as having the greatest development potential. During the period of May through July 1986 detailed surveys of each site were conducted by DNR. The results of these surveys were submitted to Vapo in August 1986 for production planning.

Two levels of production were projected for each location: for the Riley Peatland 50,000 tons per year and 75,000 tons per year, and for the Littlefork Peatland 50,000 tons per year and 150,000 tons per year. Site plans, equipment requirements, capital investment, production estimates and timing of development were determined for each level of production.

An economic evaluation was conducted using a peat production financial planning model developed by the DNR. This evaluation has shown that milled peat can be competitive with western coal, natural gas, and wood if used in either new or modified boilers. Projected prices to the consumer of DLR 1.48 per million btu (International Falls) and DLR 1.55 per million btu (Hibbing) and an after-tax rate of return of over ten percent make milled peat and attractive opportunity for both investors and consumers.

Vapo and EKONO believe that a necessary and prudent next step should include engineering designs and cost estimates for boiler installation and/or modification at each plant. There is every reason to believe that these estimates will validate the cost effectiveness of a conversion to milled peat.

1.0 Study Objective

Peatrex Limited, its parent firm VAPO Oy, and EKONO Oy, were selected by the State of Minnesota to submit a comprehensive report containing recommendations on the detailed planning, construction, and operation of milled peat production systems at two sites in northern Minnesota. An economic evaluation detailing the costs of milled peat production at various production levels for each site was also to be included in the final report.

This report was intended to determine if milled peat could be competitive with western coal at the selected sites and, if so, to provide the first step in the eventual construction of the required facilities.

2.0 Project Description

The construction of a peat production facility to be located in a virtually undisturbed peatland requires a great deal of planning and preparation. The eventual success of the enterprise often depends upon the level, and quality, of information established by the developer during the project's initial phases.

In Finland, peatlands have been developed for fuel and horticultural purposes for many decades. During this time, a systematized body of knowledge has evolved which minimizes the risks and uncertainties associated with peat development and production. We have employed this systematic approach in the development of our recommendations for the Riley and Littlefork peatlands. The following section shall provide an overview of the tasks neccessary to plan and prepare for milled peat production. As this section is an overview, it will be quite general in nature. Later sections shall deal with detailed issues and results specific to each peatland.

2.1 Project Tasks

The following is a description of the items which must be considered in a preliminary assessment of the feasibility of peat mining at a specific location. The major items to be described are the assessment of peat quality and quantity, site preparation, peat mining, stockpiling, transportation, and environmental review. The purpose of this work is to arrive at a realistic estimate of the cost of fuel peat delivered to the consumer.

2.1.1 Resource Assessment

Good peat production plans begin with a thorough assessment of the available resource and lead to the selection and utilization of a production site. This assessment usually begins with a review of existing topographic and soils maps. From these two sources, the developer is often able to quickly determine where organic soils exist and, simultaneously, rule out areas where the peat is either non-existent or of marginal value.

Once a generalized target area has been established, the next level of scrutiny involves a review of maps dealing specifically with peat deposits. In many parts of the world, maps of this nature do not exist and must be drawn by the developer. Our task was eased immeasurably at this juncture by the fine peatland maps which had been produced by the Minnesota Department of Natural Resources as part of the Peat Information Program. Specialized peatland maps and aerial photos provide a necessary measure of guidance at this stage of the site selection process. These sources enable the developer to distinguish gross differences between candidate areas and may help to narrow the field considerably.

2.1.2 Inspection and Sampling

The next stage in resource evaluation involves on-site inspection and sampling. This is necessary to determine the quality and quantity of the peat resource, to assess the accessibility and drainability of the area, and to plan the configuration of the ditch network and the production fields. Using topographic maps for guidelines, critical elevations, such as high and low points, and gradients, are verified and a drainage plan established. The thickness of the peat deposit is measured along with its areal extent. Samples are taken and analyzed for chemical composition, Btu content, degree of decomposition, and ash content. These field verifications allow the developer to reach a decision regarding the feasibility of proceeding with the development of the site and also eliminate the possibility of including mineral soil in the production fields.

2.1.3 Weather Analysis

Concurrent with the design of a drainage plan, weather data, consisting of historical records of temperature and precipation, are analyzed to quantify the occurence of periods dry enough to mill and harvest peat. The goal of this analysis is to determine the number of harvests (and thereby the number of production acres) needed to meet production quotas. Generally speaking, one harvest takes two consecutive days of dry weather. Given a rain event, an additional two days of rain-free weather would be necessary before a new production cycle could begin.

2.1.4 Description of Mining Method

There are several methods used to produce milled peat. Selection of the most suitable method depends upon the site to be developed, the level of production required, and the costs of the product. One approach, highly favored in Scandinavia, and recommended for use here, is the HAKU method. This method is characterized by two concepts, machine "chaining" and central stockpiling.

Simply put, the HAKU machine-chain is an attempt to rationalize equipment requirements and link (or "chain") machinery in such a way as to optimize production efficiency. In milled peat production the first basic chain consists of:

a) One screw miller
b) Two harrowers
c) Two lineal ridgers
d) One loader
e) Four bog trailers

The HAKU machine-chain may be thought of as a module - by increasing the number of modules, or by altering the machine mix within a module (and simultaneously adjusting the acreage under production), one is theoretically able to achieve all reasonable production targets.

The energy content of peat which has been stockpiled for long periods often declines due to increased moisture content, temperature, and microbial activity. The second element of the HAKU-method mitigates this problem through the construction of large, tightly compacted, central stockpiles. In terms of preserving the energy content of milled peat, large, highly compacted stockpiles are beneficial in two regards: first, in a large stockpile surface area is small relative to the volume of peat contained in the stockpile. This tends to minimize the effects of rain and minimize the area through which air can penetrate. Second, compacting further reduces the air flow into the stockpile and inhibits microbial activity. Stockpiles constructed in this manner reduce losses of heating value considerably.

Milling

The first step of the HAKU method is called milling. Milling is the process in which peat from the surface layer of the production field is detached for drying. The peat is cut into pieces one inch and smaller by a machine called a miller.

Millers ranging in width from fifteen to thirty feet (4.6 to 9.0 meters) are commonly used in peat production. Equipment of this size requires between 85 and 110 horsepower and is able to mill between seven and thirteen acres per hour (3 to 5 ha/hour).

The depth of milling depends upon weather conditions and the quality of peat. The milling depth can be regulated and easily adjusted as necessary during the harvest period. Once milled, peat should be left to air-dry for about 48 hours.

Harrowing

The next work phase after milling is harrowing. Harrowing turns the previously milled peat over, exposes more surface area to the air, and helps the peat to dry in a shorter time. This work can be done only during the daytime when evaporation takes place in the peat bog. A harrow is typically about sixty feet (19 meters) wide with a power requirement of sixty-five to seventy-five horsepower (50 to 55 kW). Harrowing capacity is between twenty and twenty-five acres per hour (8 to 10 ha/hour).

Ridging

When the peat is dried to about forty percent moisture, it will be collected and moved to the middle of the field with a ridger. The ridger follows field contours accurately and it collects only dry peat from the surface of the peat bog. The working width of the ridger is usually about fifteen feet (5 meters) and its working capacity is between five and ten acres per hour (2 to 4 ha/hour). The power requirement is between eighty-five and ninety-five horsepower (60 - 70 kW).

Loading and hauling

In the HAKU-method ridged peat is loaded into tractor-drawn trailers using either mechanical or hydraulic loaders. Maximum loading capacity is about 180 tons per hour. Maximum capacity can be expected only during limited time periods and if the haul distance is very short. The generally expected hauling capacity for four trailers with a haul distance of one-half mile or less is between 95 and 115 tons per hour.

Stockpiling

Powerplants usually prefer regular deliveries of peat and as a result maintain minimal peat stockpiles. Maintenance of large stockpiles at the bog, then, becomes the responsibility of the peat producer. The HAKU-method's use of large, densely compacted stockpiles provides a necessary margin of safety to the peat producer in terms of maintaining energy content and preventing spontaneous combustion.

Production Control Systems

Computer-assisted control systems have been developed in Finland to measure and predict the evaporation of moisture from the production fields. This increases the efficiency of production by helping managers to schedule tasks such as harrowing and ridging.

2.1.5 Preliminary Economic Evaluation

Analysis of weather data coupled with a thorough resource assessment allows the developer to estimate site preparation costs, equipment requirements and production quantities and costs. This, plus a knowledge of likely and potential markets permits an economic evaluation of the enterprise to proceed and provides the rationale for commercial development.

2.1.6 Mine Layout Survey

Once field checking is completed, and the number of acres needed is determined, detailed site drawings are made showing the placement of ditches, roads, production fields and stockpile areas. Based upon these drawings, the entire production area is marked with stakes.

2.1.7 Ditch Construction

In order to minimize the time spent in site preparation, drainage of the area should begin as quickly as possible. Ditch construction should begin in November if possible to provide initial release of water from the peatland surface layers and so that the ditch network is in place to accomodate the spring runoff. Three types of drainage ditches are required: an outlet ditch, a perimeter ditch, and field ditches. Each type of ditch shall be discussed in the order in which it is constructed.

Outlet Ditch.

The outlet ditch allows water to be transferred from the production area to a receiving water. Construction of the outlet ditch begins at its terminus (the receiving water) and proceeds upgradient toward the production area. Either a backhoe or a ditch excavator may be used to excavate the ditch. The ditch banks should be excavated with a slope of one foot horizontal for every foot vertical (a 1:1 slope) in peat and with a 1:1.5 slope in mineral soil. These ratios are used to minimize the possibility of the ditch walls collapsing. It is desireable to dig the main ditch to a depth of six to eight feet during this stage; however, this may not be possible if the peatland is relatively undisturbed. The outlet ditch may be deepened, as needed, at a future date. Culverts are next positioned where needed for ditch crossing in accordance with the planned layout of the production fields. Excavated peat should be spread into spoil piles adjacent to each side of the ditch and levelled in a layer not exceeding three feet (1 meter) thick. If a collapse of the ditch walls appears likely, the spoil piles must be spread more thinly (and further from the sides of the ditch). Openings should be cut at 200 foot (60 meter) intervals in the spoil banks to allow runoff water to flow into the ditch. The outlet ditch is next levelled and the levelling data checked against the benchmarks contained in the drawings. Levelling must be accurate to within 2.5 inches per mile (4 cm/km) for drainage to proceed efficiently.

Perimeter Ditch.

Another ditch, running along the perimeter of each production area is excavated and linked to the outlet ditch. The perimeter ditch is designed to allow for the development of all production areas without the need for additional perimeter ditching. As in the case of the outlet ditch, a 1:1 slope should be followed to minimize slumping.

Field Ditches.

Field ditches separate and drain the production fields. They are marked and cut at 65 foot intervals (20 meters) starting from the perimeter ditches. At the time these ditches are marked, some additional sampling along the edges of the peat production fields may be necessary to verify the depth of the peat deposit. This is a precautionary measure taken to ensure that no mineral soil has been included in the production fields.

The field ditches are cut to a depth of about 5 feet (1.5 meters) with a ditch excavator. If the peat layer has a thickness of less than 5 feet, a more precise survey is needed to prevent mineral soil and, possibly, stones from being spread over the production fields. Four to five inch diameter plastic drain pipe should be installed at the end of the production fields to convey water from the field ditches to the perimeter ditch. The piping should be seated at a depth equal to that controlled by the perimeter ditch. The pipes should be inclined so that their elevation drops 1/32 of an inch each linear foot of run (0.5 cm/meter).

In order to keep these pipes clear and to prevent solid material from entering the perimeter ditches, vertical caps of perforated pipe are installed at each pipe end. As an additional measure, small pits are constructed in the field ditches immediately upgradient of the vertical pipe to intercept drain water prior to its entering the pipe. These pits allow heavier solid material to settle.

2.1.8 Forest Clearing

After the outlet and perimeter ditches have been cut and drainage of the peatland begins, the next step in site preparation is the removal of trees larger than 1.5 to 2.0 inches in diameter. There is no need to cut smaller trees since they will be crushed with a deep miller or a screw leveller at a later time. Clearing of larger trees is most easily accomplished during winter, when the frozen surface of the peatland allows for vehicle access by men and equipment. Teams of loggers using chain saws and other light equipment are used to accomplish this. Timber cut during winter should be consolidated quickly into small piles, so as not to be buried under snow. A three foot (one meter) layer of these trees, branches, and sticks will be used as a foundation for the access roads.

If clearing is attempted during warm weather months, wide-track, high flotation tractors will be required.

2.1.9 Field Preparation

In addition to the presence of surface vegetation, peatlands often have a high percentage of woody material co-mingled with the peat. It is very important that all woody material be broken down to an acceptable particle size before production begins. This is accomplished by use of a deep miller which chips the remaining trees and mixes the woody material into the peat to a depth of about one foot (30 cm).

Each production field is next levelled and profiled using a screw leveller attached to a universal bog tractor. Profiling is needed to facilitate runoff and speed drying during production. Beginning at the field ditches, the screw leveller augers peat material from the ditch edge toward the center of the production field so that the center of the field is about 8 inches (20 centimeters) higher than at the ditch edges.

2.1.10 Road Construction

Road building is best done (in mineral soil) when the ground is not frozen and in peat soil in the winter. Access roads to the production area should be located on mineral soil and in areas where the peat layers are shallow. Trees cut during clearing operations should be used to provide a firm foundation for the access roads. In the event that the available trees are insufficient to provide a foundation for all roads, a "geotextile" mat will be used. This mat is seventy percent polypropylene and thirty percent polyethylene. It is used as an underlayment in road construction on peat or clay soils to separate gravel from the ground and to strengthen the ground under the road. All sharp stumps must be removed prior to the use of the geotextile mat to prevent puncturing during road construction.

In the stockpile area the road should be surfaced with asphalt to increase its durability. In other areas, gravel roads are sufficient.

2.1.11 Fire Protection

Fire protection standards developed in Finland will be used to protect each production site. These standards include the construction and maintenance of fire protection basins and compressor-equipped wagons at various locations in the production areas. Their number and specific location is generally determined by the number of acres under production and the configuration of the production fields.

2.1.12 Stockpile Area

Annual production, demand for the product, and the needs of the consumer shall determine how large the stockpile is to be. The stockpile area should be constructed in a way which will allow shipments year-round.

2.2 The Environmental Impacts of Peat Production

2.2.1 Introduction

The main environmental changes arising from peat production are the effects on the quality and quantity of runoff, some changes in the scenery, and an increased risk of dust and noise together with the increased risk of fire during the production season. Most of these impacts can be reduced by correct planning and careful operation during ditching and production.

2.2.2 The Impacts on Water

2.2.3 The Hydrological Effects

The most important effect of ditching is increased annual flow during the first few years of production, due to drainage of water from the peat layers. In Finland the first year quantity of runoff coming from wet, ditched peat areas can be twice the natural flow. The flow in the second year can be 30 percent higher than normal. In later years the runoff during midsummer is a little higher than normal in spite of the fact that the total annual flow is nearly the same as before ditching. However, the total ditch volume 9000 to 11000 cubic feet per acre (650 - 750 m3/ha) can be used to regulate the water level in the ditch network and the quantity and timing of runoff. The natural runoff from poorly decomposed, natural peat areas usually has quite a low pH-value. After the ditching the pH-value can be several units higher than before, because the ditches are situated in the deeper peat layers under the ombrotrophic sphagnum peat. The lowest pH is found every year during the spring flood because the runoff is coming from the peat surface and not from the deeper layers.

The ground water level in the surroundings will not change significantly, if the ditches are not dug deep into the mineral soil. Studies conducted by the DNR have shown that ground water levels 100 feet beyond the perimeter ditches stay within twelve inches of the pre-ditch levels. However, one should leave an unditched area of a few hundred meters wide between the peat production area and any possible ground water recharge zone.

2.2.4 The Changes in the Water Quality

The quality of runoff depends on the peat type and the time since ditch construction. Immediately after the ditching, the water color becomes darker and the concentrations of dissolved organic matter and particulate matter (suspended solids) increase. The load of humic components coming from the peatland is quite high, thus the brown colored water. In the early years ditching will increase the load of humic matter (dissolved organic matter) because of the increased annual flow. However, no long term impacts on water quality have been observed.

The dissolved organic load can also transport some metals. However, according to examinations conducted in Finland there is no statistically significant correlation between the metal content in small water animals and the humic load. Reference is made to a study on the effect of mercury, originated from air, on the mercury contents in fishes (Study by Water Administration, Finland, No. 320; in Finnish). It has also been found that the humic substances can decrease the poisonous effects of some metals.

Metal loadings from mineral soils are usually much higher than what is found in runoff from peatlands, because the heavy metal content in peat is usually lower than that in the mineral soils (see Table 2.1). An increased load of heavy metals might be found, if erosion in the outlet ditch is excessive.

The concentration of phosphorus in the runoff can be quite important because it can stimulate algal growth in the receiving water. Peat itself contains little phosphorus, therefore the load coming from the peat production areas is usually lower than that from agricultural areas or fertilized forests. In Finland the mean annual load of phosphorus from the natural peatlands is 0.02 to 0.04 pounds per acre (0.04 - 0.06 kg p/ha). This agrees closely with Minnesota's first year value of 0.6 kg total p/ha.

The mean annual load from peat production areas is about 0.24 pounds per acre (0.27 kg p/ha) and immediately after ditching the value can reach 1.1 pounds per acre (1.2 kg p/ha).

Table 2.1 Metal content in the mineral soil and in the peat

		Mineral soil	Natural peat
Ca	p-%	0.2-5.0	0.09-0.64
Mg	p-%	1.12-5.5	0.03-0.11
K	p-%	0.33-4.2	0.041-0.07
Fe	p-%	0.07-0.66	0.004-3.15
Al	p-%	3.2-12.7	0.069-0.92
Si	p-%	22.9-41.6	
Na	p-%	0.3-2.2	0.017
As	mg/kg	0.1-40	0.83-340
Cd	mg/kg	0.01-7	0.05-5
Co	mg/kg	1-40	0.29-700
Cr	mg/kg	5-3000	0.4-150
Cu	mg/kg	2-100	1-3000
Hg	mg/kg	0.01-0.3	0.012-0.39
Mn	mg/kg	100-4000	0-2150
Nl	mg/kg	10-1000	3-2000
Pb	mg/kg	2-200	0.9-2000
Se	mg/kg	0.01-2	
V	mg/kg		0.008-250
Zn	mg/kg	10-300	2.2-220
Mo	mg/kg		0.22-4.8
U	mg/kg		0.09-838
Th	mg/kg		0.32-2.99
Be	mg/kg		0.074-0.13

From Naturvardverket Meddelande SNVPM 1708.
Miljoeffekter av ved och torv forbrenning.
(Environmental effects of wood and peat burning)

Because peat contains nitrogen, the nitrogen content of the runoff from ditched peat areas will increase. Concentrations of ammonia can consume oxygen in the receiving waters so that the ammonia compounds change to nitrates. The nitrogen load from natural peatlands can sometimes be as high as 0.88 to 2.6 pounds per acre (1.0 - 3.0 kg p/ha). The mean annual load of inorganic nitrogen from peat production areas is about 5.7 pounds per acre (6.5 kg p/ha) in the first year and the total load in the second year after the ditching is 0.88 to 2.2 pounds per acre (1.0 - 2.5 kg p/ha).

2.2.5 The Load of Suspended Solids

Peat mining increases the release of suspended solids from the mining area. In Finland the maximum load of suspended solids immediately after ditching can be about 300 kg/ha and most of this is organic matter. Monitoring in Minnesota has recorded a value 700 kg/ha during the first year, and 140 kg/ha in the second year. Again, the heaviest loadings occur during the initial draining of the peatland, but solids loadings can continue to be heavy due to the nature of the production methods used.

During the production period, the maximum load of suspended solids occurs after heavy rains in summer, when milled peat is still on the field. These suspended solids, however, settle quite easily in the ditch network or in the settling ponds. The total load depends on the quality of peat. The annual load of suspended solids during the production period can be 88 to 264 pounds per acre (100 - 300 kg/ha).

2.2.6 The Water Treatment System

The water treatment system for a peat production area usually consists of a large sedimentation pond together with smaller ponds and flow regulating and filtering systems in the ditch network. Also, the water coming from the surrounding area should bypass the peat production area so that the treatment systems do not face additional loads.

Research in Finland has shown that the maximum catchment area for one settling pond should be 30 - 50 ha. The length and the breadth of the pond is determined by the type of cleaning equipment and the surface area required is determined by the total peat production area (10 m2/ha). The ditch network should be dug as horizontal as possible and the sides of the ditches should be sloped so that they do not collapse. Ditches that widen in the direction of flow prevent straight-through currents. The frequency of cleaning depends on the annual amount of suspended solids, and the effectiveness of the water treatment system is influenced most by regular cleaning.

Ponds constructed for the initial drainage period should be dug as shallow sludge pockets, shallower than in the final dimensioning stage. The retention capability can then be improved by surface runoff as well as by numerous deepenings and widenings in the ditches. This technique will avoid the collapse of the sides of the ponds, and the final ponds can be made and cleaned at the end of drainage period. The load of suspended solids leaving the ponds can be further reduced by regular cleaning, as well as by improving the retention capacity of the ditch network. The capability of the ponds to remove suspended solids depends on the particle size of peat, and very small peat particles cannot settle in natural situations. This effect is quite noticeable with low concentrations of suspended solids (< 20 mg/l).

3.0 Site Selection

In January, 1986, the DNR peat inventory staff began the site selection process to locate fuel peat resources for the Hibbing Public Utility Commission and Boise Cascade, International Falls. The purpose of the site selection work was to examine all peat resources near these facilities and determine the potential of each peatland for fuel extraction.

Site selection for this project consisted of two steps at each location. First, a number of preliminary peatland surveys were conducted, and, secondly, based on the preliminary data, one peatland from the candidates was selected for detailed survey.

Preliminary surveys are used to broadly assess the development potential of peatlands. Peat profiles are described at intervals along traverses within a peatland and the information is extrapolated to areas of the peatland that are not evaluated directly. Detailed surveys are more exact investigations that are conducted for site specific planning. Using a survey grid, resource data is collected systematically throughout the peatland.

Three criterion were examined in evaluating each peatland: 1) resource parameters, such as peat quality, peatland size, and potential for drainage; 2) ancillary factors, such as assessability and distance to the consumer, and 3) ownership of the resource. In brief, the selection process was used to locate 500 to 1500 contiguous acres of fuel peat (dependent on projected fuel consumption), within 25 miles of the facility, that could be leased or purchased by the developer.

An analysis of weather data, in conjunction with production estimates from VAPO, determined the minimum acreage requirements for the production scenarios.

3.1 Preliminary surveys

Preliminary surveys were conducted on a number of peatlands in the Hibbing and International Falls areas. A systematic evaluation of the peatlands was completed, with the peatlands closest to the consumers receiving more comprehensive review.

The first step in determining which peatlands should be surveyed was a office review of peat resource maps, USSG topographic maps, aerial photographs, and the DNR peat inventory database. The Hibbing review incorporated the Riley, Swan River, and North Toivola peatlands. Similarly, the review for International Falls included the Littlefork NW, Nakoda, Rainer, and West Rat Root Lake peatlands.

Near Hibbing, the DNR then conducted preliminary surveys in the Riley and North Toivola peatlands. The Swan River Peatland was eliminated from consideration because of the large number of mineral islands within the peatland.

The DNR conducted preliminary surveys in all the peatlands near International Falls, but the Littlefork and Nakota peatlands appeared to have the most potential and were examined more intensively.

The DNR then scheduled a field review with VAPO representatives to select the peatlands with the greatest development potential.

3.2 Field Reviews

Field reviews were conducted by a planning team composed of VAPO/EKONO/ Peatrex and DNR personnel. The purpose of the field reviews was to: 1) select the peatland near each consumer that appeared to have the most potential for development, and 2) define the parameters for the detailed surveys, which the DNR would conduct.

The planning team determined the potential of each peatland by examining the peat material, peatland access, and potential for drainage of each peatland. Team members, transported by bombardier and helicopter, examined the peat at random locations within the peatlands, determining the peat decomposition and the depth of the deposit. USGS topographic maps were reviewed to locate sites for access roads and calculate haul distances to the consumers, and the peatland outlets and map elevation data were studied to select the optimum drainage routes.

3.2.1 Results of the Field Reviews in the Hibbing Area

The planning team concluded that the Riley Peatland had greater potential for fuel production than the North Toivola Peatland. The following considerations led to the selection: 1) based on the preliminary survey data and laboratory analyses, the peat material in Riley is of higher fuel quality than that in North Toivola; 2) transportation costs from Riley to Hibbing would be less than those from North Toivola; 3) the outlet ditch from Riley would be shorter and less expensive to construct; and 4) Riley is less densely forested, hence clearing costs would be lower.

Of these four criteria, the quality of the peat was the most critical; the Riley peat material was more strongly decomposed, therefore, a higher quality fuel. The Riley material is generally decomposed to a von Post H5 or greater, while most of the Toivola material is a von Post H4 in decomposition, the minimum decomposition for peat fuel. The North Toivola peatland also contains many layers of non-fuel, H3 material.

3.2.2 Results of the Field Reviews in the International Falls area

The Littlefork NW Peatland has the highest potential for fuel peat production for Boise Cascade. The Nakoda peatland was ranked second. Large amounts of relatively undecomposed sphagnum peat in the Nakoda North and West Rat Root Lake peatlands precluded their use, and the Rainer Peatland was eliminated from consideration because of its small size.

Lower bog development costs were the primary reason for selecting the Littlefork NW over the Nakota peatland. The Littlefork NW Peatland is located one half mile south of US Highway 1, while the access to the fuel area of the Nakoda Peatland, in the western portion of the peatland, would be approximately one and one-half miles. Likewise, the outlet ditch from the Nakoda peatland would be longer, more costly to construct, and run through farmsteads.

The differences in the peat between these two areas were not as critical as in the Hibbing area. However, the peat material in the Littlefork NW Peatland was more decomposed than that in Nakoda. On the von Post scale, the Littlefork peat material was H4.5 or greater, while most of the Nakoda peat material was H4 in decomposition.

3.3 Detailed Surveys

The DNR conducted detailed surveys on the Riley and Littlefork peatlands during a period from May thru July, 1986. Grid line survey techniques were used to assess the quality and quantity of the resource. The surveys were designed to collect the baseline data necessary to develop comprehensive mining plans.

Survey crews measured peat depths, described peat profiles and peatland vegetation, collected samples for laboratory analysis, and measured the surface elevations at various points on the grids. The results of these surveys were submitted to VAPO in August 1986 for production planning. The complete survey reports are available from the DNR Minerals Division in St. Paul.

An overview of the surveys is presented below.

3.3.1 Riley Peatland Detailed Survey

The Riley Peatland comprises approximately 6000 acres. The peatland formed on the northwestern shore of Glacial Lake Upham in an abalation area of glacial ice. This area contains sandy soils that were reworked and modified by glacial meltwaters and lake shore currents. An irregular depositional pattern of scattered landforms typical of glacial meltout regions resulted.

The peat accumulation eventually covered many of the lower landforms. Higher landforms now protrude from the peat surface, forming mineral islands that are oriented in the direction of the glacial ice front.

The survey encompassed approximately 2400 acres of the peatland (see Figure 3.1). To record the irregularity of the mineral substrate, the grid lines were placed closer together and the more depth measurements were made.

VAPO received the following survey data: 1) depth observations from 841 points on the grid, 2) peat profile and peatland vegetation descriptions from 24 points on the grid, 3) elevation measurements from 156 points on the grid, and 4) laboratory analyses from 19 sample points on the grid.

VAPO developed the mining plan for Riley from the survey data. The production field layout, bog preparation procedures, drainage plans, and production estimates are all based on the findings of the detailed survey.

The data collected in the Riley survey is discussed in Chapter 4.

3.3.1.1 Riley Peatland Ownership

All land ownership within the surveyed area is private. Approximately ninety-five percent of the property is owned by National Steel Pellet Co.,Itasca Pellet Co., and Inland Steel Mining Co. M.A. Hanna Co., acting as the management agent for the mining companies, has indicated its willingness to cooperate with any potential developer. The remaining 80 acres are owned by E. Kelsey.

3.3.2 Littlefork NW Peatland Detailed Survey

The Littlefork NW Peatland survey covered approximately 2300 acres in the northern portion of the peatland. The peatland lies within the lacustrine plain of Glacial Lake Agassiz, bounded by lakewashed ground moraine.

The survey area is shown in Figure 3.2. Distance between grid lines in this survey is greater than in the Riley survey because of relatively constant peat depths.

VAPO received the following survey data: 1) depth observations from 29 points on the grid, 2) profile descriptions and vegetation descriptions from 110 points on the grid, 3) elevation measurements from 123 points on the grid, and 4) laboratory analyses from 6 points on the grid. As

Figure 3.1 Survey Grid within Riley Peatland

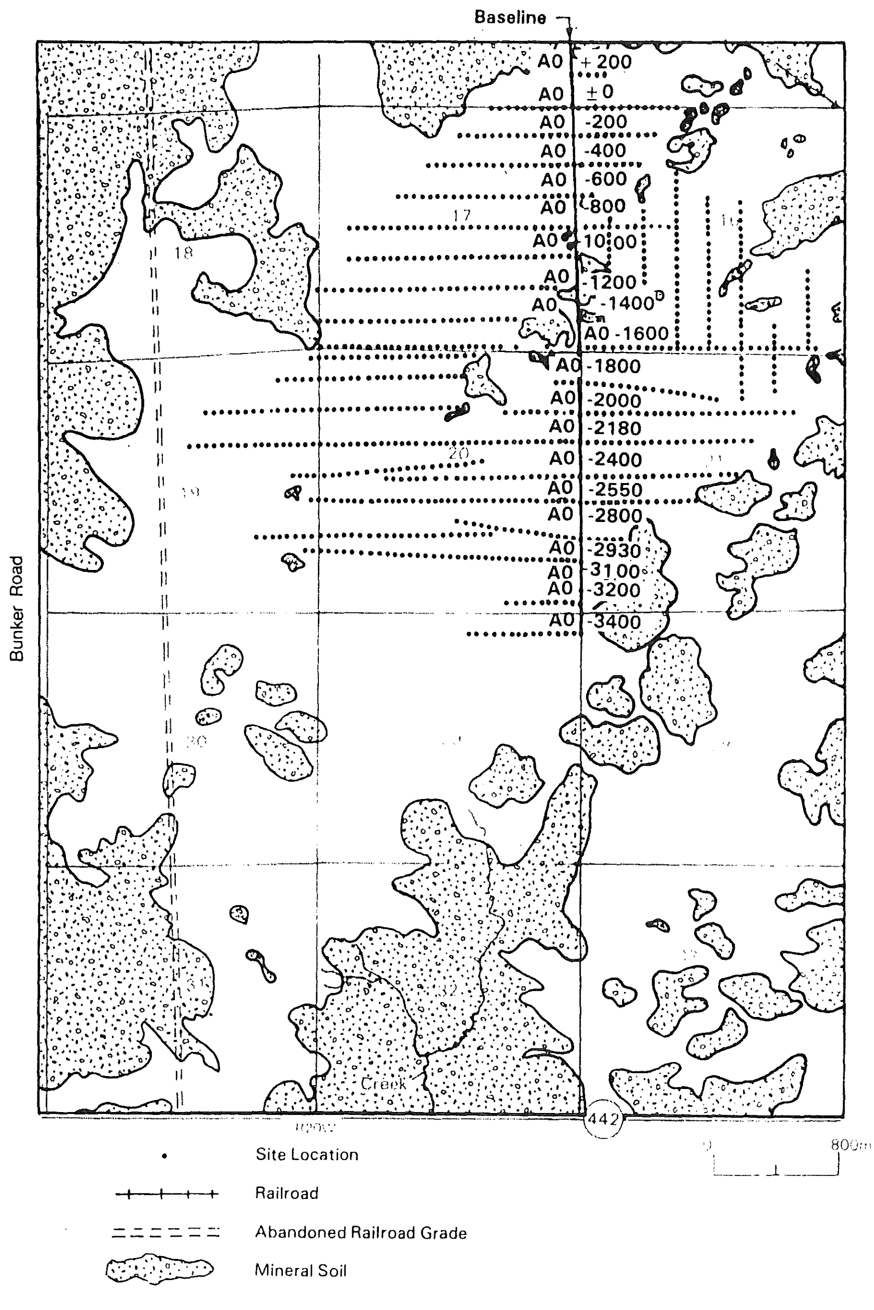
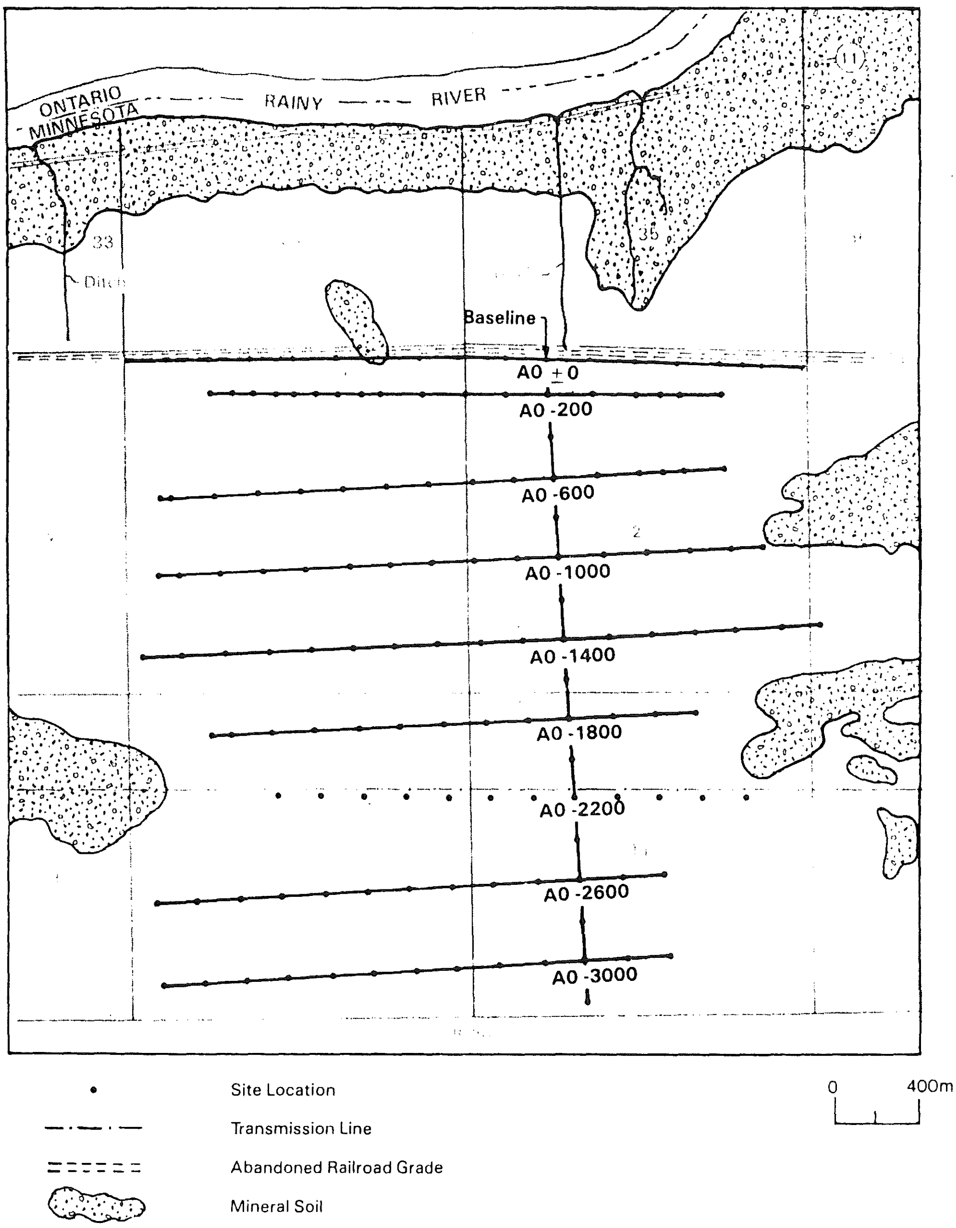


Figure 3.2 Survey Grid within Littlefork NW Peatland



with the Riley Peatland, VAPO developed the mining plan for the Littlefork NW Peatland from the survey data. The production field layout, bog preparation procedures, drainage plans, and production estimates are all based on the findings of the detailed survey.

The data collected in the Littlefork NW survey is discussed in Chapter 4.

3.3.2.1 Littlefork NW Peatland Ownership

The surveyed area lies within the Smoky Bear State Forest. The lands are classified as permanent school trust fund lands. These lands can be leased by the State. Minnkota Power Cooperative, Inc., Grand Forks, ND, holds a transmission line license from the DNR for a 230 KV line that transverses the peatland in Sections 10 and 11. The license right of way is 130 feet.

4.0 Riley Peatland Results

4.1 Peat Quality and Quantity

The peat within Riley's surveyed area totals about 1.8 million tons (4,674,000 cubic meters). Samples taken from various points in the peatland have been analyzed for moisture content, bulk density, ash content, Btu value, and degree of decomposition. In addition, ash fusion analyses have been conducted to determine initial deformation temperature, softening temperature, hemispherical temperature, and fluid temperature of the peat (see Table 4.1). These analyses have shown the entire Riley deposit to be suitable for fuel use. Appendix III contains more site specific data.

4.2 Peatland Elevation and Drainage Plans.

The highest point in the Riley peatland (approximately 1,320 feet above sea level) is located in the northwest quarter of Section 17, Township 56 North, Range 20 West. The lowest point, 1,314 feet above sea level, is located in Section 29. The natural drainage of the bog is in a south-easterly direction. Efficient drainage of the production area is be best achieved by utilizing natural topography as much as possible and directing drainage to the tributary of the West Swan River located in Section 32. The drainage will flow through two six-foot diameter culverts under St. Louis County Road 442. The base of these culverts are at an elevation of 1288 feet above mean sea level.

Based upon available data, it is possible to drain the production area as follows:

Section 16	to the level of 1310 ft
Section 17	to the level of 1310 ft
Section 20	to the level of 1308 ft
Section 21	to the level of 1308 ft

Table 4.1 LABORATORY ANALYSIS - RILEY PEATLAND

Von Post H1-3 Samples

	Average	Range	Standard Deviation	Number of Samples
Bulk Density (g/cc)	0.07	0.05 - 0.10	0.02	4
Moisture Cont. Total Wt. (%)	92.1	88.9 - 94.4	2.31	4
Ash Content (%)	10.0	8.9 - 11.3	1.16	4
pH ($CaCl_2$)	5.2	4.9 - 5.4		3
Btu/lb.	8339	8331 - 8347		2
Sulfur cont. of Btu Samples (%)	0.22	0.18 - 0.25		2

Von Post H4 Samples

	Average	Range	Standard Deviation	Number of Samples
Bulk Density (g/cc)	0.12	0.07 - 0.18	0.03	21
Moisture Cont. Total Wt. (%)	88.2	83.5 - 93.2	2.41	21
Ash content (%)	10.6	6.9 - 18.8	2.95	21
pH ($CaCl_2$)	5.1	4.6 - 5.3	0.29	8
Btu/lb.	8558	7595 - 9884	828	10
Sulfur cont. of Btu Samples (%)	0.17	0.13 - 0.23	0.03	10

Von Post H4.5-6 Samples

	Average	Range	Standard Deviation	Number of Samples
Bulk Density (g/cc)	0.16	0.11 - 0.22	0.02	42
Moisture Cont. Total Wt. (%)	85.3	80.0 - 91.8	2.17	42
Ash content (%)	13.0	7.8 - 28.5	3.90	42
pH ($CaCl_2$)	4.9	4.5 - 5.3	0.31	9
Btu/lb.	8483	7405 - 9341	586	13
Sulfur cont. of Btu Samples (%)	0.20	0.10 - 0.30	0.06	13

Table 4.1 (continued)

Von Post H7-10 Samples

	Average	Range	Standard Deviation	Number of Samples
Bulk Density (g/cc)	0.19	0.17 - 0.23	0.02	10
Moisture Cont. Total Wt. (%)	83.0	79.9 - 84.4	1.24	10
Ash content (%)	16.2	12.3 - 19.7	2.33	10
pH ($CaCl_2$)	5.1	4.9 - 5.3		2
Btu/lb.	8058	7767 - 8199	173	5
Sulfur cont. of Btu Samples (%)	0.35	0.25 - 0.45	0.83	5

Summary of All Peat Samples

	Average	Range	Standard Deviation	Number of Samples
Bulk Density (g/cc)	0.15	0.05 - 0.23	0.04	77
Moisture Cont. Total Wt. (%)	86.2	79.9 - 94.4	3.02	77
Ash content (%)	12.6	6.9 - 28.5	3.80	77
pH ($CaCl_2$)	5.0	4.5 - 5.4	0.29	22
Btu/lb.	8427	7405 - 9884	625	30
Sulfur cont. of Btu Samples (%)	0.22	0.10 - 0.45	0.08	30

Ash fusion Analysis*

Depth (cm)	Initial Deformation Temp. (°F)	Softening Temp. (°F)	Hemispherical Temp. (°F)	Fluid Temp. (°F)
25-50**	2180	2280	2320	2480
85-105**	2160	2230	2260	2380
135-155**	2170	2240	2280	2410

* Analysis performed by Lerch Brothers Incorporated, Hibbing, MN
** Samples from sites A-700-800 and A-800-1600

These drainage levels enable the production area to be drained to a depth of approximately 10 feet (3 meters) without the need for pumping. The main and outlet ditch gradient should be set at 0.05 percent. This will result in a drop in elevation of 2.6 feet per mile (50 centimeters per kilometer).

4.3 Size and Selection of Production Areas

Two levels of production, 50,000 tons per year and 75,000 tons per year, were modeled for the Riley peatland. Analysis of the weather data indicated that the production season for any given year may vary markedly in terms of starting and ending dates but that, in general, one may expect about twenty-two milled peat harvests per year. This figure compares favorably with the experience in Finland where the average season consists of eighteen harvests.

Weather data from both the Hibbing and International Falls areas were analyzed. Although slight variations were found in the weather patterns of the two sites these differences did not affect the number of harvests expected at each location.

The following table is a composite of the weather conditions found for Hibbing and International Falls.

Table 4.2 Weather data summary 1972 - 1979

	(From May to August)				Production Period Year		
	Precipitation (inches)	Number of rainy days	Night oF	Day oF	Starting date	Closing date	Number of harvests per year
1972	20.43	53	48.0	70.6	5/ 7	9/26	26
1973	20.27	57	48.0	70.8	5/13	9/20	19
1974	21.74	56	46.4	68.9	6/11	9/ 6	18
1975	21.95	54	48.4	72.3	5/ 8	9/ 7	18
1976	15.32	36	44.8	75.2	5/15	9/12	28
1977	(data not available)						
1978	22.96	53	44.0	71.9	5/13	9/10	26
1979	15.72	53	37.6	69.9	5/26	8/30	18
Average	19.77	52	45.3	71.4			22

Each harvest is estimated to yield approximately 4.6 tons per acre (30 cubic meters per hectare). On an average annual basis, production is calculated to be 100 tons per acre. For this calculation, 0.38 tons per cubic meter was used as the bulk density of the peat as received by the consumer. Using average annual yield figures, the acreage required to be actively under production at any given time was estimated to be 500 and 750 acres, respectively.

The entire Riley site was subdivided into five production areas as follows (also see Figure 4.1).

Area	1:	480 acres	(194 ha)
	2:	205 acres	(83 ha)
	3:	153 acres	(62 ha)
	4:	386 acres	(156 ha)
	5:	67 acres	(27 ha)
Total		1291 acres	(522 ha)

Each production area has its own perimeter and field ditch network. In the 50,000 ton per year scenario, Area 1 and forty acres from Area 2 would be under active production. In the 75,000 ton per year scenario Areas 1, 2 and a portion of Area 3 would be used for a total of 750 acres under active production.

4.4 Forest Clearing

Trees having diameters greater than 2 inches will have to be cut from approximately 100 acres in the Riley peatland. Location of the forest to be cleared is shown in Figure 4.2. It is based on the information provided by DNR.

4.5 Ditch Construction and Field Preparation

Various pieces of equipment are needed before ditch construction and field preparation can begin. The following is a list of necessary equipment:

- hydraulic excavator (18 metric tons)
- bog base machine (360 HP), VAPO MTA-360 equipped with screw-leveller, ditch miller and deep miller
- grader, VAPO KSL-5 or equivalent
- trailer
- bulldozer
- 4-wheel drive tractor

Ditch construction begins with an on-site check of the survey lines previously drawn from the baseline data. With the outlet to the Swan River as the point of origin, the route of the outlet ditch is staked at 100 foot intervals. Each stake should have a label citing the ditch's name, its width and depth, and the stake's distance from the outlet. At the same time, the soil quality and thickness is determined to a depth of 12 feet (3.6 meters). If bedrock is found within this twelve foot zone, alternative routes for the outlet ditch should be investigated.

Once the final route of the ditch has been determined, elevations of the ditch bottom should be marked in the labels attached to the stakes before excavation begins.

Due to heavy concentrations of wood, deep milling will be required on all production fields in the Riley area.

Figure 4.1 Riley Peatland Production plan

① FIELD NUMBER

OD OUTLET DITCH

S SECONDARY DITCH

FIELD DITCH

MAIN DITCH

PIPE

DRAIN

ROAD

CULVERT

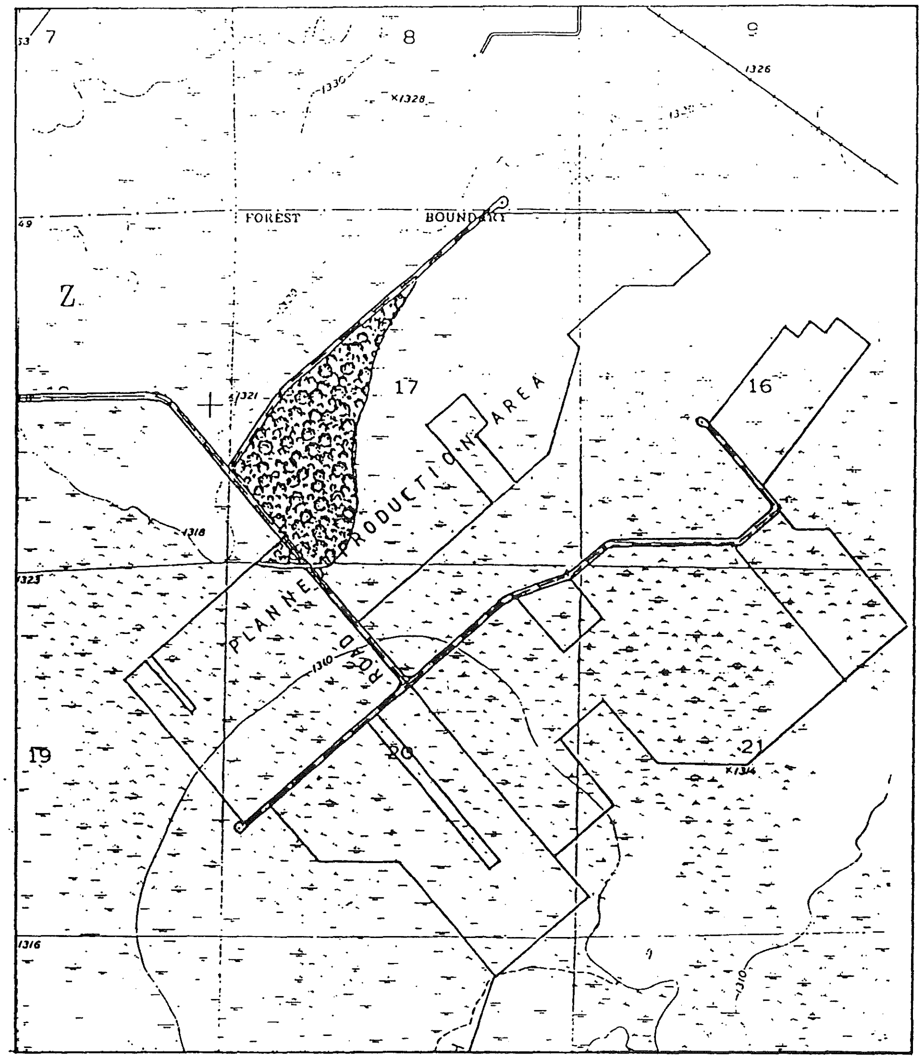
2m DEPTH IN METERS

STOCKPILE AREA

SETTLING BONDS

FEET A.S.L.

Figure 4.2 Riley Peatland forest clearing



Wooden area

4.6 Fire Protection

Measures to ensure adequate protection from fire are extremely important and should be taken early in the site preparation phase. For the Riley peatland a certain number of 15 to 22 basins have to be dug and a fire protection wagon maintained on site from the time ditching and clearing begins.

The fire protection equipment required for each level of production is as follows:

Equipment	50,000 t/yr	75,000 t/yr
Firefighting Trailer	1	1
Fire engine	2	3
Fire hose (3 inch)	600 yd	1000 yd
Fire hose (2 inch)	800 yd	1200 yd
Fire basins	15	22

4.7 Road Construction

Roads for the project should be sixteen feet (5 meters) wide and have a carrying capacity at least equal to the maximum weight of a loaded truck (38 to 40 tons).

4.8 Stockpile Areas

The stockpile area shall be situated beside the road as shown in Figure 4.1. The stockpile shall have a triangular shape, with a base of about sixty feet and a height of twenty-five feet. For the 50,000 ton per year scenario the stockpile should hold about 66,500 tons, and at the 75,000 ton per year level about 100,000 tons of peat.

4.9 Equipment Requirements

A production method using one HAKU-chain and three additional mechanical harvesters is recommended to produce 50,000 tons per year. The addition of three mechanical harvesters is more cost effective than adding a second chain if production is to be limited to 50,000 tons per year. The equipment requirements for this level of production is as follows:

- Miller 2	VAPO JTJ-6 or equivalent
- Harrow 2	VAPO JLK-19 or equivalent
- Ridger 2	VAPO JVK-5 or equivalent
- Loader 1	VAPO JKS-15 or equivalent
- Trailer 4	VAPO JPV-30 or equivalent
- Mechanical harvester 3	VAPO JMK-20 or equivalent
- Bulldozer Wide Track 8 tn 1	
- Tractor 60 - 70 kW 2	
- Tractor 75 - 100 kW 14	

For the production of 75,000 tons per year, two HAKU-chains are required. The equipment required is:

- Miller 4	VAPO JTJ-6 or equivalent
- Harrow 3	VAPO JLK-19 or equivalent
- Ridger 4	VAPO JVK-5 or equivalent
- Loader 2	VAPO JKS-15 or equivalent
- Trailer 8	VAPO JPV-30 or equivalent
- Bulldozer Wide Track 8 tn 1	
- Tractor 60 - 70 kW 3	
- Tractor 75 - 100 kW 16	

4.10 Production Estimates

Production levels in the first and second year of operation are expected to be lower than average. This is due to several factors, the most important being the relative wetness of the recently-drained production areas.

In the first production year the expected production rate is estimated to be about fifty percent of the average production rate and in the second year between seventy-five and ninety percent. This estimate is based upon average weather conditions. Should the summer(s) be drier than average, production may be greater. By the third production season the fields should be drained sufficiently to expect full production.

4.11 Environmental Assessment

Although no systematic vegetation survey was undertaken as part of the peat resource survey, the survey teams did note occurrences of protected plant species. In particular, two species of orchids were identified, Arethusa bulbosa (Arethusa) and the state flower Cypripedium reginae (Showy Lady Slipper). Both species are protected by Minnesota statues. Arethusa bulbosa is covered by Minn. Stat. 97.488 and is listed as of special concern in the "Checklist of Endangered and Threatened Animal and Plant Species of Minnesota". This species in generally confined to non-forested areas of large peatlands.

Cyprepedium reginae is protected by Minn. Stat. 17.23, "Conservation of certain wildflowers." However, this law only requires that permission must be obtained before this species can be picked. This law does not cover destruction of their habitat.

The occurrence of large numbers of these orchids in a localized area, such as in the extreme southern portions of the Riley survey area, does make this an unusual site which adds to its significance. However, of greater interest is the possibility that this peatland possess a unique environmental setting that may provide habitat for additional orchid or rare plant species.

The full assessment of the relative significance of this site cannot be made until a thorough botanical survey can be conducted during appropriate times of the year. Such a survey will be conducted as part of the state's environmental review process.

The possibility of situating development so that it would not impact the orchid area was evaluated. The production fields could be positioned to avoid this area (the southern portion of the survey area, survey lines AO-3200 and AO-3400).

Drainage of the peatland will require an outlet ditch from the south end of the production area to the receiving water, a small tributary of the West Swan River in Section 32. The outlet ditch will also be positioned so as to avoid damage to the orchid area.

5.0 Littlefork Results

5.1 Peat Quality and Quantity

The peat within the production areas of the Littlefork peatland totals about 2.1 million tons. Samples taken from various points in the peatland have been analyzed for moisture content, bulk density, ash content, Btu value, and degree of decomposition. In addition, ash fusion analyses have been conducted to determine initial deformation temperature, softening temperature, hemispherical temperature, and fluid temperature of the peat.

These analyses, contained in Table 5.1, have shown the entire Littlefork deposit to be suitable for fuel use. Further site specific data is in Appendix III.2.

5.2 Peatland Elevation and Drainage Plans

The highest point in the Littlefork peatland is approximately 1114 feet above sea level and is located in Section 10, Township 69 North, Range 26 West. Natural drainage occurs in a northwesterly direction toward the bog's lowest point of 1108 feet above sea level in Section 3.

The drainage of the production area is possible via the Big Fork River. The elevation of the river is about 1102 ft above sea level. This makes it possible to drain the production areas as follows:

Section 2	to the level of 1105 ft
Section 33	to the level of 1103 ft
Section 10	to the level of 1104 ft
Section 11	to the level of 1105 ft

These drainage conditions make it possible to drain the production area to a depth of approximately 6 to 7 feet without pumping. The gradients of both the outlet and perimeter ditches are set at 0.03 percent. In other words, the ditch elevation lowers 30 cm/km (1.5 ft/mi).

Table 5.1 LABORATORY ANALYSIS - LITTLEFORK NW PEATLAND

Von Post H4 Samples

	Average	Range	Standard Deviation	Number of Samples
Bulk Density (g/cc)	0.10	0.04 - 0.15	0.04	6
Moisture Cont. Total Wt. (%)	89.6	86.3 - 93.0	2.19	6
Ash content (%)	6.0	3.6 - 11.2	2.75	6
Btu/lb.	8273	7517 - 8805	550	6
Sulfur cont. of Btu Samples (%)	0.43	0.08 - 1.10	0.47	6

Von Post H4.5-H6 Samples

	Average	Range	Standard Deviation	Number of Samples
Bulk Density (g/cc)	0.12	0.09 - 0.15	0.02	26
Moisture Cont. Total Wt. (%)	88.0	84.8 - 90.6	1.71	26
Ash content (%)	8.1	3.5 - 12.4	2.40	26
Btu/lb.	8132	7205 - 8788	375	22
Sulfur cont. of Btu Samples (%)	0.25	0.08 - 0.93	0.18	22

Summary of All Peat Samples

	Average	Range	Standard Deviation	Number of Samples
Bulk Density (g/cc)	0.12	0.04 - 0.15	0.03	32
Moisture Cont. Total Wt. (%)	88.3	84.8 - 93.0	1.88	32
Ash content (%)	7.7	3.5 - 12.4	2.56	32
Btu/lb.	8162	7205 - 8805	411	28
Sulfur cont. of Btu Samples (%)	0.28	0.08 - 1.10	0.27	28

Table 5.1 (continued)

Ash Fusion Analysis*

Depth (cm)	Initial Deformation Temp. (^{o}F)	Softening Temp. (^{o}F)	Hemispherical Temp. (^{o}F)	Fluid Temp. (^{o}F)
0-30**	2100	2160	2430	2640
30-60**	2140	2210	2250	2310
60-90**	2180	2260	2290	2320

* Analysis performed by Lerch Brothers Incorporated, Hibbing, MN.

** Samples from sites A-1800-1400 and AO-2200 were combined for this analysis.

5.3 Size and Selection of Production Areas

Weather analysis has indicated that twenty-two harvests could be expected each year in the Littlefork peatland. Using this data, and the estimated amount of yield per acre of 4.6 tons per harvest, it was determined that approximately 500 acres would be needed to sustain operations at the 50,000 ton per year level and 1500 acres would be necessary for the 150,000 ton per year level.

The production site is divided into four different sections, each having its own ditch network (see Figure 5.1).

Area	1:	294 acres (119 ha)
	2:	344 acres (139 ha)
	3:	535 acres (216 ha)
	4:	275 acres (111 ha)
Total		1448 acres (585 ha)

At the 50,000 ton per year production level, peat will be actively mined from all of Area 1 and part (239 acres) of Area 2 for a combined total of 533 acres. For the 150,000 ton per year scenario, peat will be actively mined throughout Areas 1 through 4. It should be noted that additional production areas can easily be found beyond the proposed areas 1 through 4 and that the availability of adequate production areas will not be a limiting factor.

5.4 Forest Clearing

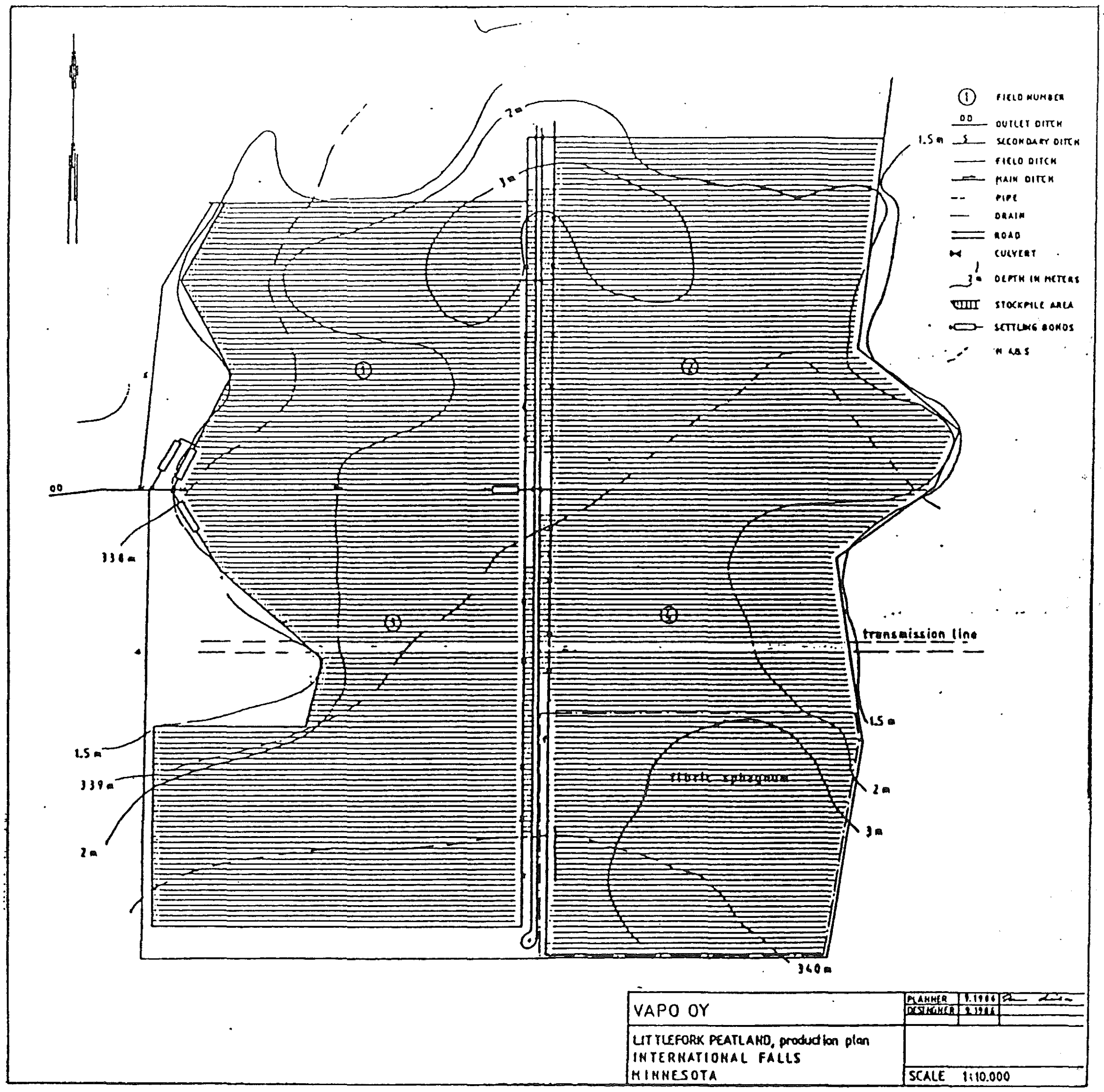
For the 50,000 ton per year production level, trees having diameters greater than two inches will have to be cut from approximately 175 acres (70 hectares). For the 150,000 ton per year option, trees will have to be cut from approximately 260 acres (105 hectares). Figure 5.2 contains a map showing the tree coverage.

5.5 Ditch Construction and Field Preparation.

Various pieces of equipment are needed before ditch construction and field preparation can begin. The following is a list of necessary equipment:

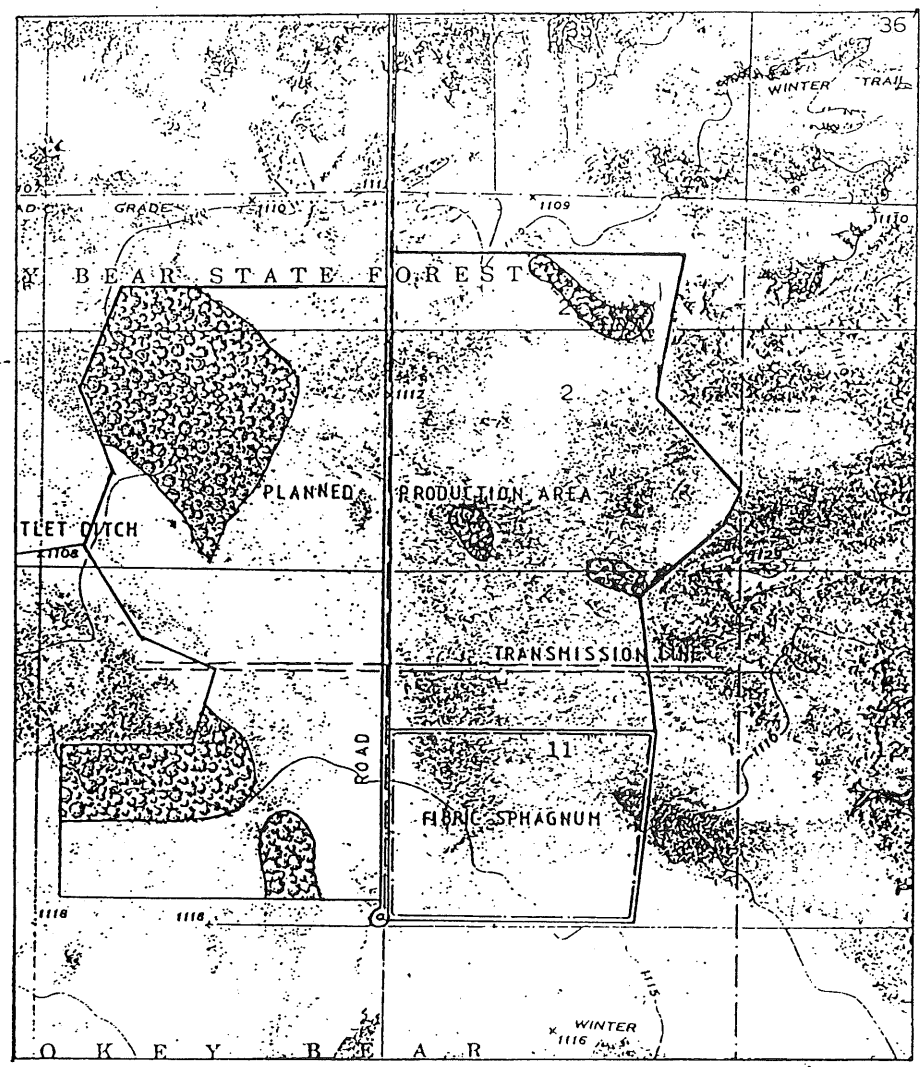
- hydraulic excavator (18 metric tons)
- bog base machine (360 HP), VAPO MTA-360 equipped with screw-leveller, ditch miller and deep miller
- grader, VAPO KSL-5 or equivalent
- trailer
- bulldozer
- 4-wheel drive tractor

Figure 5.1 Littlefork Peatland Production plan



(1) FIELD NUMBER
OD OUTLET DITCH
S SECONDARY DITCH
FIELD DITCH
MAIN DITCH
PIPE
DRAIN
ROAD
CULVERT
2m DEPTH IN METERS
STOCKPILE AREA
SETTLING BONDS
M A.B.S

Figure 5.2 Littlefork Peatland forest clearing



Wooden area

Ditch construction begins with an on-site check of the survey lines previously drawn from the baseline data. With the outlet to the Bigfork River as the point of origin, the route of the outlet ditch is staked at 100 foot intervals. Each stake should have a label citing the ditch's name, its width and depth, and the stake's distance from the outlet. At the same time, the soil quality and thickness is determined to a depth of 12 feet (3.6 meters). If bedrock is found within this twelve foot zone, alternative routes for the outlet ditch should be investigated.

Once the final route of the ditch has been determined, elevations of the ditch bottom should be marked in the labels attached to the stakes before excavation begins.

Deep milling will be required on approximately 272 acres (110 hectares) of Area 1 for the 50,000 ton per year scenario and on 620 acres (250 hectares) for the 150,000 ton per year scenario. These estimates are based upon experience in Finnish peatlands.

A more accurate estimate can be obtained by sampling the peat for woody material prior to milling. Stumps and trees are chipped by the miller and mixed into the peat to a depth of about one foot (30 cm).

5.6 Fire Protection

Measures to ensure adequate protection from fire are extremely important and should be taken early in the site preparation phase. For the Littlefork peatland it was determined that fifteen basins be constructed for the 50,000 ton per year scenario and 30 basins constructed for the 150,000 ton per year scenario. In addition, a fire protection wagon must be maintained on site from the time ditching and clearing begins.

See Figure 5.1 for the location and size of the basins.

The fire protection equipment required for each level of production is as follows:

Equipment	50,000 t/yr	150,000 t/yr
Firefighting Trailer	1	2
Fire engine	2	4
Fire hose (3 inch)	600 yd	1200 yd
Fire hose (2 inch)	800 yd	1600 yd

5.7 Road Construction

Since there is little variability in peat depth throughout the Littlefork area, the road can bisect the production fields (see Figure 5.1). This configuration is advantageous because it allows the stockpile to be built on both sides of the road allowing easy access. The entrance and exit routes are planned to be on the northern side.

5.8 Stockpile Areas

As stated in Section 5.7, the stockpile areas are to be located on either side of the access road. It is estimated that the stockpile for the 50,000 ton per year scenario would be 5500 feet long, 25 feet high, and have a volume of about 50,000 tons. For the 150,000 ton per year scenario the stockpile would be 16,500 feet long, 25 feet high, and have a volume of about 150,000 tons.

5.9 Equipment Requirements

A production method using one HAKU-chain and three additional mechanical harvesters is recommended to produce 50,000 tons per year. The addition of three mechanical harvesters is more cost effective than adding a second chain if production is to be limited to 50,000 tons per year. The equipment requirements for this level of production is as follows:

- Miller 2	VAPO JTJ-6 or equivalent
- Harrow 2	VAPO JLK-19 or equivalent
- Ridger 2	VAPO JVK-5 or equivalent
- Loader 1	VAPO JKS-15 or equivalent
- Trailer 4	VAPO JPV-30 or equivalent
- Mechanical harvester 3	VAPO JMK-20 or equivalent
- Bulldozer Wide Track 8 tn 1	
- Tractor 60 - 70 kW 2	
- Tractor 75 - 100 kW 14	

For the production of 150,000 tons per year, four HAKU-chains are required. The equipment required is:

- Miller 7	VAPO JTJ-6 or equivalent
- Harrow 6	VAPO JLK-19 or equivalent
- Ridger 8	VAPO JVK-5 or equivalent
- Loader 5	VAPO JKS-15 or equivalent
- Trailer 16	VAPO JPV-30 or equivalent
- Bulldozer Wide Track 8 tn 3	
- Tractor 60 - 70 kW 6	
- Tractor 75 - 100 kW 30	

5.10 Production Estimates

Production levels in the first and second year of operation are expected to be lower than average. This is due to several factors, the most important being the relative wetness of the recently-drained production areas.

In the first production year the expected production rate is estimated to be about fifty percent of the average production rate and in the second year between seventy-five and ninety percent. This estimate is based upon average weather conditions. Should the summer(s) be drier than average, production may be greater.

By the third production season the fields should be drained sufficiently to expect full production.

5.11 Environmental Assessment

The peatland vegetation was classified as bog. Black spruce coverage within the peatland varies from a crown cover of one to five percent, classified as open bog, to a crown cover of greater than twenty-five percent, classified as forested bog. Bogs are characteristically not floristically diverse and are not likely to contain plant species protected by the "Checklist of Endangered and Threatened Animal and Plant Species of Minnesota."

Treed shrub swamp vegetation is present on approximately 80 acres of the survey area.

During the peat resource survey of the Littlefork NW Peatland, the survey crews did not observe any protected plant species (rare or orchid species).

A systematic vegetation survey of the area will be conducted as part of the state's environmental review process.

6.0 Economic Evaluation.

After site planning was completed and equipment requirements detailed for two levels of production at each site, an economic evaluation was conducted to determine the competitiveness of each scenario. The tool employed to gauge this competitiveness was a peat production financial planning model developed by the DNR.

6.1 Methodology

The model, which is interactive, allows the user to alter all elements of the proposed peat production enterprise. Tables 1 through 3 (see Appendix II) are the controlling tables of the model. Here, all the elements used in the economic calculations are entered.

Assumptions are made concerning the debt/equity ratio, timing and amounts of loans, interest rates and terms, the average wage rate paid to employees, taxes and depreciation, and annual charges for such items as plant overhead, utilities, and insurance.

Actual transportation distances was determined by calculating the mileage from the proposed production sites to consumers. Transportation charges were based upon DNR experience.

Other variables, such as the number of acres required to sustain an operation at a given level of production, were determined based upon weather and resource data provided by DNR, and on VAPO's experience with Finnish peat production techniques and equipment. The timing and duration of various pre-production tasks such as permitting, preparation of necessary environmental documents, and bog preparation, were decided jointly with DNR and were based upon a combination of actual experience and best engineering judgment. Establishment costs, manpower, and equipment requirements were calculated for two production scenarios at each site and entered into the model.

All variables such as haul distance, base wage rate, land rental and royalty charges, etc., were held constant while calculating each scenario so that the different scenarios could be compared.

Some variables were altered, however, during sensitivity analyses to determine the relative importance that changed values for these elements would have on the profitability of the enterprise.

The model calculates revenues, deducts all expenditures, and generates income and cash flow statements. By contrasting the statements associated with each level of capacity, a determination was made regarding the competitiveness of each scenario and its attractiveness as an investment opportunity.

6.2 Riley Peatland Results.

Meetings with representatives of the Hibbing Public Utility and the DNR resulted in projection and analysis of production rates of 50,000 and 75,000 tons per year from the Riley peatland.

Comparative analysis of the financial statements from the two Riley scenarios indicate that significant economies of scale result from pursuing the 75,000 ton per year option.

The economies of scale resulting from the ability to produce at the 75,000 ton per year level enable a producer to deliver peat to the Hibbing Public Utility at $1.55 per million Btu, while maintaining an after-tax rate of return of 10.27 percent. This price is clearly competitive with the western subbituminous coal currently being used at the Utility.

6.3 Littlefork Peatland Results

As was seen in the case of the Riley peatland, higher production levels result in considerably better economics. For example, a tripling of production can be achieved by approximately doubling the original investment. The incremental investment is used to prepare 1,000 additional acres of land and to purchase additional production equipment.

Table 6.1 Riley Peatland Scenario Comparison

Annual Production (tons)	50,000	75,000
Establishment Cost Variables:		
Organization and Legal Fees	$ 40,000	$ 40,000
Site Selection	5,000	5,000
Permitting	13,000	13,000
Engineering Survey	6,800	10,000
Bog Preparation	438,570	651,570
Site Development & Utilities	200,000	250,000
Equipment Procurement	978,700	1,110,996
Total Establishment Cost	$1,682,070	$2,080,566
Investment Cost ($/ton)	$33.64	$27.74
Operational Expenses ($/ton):		
Variable Expense Items		
Raw Materials (royalty)	$ .70	$ .70
Transportation	1.32	1.32
Direct Labor	2.83	3.04
Fuel	.86	.86
Equipment Maintenance	.40	.40
Total Variable Expense Items	$6.11	$6.32
Fixed Expense Items		
Admin. and Fulltime Salaries	$2.77	$1.85
Utilities	.20	.13
Land Rental	.05	.05
Insurance	.80	.53
Total Fixed Expense Items	$3.82	$2.56
Total Operational Expenses ($/ton):	$9.93	$8.88
Delivered Price to Consumer:		
Price per ton	$15.90	$13.65
Price per million Btu	$1.81	$1.55
Rate of Return on Investment	10.24%	10.27%

Table 6.2 Littlefork Peatland Scenario Comparison

Annual Production (tons)	50,000	150,000
Establishment Cost Variables:		
Organization and Legal Fees	$ 40,000	$ 40,000
Site Selection	5,000	5,000
Permitting	13,000	13,000
Engineering Survey	6,800	10,000
Bog Preparation	438,570	1,036,520
Site Development & Utilities	200,000	300,000
Equipment Procurement	978,700	2,070,649
Total Establishment Cost	$1,682,070	$3,475,169
Investment Cost ($/ton)	$33.64	$23.17
Operational Expenses ($/ton):		
Variable Expense Items		
Raw Materials (royalty)	$ .70	$ .70
Transportation	1.87	1.87
Direct Labor	2.83	3.04
Fuel	.86	.86
Equipment Maintenance	.40	.40
Total Variable Expense Items	$6.66	$6.87
Fixed Expense Items		
Admin. and Fulltime Salaries	$2.77	$1.59
Utilities	.20	.07
Land Rental	.05	.05
Insurance	.80	.27
Total Fixed Expense Items	$3.82	$1.98
Total Operational Expenses ($/ton):	$10.48	$8.85
Delivered Price to Consumer:		
Price per ton	$16.60	$13.00
Price per million Btu	$1.89	$1.48
Rate of Return on Investment	10.05%	10.06%

The benefits of increased production are clearly manifested in the degree of competitiveness the enterprise would display in the marketplace. At the 150,000 ton per year level, the delivered price of peat to the Boise Cascade plant could be $1.48 per million Btu and still yield an after-tax rate of return of greater than 10 percent. At the 50,000 ton per year level, the delivered price of peat would need to be raised to $1.89 per million Btu in order to maintain the same rate of return.

6.4 General Economic Conclusions

The rates of return possible and the expected selling price of the product make the production of milled peat from both the Riley and the Littlefork sites an attractive opportunity for investors and consumers alike. An after-tax rate of return of slightly over ten percent compares favorably with the average earned by all U.S. companies in 1985, and prices in the $1.48 to $1.55 per million Btu range are extremely competitive with the bark, natural gas, and coal currently being burned by Boise Cascade and the Hibbing Public Utility.

Additional modeling has shown that the economics of milled peat production are quite sensitive to two distinct cost components: cost of capital and haul distance from bog to consumer. The base case scenario for each level of production at each site called for an interest rate on all loans of 10 percent. More favorable financing, at, say, 8 percent, could result in fuel costs lowered by about $0.05 per million Btu. Sensitivity analysis has shown how important it is to situate production sites as close as possible to consumers. For example, increasing haul distance by only 5 miles adds about $0.05 per million Btu. The effect of haul distance increases dramatically above the twenty-five mile range.

Finally, both financial estimates are highly leveraged with debt, so firm contracts with consumers will be needed to ensure adequate debt service coverage.

7.0 Summary and Recommendations

The results contained in this report indicate that milled peat can be highly competitive with traditional fuels when used in either new or modified boilers at both Hibbing and International Falls.

The Hibbing Public Utility is currently engaged in a five-year boiler upgrading program. This program calls for rebuilding two existing boilers by 1989 and installing a new boiler during either 1990 or 1991.

Similar changes are planned for the Boise Cascade plant in International Falls. Company policy has directed that the plant become independent of imported fuels by 1991. One of their existing boilers will be rebuilt to accomplish this.

VAPO and EKONO believe that, based upon the cost projections contained in this report, work should continue to include engineering designs and cost estimates for boiler installation and/or modification at each location. A description of these Phase II tasks is contained in Appendix I of this report.

APPENDIX I

PHASE II TASKS

Phase II Tasks

For the Hibbing Public Utility:

1. Survey of the existing power and steam generation equipment and operation of the powerplant

2. Size optimization of a new solid fuel boiler
    - operation mode of the plant (boiler)
    - ratings with peat, coal, and wood

3. Technical Implementation
    - receiving and handling of solid fuels
    - combustion equipment
    - boiler design (including water-steam cycle)
    - emission control
    - ash handling
    - instrumentation and controls
    - civil engineering and construction

4. Layout Drawings and Flowsheets

5. Economic Evaluation
    - capital cost
    - costs of operation
    - fuel and auxiliary power costs
    - profitability of peat firing

6. Summary and Conclusions

TIMEFRAME: 6 MONTHS

For Boise Cascade, International Falls:

1. Survey of the existing power and steam generation equipment and operation of the powerplant

2. Selection of boiler to be converted (or a new peat-fired boiler
    - selection of boiler rating with peat and gas
    - evaluation of boiler performance after conversion

3. Technical Implementation
    - receiving and handling of solid fuels
    - combustion equipment
    - boiler design (including water-steam cycle)
    - emission control
    - ash handling
    - instrumentation and controls
    - civil engineering and construction

4. Layout Drawings and Flowsheets

5. Economic Evaluation
    - capital cost
    - costs of operation
    - fuel and auxiliary power costs
    - profitability of peat firing

6. Summary and Conclusions

APPENDIX II

FINANCIAL VARIABLES

RILEY 50,000 T/YR - FINANCIAL VARIABLES TABLE 1

Establishment Cost Variables	
Organization & Legal Fees	$40,000
Site Selection	$5,000
Permitting	$13,000
Engineering Survey	$6,800
Bog Preparation	$438,570
Site Development & Utilities	$200,000
Equipment Procurement	$978,700
Total Establishment Cost	$1,682,070

Revenue Variables	
Selling price - primary customer	$15.90 per ton
Selling price - secondary customer	$.00 per ton

Transport Variables	
Transportation rate per ton/mile	.11
Haul distance - primary customer	12.0 miles
Haul distance - secondary customer	.0 miles
Average load size	23.0 tons

Volume Variables	
Number tons sold - primary customer	100.00 % of prod.
Number tons sold - secondary customer	.00 % of prod.

Financing Variables	Loan 1	Loan 2	Loan 3	Loan 4
Loan Principal	$45,360	$475,249	$100,000	656,840
Interest Rate	10.0	10.0	10.0	10.0
Loan Period (yrs)	20	20	10	20
Monthly payment	$438	$4,586	$1,322	$6,339
Annual payment	$5,253	$55,035	$15,858	$76,064

RILEY 50,000 T/YR -- EQUIPMENT REQUIREMENTS TABLE 2

Bog preparation equipment, including a Universal Bog Tractor equipped with a screw leveler, a deep miller and a ditcher, a light bulldozer and a 4-wheel drive tractor, will be contracted during site preparation. Other equipment, required to be purchased, follows:

Production Equipment:				
Mechanical harvester	3	26,734	80,202	
Miller	2	14,751	29,502	
Harrower	2	6,000	12,000	
Ridger	2	4,510	9,020	
Loader	1	23,408	23,408	
Trailer	4	11,142	44,568	
Subtotal: Production Equipment				198,700
Bulldozers and Tractors:				
Bulldozer	1	30,000	30,000	
Tractor,4-wd 60 kw	2	30,000	60,000	
Tractor,4-wd 75-100 kW	14	35,000	490,000	
Subtotal: Bulldozers and Tractors				580,000
Misc. Equipment:				
Hydraulic Excavator	1	120,000	120,000	
Pickup Truck (used)	2	10,000	20,000	
Fire protection wagon (incl. compressor and tractor)	1	50,000	50,000	
Grader	1	10,000	10,000	
Subtotal: Misc. Equipment				$200,000
Total Equipment Cost				978,700

RILEY 50,000 T/YR -- PRODUCTION VARIABLES TABLE 3

Capital Expenditure Variables

Year 1:	$64,800
Year 2:	$678,928
Year 3:	$938,343
Year 4:	$0
Year 5:	$0

Production Variables

No. of acres in production			520
Average no. of tons/acre/harvest			4.37063
No. of harvests/season			22.0
Total tonnage/yr (optimal)			50,000
Annual bog maintenance			$0
Anticipated % of optimal production/yr			
Year 2	0%	Year 6	100
Year 3	50%	Year 7	100
Year 4	90%		
Year 5	100%		

Operating Expense Variables

Raw Materials ($/ton)		.75
Hourly Labor Base Rate:	$12.00	
Milling	1,440 Hrs.	.35
Harrowing	720 Hrs.	.17
Ridging	1,440 Hrs.	.35
Loading	720 Hrs.	.17
Transporting	2,880 Hrs.	.69
Stockpiling	720 Hrs.	.17
Mech.harvest	720 Hrs.	
Fitting	1,680 Hrs.	.40
Field maint.	840 Hrs.	.52
Total Direct Labor ($/ton)		2.83
Fuel		.86
Equipment rental		.00
Annual Bog Maintenance		.00
Routine equip maint (supplies)		.40
Utilities (annual)		$10,000
Insurance		$40,000
Administrative salaries		$52,000
Loading and other fulltime employees		$86,400

Depreciation: Double Declining Balance Method

Leasing variables

Acres leased	520
Rental rate	$5.00

RILEY 50,000T/YR -- CASH FLOW PROJECTION TABLE 4

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
Capital Expenditures	64,800	678,928	938,343	0	0	0	0	0	0	0
Working Capital (including stockpile valuation)	0	0	100,000	100,000	100,000	0	0	0	0	0
Debt Service Reserve	0	0	0	0	0	0	0	0	0	0
Production Rate (tons)	0	0	25,000	45,000	50,000	50,000	50,000	50,000	50,000	50,000
Revenue from Sales	0	0	397,500	715,500	795,000	795,000	795,000	795,000	795,000	795,000
Interest Income from Debt Reserve	0	0	0	0	0	0	0	0	0	0
Total Gross Revenue	0	0	397,500	715,500	795,000	795,000	795,000	795,000	795,000	795,000
Less Operating Costs:										
Cost of Goods Sold	0	0	172,487	293,482	305,187	305,187	305,187	305,187	305,187	305,187
Plant Operation	2,600	69,600	147,800	182,360	191,000	191,000	191,000	191,000	191,000	191,000
Interest Expense -- Loans	4,502	51,595	125,603	132,492	138,271	133,136	127,463	121,196	114,272	106,624
Interest Expense -- Line of Credit	0	0	0	0	0	0	0	0	0	0
Depreciation	0	25,920	287,123	547,611	328,566	195,699	101,169	27,775	0	0
State and Local Taxes	3,995	3,995	3,995	3,995	3,995	3,995	3,995	3,995	3,995	3,995
Net Income Before Federal Taxes	-11,097	-151,110	-339,507	-444,440	-172,020	-34,016	66,186	145,848	180,546	188,194
Tax Loss Computation:										
Net Income subject to offset	0	0	0	0	0	0	66,186	145,848	180,546	188,194
Tax losses from prior periods	0	11,097	162,207	501,714	946,154	1,118,173	1,152,190	1,086,003	940,156	759,610
Tax losses this period	11,097	151,110	339,507	444,440	172,020	34,016	0	0	0	0
Amount of tax loss applied	0	0	0	0	0	0	66,186	145,848	180,546	188,194
Amount of tax loss carried forward	11,097	162,207	501,714	946,154	1,118,173	1,152,190	1,086,003	940,156	759,610	571,416
Adjusted Net Income Before Taxes	0	0	0	0	0	0	0	0	0	0
Federal Income Taxes	0	0	0	0	0	0	0	0	0	0
Profits After Taxes	-11,097	-151,110	-339,507	-444,440	-172,020	-34,016	66,186	145,848	180,546	188,194
Total Borrowing -- All Sources	45,360	475,249	756,840	100,000	100,000	0	0	0	0	0
Total Debt Repayments -- All Loans	5,253	60,288	152,210	169,104	187,313	187,313	187,313	187,313	187,313	187,313
Net Cash Flow	-31,288	-337,561	-360,494	66,559	107,505	107,505	107,505	107,505	107,505	107,505
Cumulative Cash Flow (No Int.)	-31,288	-368,849	-729,343	-662,784	-555,279	-447,774	-340,269	-232,763	-125,258	-17,753

	YEAR 11	YEAR 12	YEAR 13	YEAR 14	YEAR 15	YEAR 16	YEAR 17	YEAR 18	YEAR 19	YEAR 20
Capital Expenditures	0	0	0	0	0	0	0	0	0	0
Working Capital (including stockpile valuation)	0	0	0	0	0	0	0	0	0	0
Debt Service Reserve	0	0	0	0	0	0	0	0	0	0
Production Rate (tons)	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Revenue from Sales	795,000	795,000	795,000	795,000	795,000	795,000	795,000	795,000	795,000	795,000
Interest Income from Debt Reserve	0	0	0	0	0	0	0	0	0	0
Total Gross Revenue	795,000	795,000	795,000	795,000	795,000	795,000	795,000	795,000	795,000	795,000
Less Operating Costs:										
Cost of Goods Sold	305,187	305,187	305,187	305,187	305,187	305,187	305,187	305,187	305,187	305,187
Plant Operation	191,000	191,000	191,000	191,000	191,000	191,000	191,000	191,000	191,000	191,000
Interest Expense -- Loans	98,175	88,841	80,931	75,128	68,717	61,635	53,811	45,168	35,620	25,072
Interest Expense -- Line of Credit	0	0	0	0	0	0	0	0	0	0
Depreciation	0	0	0	0	0	0	0	0	0	0
State and Local Taxes	3,995	3,995	3,995	3,995	3,995	3,995	3,995	3,995	3,995	3,995
Net Income Before Federal Taxes	196,643	205,977	213,887	219,690	226,101	233,183	241,007	249,650	259,198	269,746
Tax Loss Computation:										
Net Income subject to offset	196,643	205,977	213,887	219,690	226,101	233,183	241,007	249,650	259,198	269,746
Tax losses from prior periods	571,416	374,772	168,795	0	0	0	0	0	0	0
Tax losses this period	0	0	0	0	0	0	0	0	0	0
Amount of tax loss applied	196,643	205,977	168,795	0	0	0	0	0	0	0
Amount of tax loss carried forward	374,772	168,795	0	0	0	0	0	0	0	0
Adjusted Net Income Before Taxes	0	0	45,092	219,690	226,101	233,183	241,007	249,650	259,198	269,746
Federal Income Taxes	0	0	15,331	74,695	76,874	79,282	81,942	84,881	88,127	91,714
Profits After Taxes	196,643	205,977	198,556	144,995	149,227	153,901	159,065	164,769	171,071	178,032
Total Borrowing -- All Sources	0	0	0	0	0	0	0	0	0	0
Total Debt Repayments -- All Loans	187,313	187,313	136,352	136,352	136,352	136,352	136,352	136,352	136,352	136,352
Net Cash Flow	107,505	107,505	143,135	83,772	81,592	79,184	76,524	73,586	70,339	66,753
Cumulative Cash Flow (No Int.)	89,752	197,257	340,392	424,164	505,756	584,941	661,465	735,051	805,390	872,143

DCF Return on Investment 10.24%

Selling price (delivered) $15.90

$1.81 per million Btu

RILEY 75,000 T/YR -- FINANCIAL VARIABLES TABLE 1

Establishment Cost Variables	
Organization & Legal Fees	$40,000
Site Selection	$5,000
Permitting	$13,000
Engineering Survey	$10,000
Bog Preparation	$651,570
Site Development & Utilities	$250,000
Equipment Procurement	$1,110,996
Total Establishment Cost	$2,080,566

Revenue Variables	
Selling price - primary customer	$13.65 per ton
Selling price - secondary customer	$.00 per ton

Transport Variables	
Transportation rate per ton/mile	.11
Haul distance - primary customer	12.0 miles
Haul distance - secondary customer	.0 miles
Average load size	23.0 tons

Volume Variables	
Number tons sold - primary customer	100.00 % of prod.
Number tons sold - secondary customer	.00 % of prod.

Financing Variables	Loan 1	Loan 2	Loan 3	Loan 4
Loan Principal	$47,600	$613,324	$100,000	795,472
Interest Rate	10.0	10.0	10.0	10.0
Loan Period (yrs)	20	20	10	20
Monthly payment	$459	$5,919	$1,322	$7,676
Annual payment	$5,512	$71,025	$15,858	$92,118

RILEY 75,000 T/YR -- EQUIPMENT REQUIREMENTS TABLE 2

Bog preparation equipment, including a Universal Bog Tractor equipped with a screw leveler, a deep miller and a ditcher, a light bulldozer and a 4-wheel drive tractor, will be contracted during site preparation. Other equipment, required to be purchased, follows:

Production Equipment:				
Miller	4	14,751	59,004	
Harrower	3	6,000	18,000	
Ridger	4	4,510	18,040	
Loader	2	23,408	46,816	
Trailer	8	11,142	89,136	
Subtotal: Production Equipment				230,996
Bulldozers and Tractors:				
Bulldozer	1	30,000	30,000	
Tractor,4-wd 60 kw	3	30,000	90,000	
Tractor,4-wd 75-100 kW	16	35,000	560,000	
Subtotal: Bulldozers and Tractors				680,000
Misc. Equipment:				
Hydraulic Excavator	1	120,000	120,000	
Pickup Truck (used)	2	10,000	20,000	
Fire protection wagon (incl. compressor and tractor)	1	50,000	50,000	
Grader	1	10,000	10,000	
Subtotal: Misc. Equipment				$200,000
Total Equipment Cost				1,110,996

RILEY 75,000 T/YR -- PRODUCTION VARIABLES TABLE 3

Capital Expenditure Variables			
Year 1:			$68,000
Year 2:			$876,178
Year 3:			$1,136,389
Year 4:			$0
Year 5:			$0
Production Variables			
No. of acres in production			750
Average no. of tons/acre/harvest			4.54545
No. of harvests/season			22.0
Total tonnage/yr (optimal)			75,000
Annual bog maintenance			$0
Anticipated % of optimal production/yr			
Year 2	0%	Year 6	100
Year 3	50%	Year 7	100
Year 4	90%		
Year 5	100%		
Operating Expense Variables			
Raw Materials ($/ton)			.75
Hourly Labor Base Rate:		$12.00	
Milling	2,160 Hrs.		.35
Harrowing	1,080 Hrs.		.17
Ridging	2,160 Hrs.		.35
Loading	1,440 Hrs.		.23
Transporting	5,760 Hrs.		.92
Stockpiling	1,440 Hrs.		.23
Mech.harvest	0 Hrs.		
Fitting	1,680 Hrs.		.27
Field maint.	840 Hrs.		.52
Total Direct Labor ($/ton)			3.04
Fuel			.86
Equipment rental			.00
Annual Bog Maintenance			.00
Routine equip maint (supplies)			.40
Utilities (annual)			$10,000
Insurance			$40,000
Administrative salaries			$52,000
Loading and other fulltime employees			$86,400
Depreciation: Double Declining Balance Method			
Leasing variables			
Acres leased			750
Rental rate			$5.00

RILEY 75,000 T/YR -- CASH FLOW PROJECTION TABLE 4

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
Capital Expenditures	68,000	876,178	1,136,389	0	0	0	0	0	0	0
Working Capital (including stockpile valuation)	0	0	100,000	100,000	100,000	0	0	0	0	0
Debt Service Reserve	0	0	0	0	0	0	0	0	0	0
Production Rate (tons)	0	0	37,500	67,500	75,000	75,000	75,000	75,000	75,000	75,000
Revenue from Sales	0	0	511,874	921,374	1,023,749	1,023,749	1,023,749	1,023,749	1,023,749	1,023,749
Interest Income from Debt Reserve	0	0	0	0	0	0	0	0	0	0
Total Gross Revenue	0	0	511,874	921,374	1,023,749	1,023,749	1,023,749	1,023,749	1,023,749	1,023,749
Less Operating Costs:										
Cost of Goods Sold	0	0	269,176	456,767	473,770	473,770	473,770	473,770	473,770	473,770
Plant Operation	3,750	70,750	148,950	183,510	192,150	192,150	192,150	192,150	192,150	192,150
Interest Expense -- Loans	4,725	65,518	153,043	159,422	164,639	158,882	152,523	145,497	137,736	129,162
Interest Expense -- Line of Credit	0	0	0	0	0	0	0	0	0	0
Depreciation	0	27,200	366,791	674,630	404,778	241,354	124,119	33,637	0	0
State and Local Taxes	4,941	4,941	4,941	4,941	4,941	4,941	4,941	4,941	4,941	4,941
Net Income Before Federal Taxes	-13,416	-168,409	-431,026	-557,897	-216,530	-47,349	76,246	173,753	215,152	223,726
Tax Loss Computation:										
Net Income subject to offset	0	0	0	0	0	0	76,246	173,753	215,152	223,726
Tax losses from prior periods	0	13,416	181,825	612,851	1,170,748	1,387,277	1,434,626	1,358,380	1,184,627	969,475
Tax losses this period	13,416	168,409	431,026	557,897	216,530	47,349	0	0	0	0
Amount of tax loss applied	0	0	0	0	0	0	76,246	173,753	215,152	223,726
Amount of tax loss carried forward	13,416	181,825	612,851	1,170,748	1,387,277	1,434,626	1,358,380	1,184,627	969,475	745,749
Adjusted Net Income Before Taxes	0	0	0	0	0	0	0	0	0	0
Federal Income Taxes	0	0	0	0	0	0	0	0	0	0
Profits After Taxes	-13,416	-168,409	-431,026	-557,897	-216,530	-47,349	76,246	173,753	215,152	223,726
Total Borrowing -- All Sources	47,600	613,324	895,472	100,000	100,000	0	0	0	0	0
Total Debt Repayments -- All Loans	5,512	76,537	184,513	201,407	219,616	219,616	219,616	219,616	219,616	219,616
Net Cash Flow	-34,604	-415,081	-436,622	74,749	133,272	133,272	133,272	133,272	133,272	133,272
Cumulative Cash Flow (No Int.)	-34,604	-449,685	-886,306	-311,558	-678,286	-545,015	-411,743	-278,472	-145,200	-11,929

	YEAR 11	YEAR 12	YEAR 13	YEAR 14	YEAR 15	YEAR 16	YEAR 17	YEAR 18	YEAR 19	YEAR 20
Capital Expenditures	0	0	0	0	0	0	0	0	0	0
Working Capital (including stockpile valuation)	0	0	0	0	0	0	0	0	0	0
Debt Service Reserve	0	0	0	0	0	0	0	0	0	0
Production Rate (tons)	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000
Revenue from Sales	1,023,749	1,023,749	1,023,749	1,023,749	1,023,749	1,023,749	1,023,749	1,023,749	1,023,749	1,023,749
Interest Income from Debt Reserve	0	0	0	0	0	0	0	0	0	0
Total Gross Revenue	1,023,749	1,023,749	1,023,749	1,023,749	1,023,749	1,023,749	1,023,749	1,023,749	1,023,749	1,023,749
Less Operating Costs:										
Cost of Goods Sold	473,770	473,770	473,770	473,770	473,770	473,770	473,770	473,770	473,770	473,770
Plant Operation	192,150	192,150	192,150	192,150	192,150	192,150	192,150	192,150	192,150	192,150
Interest Expense -- Loans	119,690	109,227	100,069	92,887	84,954	76,189	66,507	55,811	43,994	30,941
Interest Expense -- Line of Credit	0	0	0	0	0	0	0	0	0	0
Depreciation	0	0	0	0	0	0	0	0	0	0
State and Local Taxes	4,941	4,941	4,941	4,941	4,941	4,941	4,941	4,941	4,941	4,941
Net Income Before Federal Taxes	233,197	243,661	252,818	260,000	267,934	276,698	286,381	297,077	308,893	321,947
Tax Loss Computation:										
Net Income subject to offset	233,197	243,661	252,818	260,000	267,934	276,698	286,381	297,077	308,893	321,947
Tax losses from prior periods	745,749	512,552	268,891	16,073	0	0	0	0	0	0
Tax losses this period	0	0	0	0	0	0	0	0	0	0
Amount of tax loss applied	233,197	243,661	252,818	16,073	0	0	0	0	0	0
Amount of tax loss carried forward	512,552	268,891	16,073	0	0	0	0	0	0	0
Adjusted Net Income Before Taxes	0	0	0	243,927	267,934	276,698	286,381	297,077	308,893	321,947
Federal Income Taxes	0	0	0	82,935	91,097	94,077	97,369	101,006	105,024	109,462
Profits After Taxes	233,197	243,661	252,818	177,065	176,836	182,621	189,011	196,071	203,869	212,485
Total Borrowing -- All Sources	0	0	0	0	0	0	0	0	0	0
Total Debt Repayments -- All Loans	219,616	219,616	168,654	168,654	168,654	168,654	168,654	168,654	168,654	168,654
Net Cash Flow	133,272	133,272	184,233	101,298	93,136	90,156	86,864	83,227	79,209	74,771
Cumulative Cash Flow (No Int.)	121,343	254,614	438,847	540,145	633,281	723,436	810,300	893,527	972,736	1,047,507

DCF Return on Investment 10.27%

Selling price (delivered) $13.65

$1.55 per million Btu

LITTLEFORK 50,000 T/YR -- FINANCIAL VARIABLES TABLE 1

Establishment Cost Variables	
Organization & Legal Fees	$40,000
Site Selection	$5,000
Permitting	$13,000
Engineering Survey	$6,800
Bog Preparation	$438,570
Site Development & Utilities	$200,000
Equipment Procurement	$978,700
Total Establishment Cost	$1,682,070

Revenue Variables	
Selling price - primary customer	$16.60 per ton
Selling price - secondary customer	$.00 per ton

Transport Variables	
Transportation rate per ton/mile	.11
Haul distance - primary customer	17.0 miles
Haul distance - secondary customer	10.0 miles
Average load size	23.0 tons

Volume Variables	
Number tons sold - primary customer	100.00 % of prod.
Number tons sold - secondary customer	.00 % of prod.

Financing Variables	Loan 1	Loan 2	Loan 3	Loan 4
Loan Principal	$45,360	$475,249	$100,000	656,840
Interest Rate	10.0	10.0	10.0	10.0
Loan Period (yrs)	20	20	10	20
Monthly payment	$438	$4,586	$1,322	$6,339
Annual payment	$5,253	$55,035	$15,858	$76,064

LITTLEFORK 50,000 T/YR -- EQUIPMENT REQUIREMENTS TABLE 2

Bog preparation equipment, including a Universal Bog Tractor equipped with a screw leveler, a deep miller and a ditcher, a light bulldozer and a 4-wheel drive tractor, will be contracted during site preparation. Other equipment, required to be purchased, follows:

Production Equipment:				
Mechanical harvester	3	26,734	80,202	
Miller	2	14,751	29,502	
Harrower	2	6,000	12,000	
Ridger	2	4,510	9,020	
Loader	1	23,408	23,408	
Trailer	4	11,142	44,568	
Subtotal: Production Equipment				198,700
Bulldozers and Tractors:				
Bulldozer	1	30,000	30,000	
Tractor,4-wd 60 kw	2	30,000	60,000	
Tractor,4-wd 75-100 kW	14	35,000	490,000	
Subtotal: Bulldozers and Tractors				580,000
Misc. Equipment:				
Hydraulic Excavator	1	120,000	120,000	
Pickup Truck (used)	2	10,000	20,000	
Fire protection wagon (incl. compressor and tractor)	1	50,000	50,000	
Grader	1	10,000	10,000	
Subtotal: Misc. Equipment				$200,000
Total Equipment Cost				978,700

LITTLEFORK 50,000 T/YR -- PRODUCTION VARIABLES TABLE 3

Capital Expenditure Variables			
Year 1:			$64,800
Year 2:			$678,928
Year 3:			$938,343
Year 4:			$0
Year 5:			$0
Production Variables			
No. of acres in production			520
Average no. of tons/acre/harvest			4.37063
No. of harvests/season			22.0
Total tonnage/yr (optimal)			50,000
Annual bog maintenance			$0
Anticipated % of optimal production/yr			
Year 2	0%	Year 6	100
Year 3	50%	Year 7	100
Year 4	90%		
Year 5	100%		
Operating Expense Variables			
Raw Materials ($/ton)			.75
Hourly Labor Base Rate:		$12.00	
Milling	1,440 Hrs.		.35
Harrowing	720 Hrs.		.17
Ridging	1,440 Hrs.		.35
Loading	720 Hrs.		.17
Transporting	2,880 Hrs.		.69
Stockpiling	720 Hrs.		.17
Mech.harvest	720 Hrs.		
Fitting	1,680 Hrs.		.40
Field maint.	840 Hrs.		.52
Total Direct Labor ($/ton)			2.83
Fuel			.86
Equipment rental			.00
Annual Bog Maintenance			.00
Routine equip maint (supplies)			.40
Utilities (annual)			$10,000
Insurance			$40,000
Administrative salaries			$52,000
Loading and other fulltime employees			$86,400
Depreciation: Double Declining Balance Method			
Leasing variables			
Acres leased			520
Rental rate			$5.00

LITTLEFORK 50,000 T/YR -- CASH FLOW PROJECTION TABLE 4

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
Capital Expenditures	64,800	678,928	938,343	0	0	0	0	0	0	0
Working Capital (including stockpile valuation)	0	0	100,000	100,000	100,000	0	0	0	0	0
Debt Service Reserve	0	0	0	0	0	0	0	0	0	0
Production Rate (tons)	0	0	25,000	45,000	50,000	50,000	50,000	50,000	50,000	50,000
Revenue from Sales	0	0	415,000	747,000	830,000	830,000	830,000	830,000	830,000	830,000
Interest Income from Debt Reserve	0	0	0	0	0	0	0	0	0	0
Total Gross Revenue	0	0	415,000	747,000	830,000	830,000	830,000	830,000	830,000	830,000
Less Operating Costs:										
Cost of Goods Sold	0	0	186,237	318,232	332,687	332,687	332,687	332,687	332,687	332,687
Plant Operation	2,600	69,600	147,800	182,360	191,000	191,000	191,000	191,000	191,000	191,000
Interest Expense -- Loans	4,502	51,595	125,603	132,492	138,271	133,136	127,463	121,196	114,272	106,624
Interest Expense -- Line of Credit	0	0	5,114	8,582	8,769	8,769	8,769	8,769	8,769	8,769
Depreciation	0	25,920	287,123	547,611	328,566	195,699	101,169	27,775	0	0
State and Local Taxes	3,995	3,995	3,995	3,995	3,995	3,995	3,995	3,995	3,995	3,995
Net Income Before Federal Taxes	-11,097	-151,110	-340,871	-446,271	-173,288	-35,285	64,918	144,579	179,277	186,925
Tax Loss Computation:										
Net Income subject to offset	0	0	0	0	0	0	64,918	144,579	179,277	186,925
Tax losses from prior periods	0	11,097	162,207	503,078	949,349	1,122,637	1,157,922	1,093,005	948,426	769,149
Tax losses this period	11,097	151,110	340,871	446,271	173,288	35,285	0	0	0	0
Amount of tax loss applied	0	0	0	0	0	0	64,918	144,579	179,277	186,925
Amount of tax loss carried forward	11,097	162,207	503,078	949,349	1,122,637	1,157,922	1,093,005	948,426	769,149	582,223
Adjusted Net Income Before Taxes	0	0	0	0	0	0	0	0	0	0
Federal Income Taxes	0	0	0	0	0	0	0	0	0	0
Profits After Taxes	-11,097	-151,110	-340,871	-446,271	-173,288	-35,285	64,918	144,579	179,277	186,925
Total Borrowing -- All Sources	45,360	475,249	756,840	100,000	100,000	0	0	0	0	0
Total Debt Repayments -- All Loans	5,253	60,288	152,210	169,104	187,313	187,313	187,313	187,313	187,313	187,313
Net Cash Flow	-31,288	-337,561	-361,858	64,727	106,236	106,236	106,236	106,236	106,236	106,236
Cumulative Cash Flow (No Int.)	-31,288	-368,849	-730,706	-665,979	-559,743	-453,506	-347,270	-241,033	-134,797	-28,561

	YEAR 11	YEAR 12	YEAR 13	YEAR 14	YEAR 15	YEAR 16	YEAR 17	YEAR 18	YEAR 19	YEAR 20
Capital Expenditures	0	0	0	0	0	0	0	0	0	0
Working Capital (including stockpile valuation)	0	0	0	0	0	0	0	0	0	0
Debt Service Reserve	0	0	0	0	0	0	0	0	0	0
Production Rate (tons)	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Revenue from Sales	830,000	830,000	830,000	830,000	830,000	830,000	830,000	830,000	830,000	830,000
Interest Income from Debt Reserve	0	0	0	0	0	0	0	0	0	0
Total Gross Revenue	830,000	830,000	830,000	830,000	830,000	830,000	830,000	830,000	830,000	830,000
Less Operating Costs:										
Cost of Goods Sold	332,687	332,687	332,687	332,687	332,687	332,687	332,687	332,687	332,687	332,687
Plant Operation	191,000	191,000	191,000	191,000	191,000	191,000	191,000	191,000	191,000	191,000
Interest Expense -- Loans	98,175	88,841	80,931	75,128	68,717	61,635	53,811	45,168	35,620	25,072
Interest Expense -- Line of Credit	8,769	8,769	8,769	8,769	8,769	8,769	8,769	8,769	8,769	8,769
Depreciation	0	0	0	0	0	0	0	0	0	0
State and Local Taxes	3,995	3,995	3,995	3,995	3,995	3,995	3,995	3,995	3,995	3,995
Net Income Before Federal Taxes	195,375	204,709	212,618	218,421	224,832	231,914	239,738	248,381	257,929	268,477
Tax Loss Computation:										
Net Income subject to offset	195,375	204,709	212,618	218,421	224,832	231,914	239,738	248,381	257,929	268,477
Tax losses from prior periods	582,223	386,849	182,140	0	0	0	0	0	0	0
Tax losses this period	0	0	0	0	0	0	0	0	0	0
Amount of tax loss applied	195,375	204,709	182,140	0	0	0	0	0	0	0
Amount of tax loss carried forward	386,849	182,140	0	0	0	0	0	0	0	0
Adjusted Net Income Before Taxes	0	0	30,478	218,421	224,832	231,914	239,738	248,381	257,929	268,477
Federal Income Taxes	0	0	10,363	74,263	76,443	78,851	81,511	84,450	87,696	91,282
Profits After Taxes	195,375	204,709	202,256	144,158	148,389	153,063	158,227	163,932	170,233	177,195
Total Borrowing -- All Sources	0	0	0	0	0	0	0	0	0	0
Total Debt Repayments -- All Loans	187,313	187,313	136,352	136,352	136,352	136,352	136,352	136,352	136,352	136,352
Net Cash Flow	106,236	106,236	146,835	82,935	80,755	78,347	75,687	72,748	69,502	65,916
Cumulative Cash Flow (No Int.)	77,676	183,912	330,747	413,682	494,437	572,784	648,471	721,219	790,721	856,637

DCF Return on Investment 10.05%

Selling price (delivered) $16.60

$1.89 per million Btu

LITTLEFORK 150,000 T/YR -- FINANCIAL VARIABLES TABLE 1

Establishment Cost Variables	
Organization & Legal Fees	$40,000
Site Selection	$5,000
Permitting	$13,000
Engineering Survey	$10,000
Bog Preparation	$1,036,520
Site Development & Utilities	$300,000
Equipment Procurement	$2,070,649
Total Establishment Cost	$3,475,169

Revenue Variables	
Selling price - primary customer	$13.00 per ton
Selling price - secondary customer	$.00 per ton

Transport Variables	
Transportation rate per ton/mile	.11
Haul distance - primary customer	17.0 miles
Haul distance - secondary customer	10.0 miles
Average load size	23.0 tons

Volume Variables	
Number tons sold - primary customer	100.00 % of prod.
Number tons sold - secondary customer	.00 % of prod.

Financing Variables	Loan 1	Loan 2	Loan 3	Loan 4
Loan Principal	$47,600	$876,673	$200,000	1,508,345
Interest Rate	10.0	10.0	10.0	10.0
Loan Period (yrs)	20	20	10	20
Monthly payment	$459	$8,460	$2,643	$14,556
Annual payment	$5,512	$101,521	$31,716	$174,670

LITTLEFORK 150,000 T/YR -- EQUIPMENT REQUIREMENTS TABLE 2

Bog preparation equipment, including a Universal Bog Tractor equipped with a screw leveler, a deep miller and a ditcher, a light bulldozer and a 4-wheel drive tractor, will be contracted during site preparation. Other equipment, required to be purchased, follows:

Production Equipment:				
Miller	7	14,751	103,257	
Harrower	6	6,000	36,000	
Ridger	8	4,510	36,080	
Loader	5	23,408	117,040	
Trailer	16	11,142	178,272	
Subtotal: Production Equipment				470,649
Bulldozers and Tractors:				
Bulldozer	4	30,000	120,000	
Tractor,4-wd 60 kw	6	30,000	180,000	
Tractor,4-wd 75-100 kW	30	35,000	1,050,000	
Subtotal: Bulldozers and Tractors				1,350,000
Misc. Equipment:				
Hydraulic Excavator	1	120,000	120,000	
Pickup Truck (used)	2	10,000	20,000	
Fire protection wagon (incl. compressor and tractor)	2	50,000	100,000	
Grader	1	10,000	10,000	
Subtotal: Misc. Equipment				$250,000
Total Equipment Cost				2,070,649

LITTLEFORK 150,000 T/YR -- PRODUCTION VARIABLES TABLE 3

Capital Expenditure Variables

Year 1:	$68,000
Year 2:	$1,252,390
Year 3:	$2,154,779
Year 4:	$0
Year 5:	$0

Production Variables

No. of acres in production			1448
Average no. of tons/acre/harvest			4.7087
No. of harvests/season			22.0
Total tonnage/yr (optimal)			150,000
Annual bog maintenance			$0
Anticipated % of optimal production/yr			
Year 2	0%	Year 6	100
Year 3	50%	Year 7	100
Year 4	90%		
Year 5	100%		

Operating Expense Variables

Raw Materials ($/ton)			.75
Hourly Labor Base Rate:		$12.00	
Milling	4,320 Hrs.		.35
Harrowing	2,160 Hrs.		.17
Ridging	4,320 Hrs.		.35
Loading	2,880 Hrs.		.23
Transporting	11,520 Hrs.		.92
Stockpiling	2,880 Hrs.		.23
Mech.harvest	0 Hrs.		
Fitting	3,360 Hrs.		.27
Field maint.	2,520 Hrs.		.52
Total Direct Labor ($/ton)			3.04
Fuel			.86
Equipment rental			.00
Annual Bog Maintenance			.00
Routine equip maint (supplies)			.40
Utilities (annual)			$10,000
Insurance			$40,000
Administrative salaries			$65,000
Loading and other fulltime employees			$172,800

Depreciation: Double Declining Balance Method

Leasing variables

Acres leased	1,448
Rental rate	$5.00

LITTLEFORK 150,000 T/YR -- CASH FLOW PROJECTION TABLE 4

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
Capital Expenditures	68,000	1,252,390	2,154,779	0	0	0	0	0	0	0
Working Capital (including stockpile valuation)	0	0	200,000	200,000	200,000	0	0	0	0	0
Debt Service Reserve	0	0	0	0	0	0	0	0	0	0
Production Rate (tons)	0	0	75,000	135,000	150,000	150,000	150,000	150,000	150,000	150,000
Revenue from Sales	0	0	975,002	1,755,004	1,950,005	1,950,005	1,950,005	1,950,005	1,950,005	1,950,005
Interest Income from Debt Reserve	0	0	0	0	0	0	0	0	0	0
Total Gross Revenue	0	0	975,002	1,755,004	1,950,005	1,950,005	1,950,005	1,950,005	1,950,005	1,950,005
Less Operating Costs:										
Cost of Goods Sold	0	0	579,862	988,046	1,030,302	1,030,302	1,030,302	1,030,302	1,030,302	1,030,302
Plant Operation	7,240	87,240	208,640	277,760	295,040	295,040	295,040	295,040	295,040	295,040
Interest Expense -- Loans	4,725	91,656	259,205	272,878	284,321	273,923	262,435	249,745	235,726	220,239
Interest Expense -- Line of Credit	0	0	16,116	26,967	27,488	27,488	27,488	27,488	27,488	27,488
Depreciation	0	27,200	517,276	1,172,277	703,366	420,507	223,244	63,781	0	0
State and Local Taxes	8,254	8,254	8,254	8,254	8,254	8,254	8,254	8,254	8,254	8,254
Net Income Before Federal Taxes	-20,218	-214,350	-614,351	-991,179	-398,767	-105,510	103,242	275,394	353,195	368,682
Tax Loss Computation:										
Net Income subject to offset	0	0	0	0	0	0	103,242	275,394	353,195	368,682
Tax losses from prior periods	0	20,218	234,568	848,919	1,840,098	2,238,865	2,344,374	2,241,133	1,965,739	1,612,544
Tax losses this period	20,218	214,350	614,351	991,179	398,767	105,510	0	0	0	0
Amount of tax loss applied	0	0	0	0	0	0	103,242	275,394	353,195	368,682
Amount of tax loss carried forward	20,218	234,568	848,919	1,840,098	2,238,865	2,344,374	2,241,133	1,965,739	1,612,544	1,243,862
Adjusted Net Income Before Taxes	0	0	0	0	0	0	0	0	0	0
Federal Income Taxes	0	0	0	0	0	0	0	0	0	0
Profits After Taxes	-20,218	-214,350	-614,351	-991,179	-398,767	-105,510	103,242	275,394	353,195	368,682
Total Borrowing -- All Sources	47,600	876,673	1,708,345	200,000	200,000	0	0	0	0	0
Total Debt Repayments -- All Loans	5,512	107,033	313,420	347,209	383,627	383,627	383,627	383,627	383,627	383,627
Net Cash Flow	-41,406	-578,244	-797,723	106,769	205,294	205,294	205,294	205,294	205,294	205,294
Cumulative Cash Flow (No Int.)	-41,406	-619,649	-1,417,373	-1,310,604	-1,105,310	-900,016	-694,722	-489,428	-284,134	-78,840

	YEAR 11	YEAR 12	YEAR 13	YEAR 14	YEAR 15	YEAR 16	YEAR 17	YEAR 18	YEAR 19	YEAR 20
Capital Expenditures	0	0	0	0	0	0	0	0	0	0
Working Capital (including stockpile valuation)	0	0	0	0	0	0	0	0	0	0
Debt Service Reserve	0	0	0	0	0	0	0	0	0	0
Production Rate (tons)	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000
Revenue from Sales	1,950,005	1,950,005	1,950,005	1,950,005	1,950,005	1,950,005	1,950,005	1,950,005	1,950,005	1,950,005
Interest Income from Debt Reserve	0	0	0	0	0	0	0	0	0	0
Total Gross Revenue	1,950,005	1,950,005	1,950,005	1,950,005	1,950,005	1,950,005	1,950,005	1,950,005	1,950,005	1,950,005
Less Operating Costs:										
Cost of Goods Sold	1,030,302	1,030,302	1,030,302	1,030,302	1,030,302	1,030,302	1,030,302	1,030,302	1,030,302	1,030,302
Plant Operation	295,040	295,040	295,040	295,040	295,040	295,040	295,040	295,040	295,040	295,040
Interest Expense -- Loans	203,130	184,229	168,154	156,264	143,128	128,618	112,588	94,879	75,316	53,705
Interest Expense -- Line of Credit	27,488	27,488	27,488	27,488	27,488	27,488	27,488	27,488	27,488	27,488
Depreciation	0	0	0	0	0	0	0	0	0	0
State and Local Taxes	8,254	8,254	8,254	8,254	8,254	8,254	8,254	8,254	8,254	8,254
Net Income Before Federal Taxes	385,791	404,691	420,767	432,657	445,792	460,303	476,333	494,042	513,605	535,216
Tax Loss Computation:										
Net Income subject to offset	385,791	404,691	420,767	432,657	445,792	460,303	476,333	494,042	513,605	535,216
Tax losses from prior periods	1,243,862	858,071	453,380	32,614	0	0	0	0	0	0
Tax losses this period	0	0	0	0	0	0	0	0	0	0
Amount of tax loss applied	385,791	404,691	420,767	32,614	0	0	0	0	0	0
Amount of tax loss carried forward	858,071	453,380	32,614	0	0	0	0	0	0	0
Adjusted Net Income Before Taxes	0	0	0	400,043	445,792	460,303	476,333	494,042	513,605	535,216
Federal Income Taxes	0	0	0	136,015	151,569	156,503	161,953	167,974	174,626	181,973
Profits After Taxes	385,791	404,691	420,767	296,642	294,223	303,800	314,380	326,067	338,979	353,243
Total Borrowing -- All Sources	0	0	0	0	0	0	0	0	0	0
Total Debt Repayments -- All Loans	383,627	383,627	281,704	281,704	281,704	281,704	281,704	281,704	281,704	281,704
Net Cash Flow	205,294	205,294	307,217	171,202	155,648	150,714	145,264	139,243	132,591	125,244
Cumulative Cash Flow (No Int.)	126,454	331,748	638,965	810,167	965,815	1,116,529	1,261,792	1,401,035	1,533,627	1,658,870

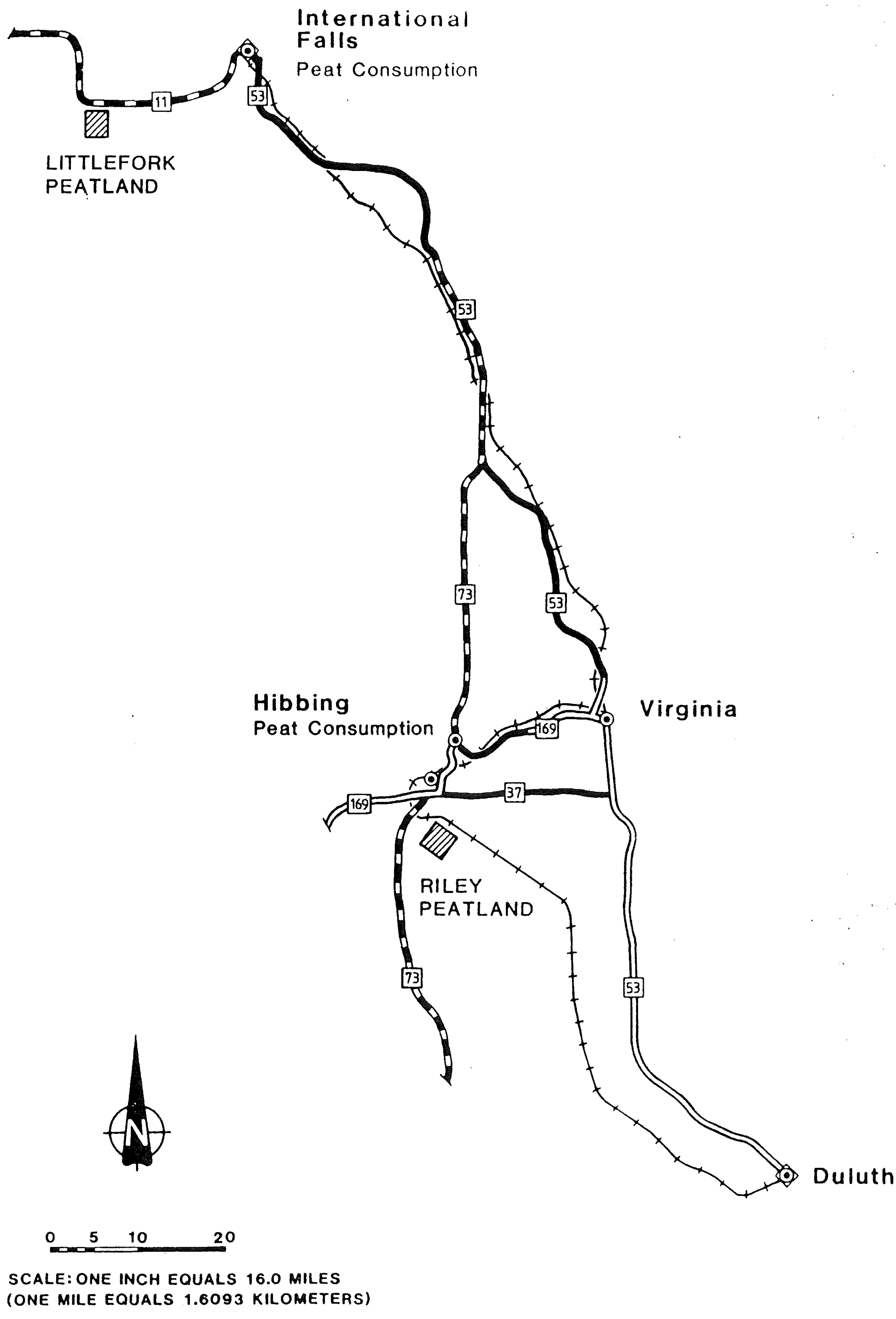
DCF Return on Investment 10.06%

Selling price (delivered) $13.00

$1.48 per million Btu

APPENDIX III

SITE SPECIFIC DATA



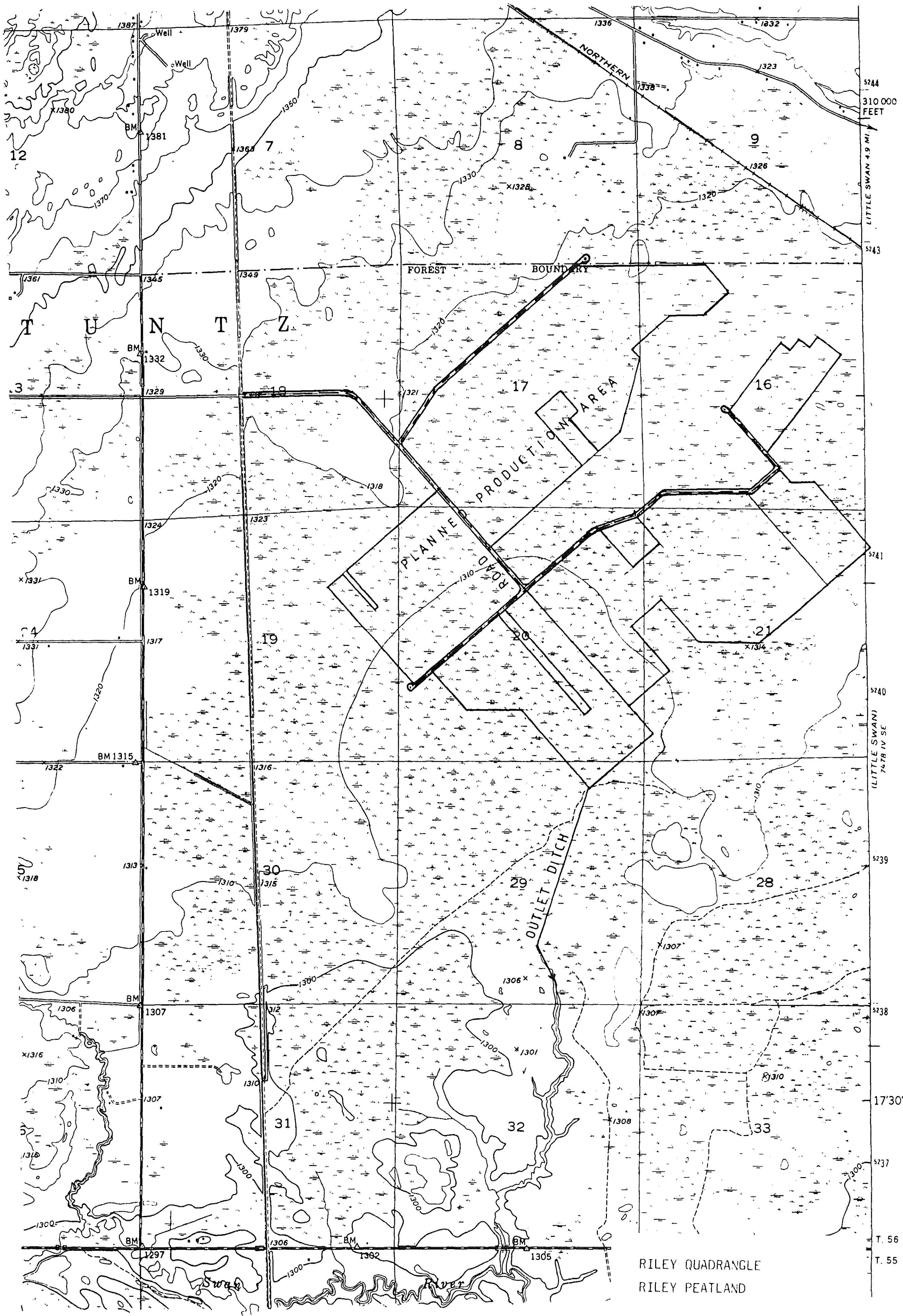
LOCATION OF PEAT PRODUCTION AND RESPECTIVE CONSUMPTION AREAS

Peat quality and quantity

	Volume in situ million m^3	Dry matter mill. tons	Fuel peat at 50 % moisture mill m^3	Energy content of fuel peat MWh/m^3
Riley				
Section 1	5.6	1.4	4.2	0.69
2	2.0	0.6	1.7	0.81
3	1.5	0.4	1.2	0.81
4	3.7	0.8	2.0	0.90
5	0.5	0.1	0.3	0.86
Total	13.3	3.3	9.4	
Littlefork				
Sections 1 to 2	5.5	1.2	3.5	0.71
Sections 3 to 4	8.2	2.0	5.4	0.82
Total	13.7	3.2	8.9	

APPENDIX III. 1.

RILEY



RILEY QUADRANGLE
RILEY PEATLAND

LABORATORY ANALYSIS - RILEY PEATLAND

Site A (A-700-800)

Depth (cm)	Bulk Density (g/cm^3)	Ash Cont. (%)	Btu/lb. (dry peat)	MJ/Kg (dry peat)	Moisture Cont. (%)
15-30	0.05	8.9	8347	19.4	94.4
30-45	0.09	10.4	8064	18.8	93.2
45-60	0.09	11.7	7595	17.7	89.6
60-75	0.09	11.2	8067	18.8	88.4
75-90	0.12	12.2	7405	17.2	87.0
90-105	0.13	10.7	8298	19.3	87.4
105-120	0.17	13.5	8179	19.0	84.4
120-135	0.18	14.6	8084	18.8	83.4
135-150	0.18	16.5	8060	18.7	83.6
150-165	0.19	18.5	7767	18.1	83.0
165-180	0.18	15.0	8199	19.1	83.3
180-195	0.16	14.6	8322	19.4	84.9

Site B (A + 800-1600)

Depth (cm)	Bulk Density (g/cm^3)	Ash Cont. (%)	Btu/lb. (dry peat)	MJ/Kg (dry peat)	Moisture Cont. (%)
15-30	0.13	9.7	9080	21.1	91.8
30-45	0.07	8.4	9394	21.8	89.8
45-60	0.09	7.5	9884	23.0	89.3
60-75	0.10	7.5	8066	18.8	88.7
75-90	0.10	7.5	9360	21.8	89.0
90-105	0.11	9.4	9341	21.7	88.5
105-120	0.09	6.9	9313	21.7	90.3
120-135	0.13	12.5	8468	19.7	87.5
135-150	0.13	10.1	9146	21.3	87.5
150-165	0.13	8.6	9180	21.3	87.7
165-180	0.16	14.0	8720	20.3	85.4
180-195	0.16	16.9	8407	19.6	84.6

ASH FUSION ANALYSIS*

Depth (cm)	Initial Deformation Temp. (°F)	Softening Temp. (°F)	Hemispherical Temp. (°F)	Fluid Temp. (°F)
25-50	2180	2280	2320	2480
85-105	2160	2230	2260	2380
135-155	2170	2240	2280	2410

* Samples from sites A and B were combined for this analysis.

RILEY PEATLAND - PROFILE DESCRIPTIONS

Site 1 (A+800-1500)

DEPTH (CM)	DEGREE OF DECOMPOSITION	BOTANICAL ORIGIN
30	H4/H5	$(L)C_2Dg_4$
50	H4/H5	$L_1C_1Dg_4$
60	H4	$(S)L_1C_2Dg_3$
90	H4/H5	C_3Dg_3
90+	Peat	No samples taken
230+	Bottom	Sand

Site 2 (A+700-2000)

DEPTH (CM)	DEGREE OF DECOMPOSITION	BOTANICAL ORIGIN
30	H4/H5	$(L)C_2Dg_4$
70	H5	$(C)L_2Dg_4$
90	H6	L_2Dg_4
130	H7	L_2Dg_4
150	H5 dry rub	$C_1L_2Dg_3$
170	H5 dry rub	$(L)C_2Dg_4$
190	H7 dry rub	L_1Dg_5
190+	Peat	No samples taken
240+	Bottom	Sand

Site 3 (A+500-2400)

DEPTH (CM)	DEGREE OF DECOMPOSITION	BOTANICAL ORIGIN
0- 60	H4/H5	$C_1L_1Dg_4$
60-150	H5	$(EqL)C_1Dg_5$
150-200	H7	$(LC)Dg_6$
200-250	H6	$(L)C_1Dg_5$
250+	Bottom	Sand

Site 4 (A-450-2800)

DEPTH (CM)	DEGREE OF DECOMPOSITION	BOTANICAL ORIGIN
0- 80	H5 dry rub	$(C)L_1Dg_5$
80-100	H5 dry rub	$(EqC)L_2Dg_4$
100-160	H5 dry rub	$L_1C_1Dg_4$
160-220	H6	$(LCEq)Dg_6$
220-250	H8	$(C)Dg_6$
250+	Bottom Unknown	

VAPO CO. LTD. RESEARCH
PRMSS II

PRODUCTION FORECAST
09/22/86

District: Nothern Minnesota
Site name: Riley Peatland
Site code: 3002 Subsite code: 01

GENERAL INFORMATION
Survey year: 1986
1st production year: 1987
Termination of lease: 9999
Status of landuse: MP
Produces after survey: 0 (cu-m)**

SUBSITE PRODUCTION FORECAST

YEAR	PREDICTED VOLUME** (cu-m)	PROD. ENERGY (MWh)	ENERGY CONTENT ** (MWh/cu-m)	PROD. AREA (ha)	OUTMINED AREA (ha/a)	ANNUAL PROD. RATE ** (cu-m/ha/a)
1987	128040	86886	0.68	194.0	0.0	660.00
1988	128040	86886	0.68	194.0	0.0	660.00
1989	128040	86886	0.68	194.0	0.0	660.00
1990	128040	85677	0.67	194.0	0.0	660.00
1991	128040	84735	0.66	194.0	0.0	660.00
1992	128040	84735	0.66	194.0	0.0	660.00
1993	128040	84735	0.66	194.0	0.0	660.00
1994	128040	84735	0.66	194.0	0.0	660.00
1995	128021	86413	0.67	194.0	0.1	660.00
1996	127815	88907	0.70	193.9	0.4	660.00
1997	127562	88731	0.70	193.5	0.4	660.00
1998	127309	88555	0.70	193.1	0.4	660.00
1999	127056	88380	0.70	192.7	0.4	660.00
2000	126803	88204	0.70	192.3	0.4	660.00
2001	126550	88028	0.70	191.9	0.4	660.00
2002	126298	87852	0.70	191.6	0.4	660.00
2003	126045	87676	0.70	191.2	0.4	660.00
2004	125792	87500	0.70	190.8	0.4	660.00
2005	125539	87324	0.70	190.4	0.4	660.00
2006	125286	87148	0.70	190.0	0.4	660.00
2007	125033	86972	0.70	189.6	0.4	660.00
2008	124780	86797	0.70	189.3	0.4	660.00
2009	124528	86621	0.70	188.9	0.4	660.00
2010	124275	86445	0.70	188.5	0.4	660.00
2011	122319	85085	0.70	188.1	7.5	660.00
TOTAL	3165332	2171913	0.69	181	13	

** (cu-m) = Plant door cubic meters

VAPO CO. LTD. RESEARCH
PRMSS II

PRODUCTION FORECAST
09/22/86

District: Nothern Minnesota
Site name: Riley Peatland
Site code: 3002 Subsite code: 02

GENERAL INFORMATION
Survey year: 1986
1st production year: 1987
Termination of lease: 9999
Status of landuse: MP
Produces after survey: 0 (cu-m)**

SUBSITE PRODUCTION FORECAST

YEAR	PREDICTED VOLUME** (cu-m)	PROD. ENERGY (MWh)	ENERGY CONTENT ** (MWh/cu-m)	PROD. AREA (ha)	OUTMINED AREA (ha/a)	ANNUAL PROD. RATE ** (cu-m/ha/a)
1987	54780	44272	0.81	83.0	0.0	660.00
1988	54780	44272	0.81	83.0	0.0	660.00
1989	54780	44272	0.81	83.0	0.0	660.00
1990	54780	44272	0.81	83.0	0.0	660.00
1991	54780	44272	0.81	83.0	0.0	660.00
1992	54780	44272	0.81	83.0	0.0	660.00
1993	54780	44272	0.81	83.0	0.0	660.00
1994	54780	44272	0.81	83.0	0.0	660.00
1995	54780	44272	0.81	83.0	0.0	660.00
1996	54780	44272	0.81	83.0	0.0	660.00
1997	54780	44272	0.81	83.0	0.0	660.00
1998	54780	44272	0.81	83.0	0.0	660.00
1999	54780	44272	0.81	83.0	0.0	660.00
2000	54780	44272	0.81	83.0	0.0	660.00
2001	54766	44261	0.81	83.0	0.2	660.00
2002	54434	43992	0.81	82.8	0.7	660.00
2003	53966	43614	0.81	82.1	0.7	660.00
2004	53499	43237	0.81	81.4	0.7	660.00
2005	53031	42859	0.81	80.7	0.7	660.00
2006	52564	42481	0.81	80.0	0.7	660.00
2007	52096	42103	0.81	79.3	0.7	660.00
2008	51629	41725	0.81	78.6	0.7	660.00
2009	51161	41348	0.81	77.9	0.7	660.00
2010	50694	40970	0.81	77.2	0.7	660.00
2011	50226	40592	0.81	76.5	0.7	660.00
TOTAL	1344987	1086992	0.81	76	7	

** (cu-m) = Plant door cubic meters

VAPO CO. LTD. RESEARCH
PRMSS II

PRODUCTION FORECAST
09/22/86

District: Nothern Minnesota
Site name: Riley Peatland
Site code: 3002 Subsite code: 03

GENERAL INFORMATION
Survey year: 1986
1st production year: 1987
Termination of lease: 9999
Status of landuse: MP
Produces after survey: 0 (cu-m)**

SUBSITE PRODUCTION FORECAST

YEAR	PREDICTED VOLUME** (cu-m)	PROD. ENERGY (MWh)	ENERGY CONTENT** (MWh/cu-m)	PROD. AREA (ha)	OUTMINED AREA (ha/a)	ANNUAL PROD. RATE** (cu-m/ha/a)
1987	40920	33071	0.81	62.0	0.0	660.00
1988	40920	33071	0.81	62.0	0.0	660.00
1989	40920	33071	0.81	62.0	0.0	660.00
1990	40920	33071	0.81	62.0	0.0	660.00
1991	40920	33071	0.81	62.0	0.0	660.00
1992	40920	33071	0.81	62.0	0.0	660.00
1993	40920	33071	0.81	62.0	0.0	660.00
1994	40920	33071	0.81	62.0	0.0	660.00
1995	40920	33071	0.81	62.0	0.0	660.00
1996	40920	33071	0.81	62.0	0.0	660.00
1997	40920	33071	0.81	62.0	0.0	660.00
1998	40920	33071	0.81	62.0	0.0	660.00
1999	40920	33071	0.81	62.0	0.0	660.00
2000	40920	33071	0.81	62.0	0.0	660.00
2001	40909	33062	0.81	62.0	0.1	660.00
2002	40642	32846	0.81	61.9	0.6	660.00
2003	40267	32543	0.81	61.3	0.6	660.00
2004	39891	32239	0.81	60.7	0.6	660.00
2005	39516	31936	0.81	60.2	0.6	660.00
2006	39141	31633	0.81	59.6	0.6	660.00
2007	38766	31330	0.81	59.0	0.6	660.00
2008	38390	31026	0.81	58.5	0.6	660.00
2009	38015	30723	0.81	57.9	0.6	660.00
2010	37640	30420	0.81	57.3	0.6	660.00
2011	37264	30116	0.81	56.7	0.6	660.00
TOTAL	1003322	810865	0.81	56	6	

** (cu-m) = Plant door cubic meters

VAPO CO. LTD. RESEARCH
PRMSS II

PRODUCTION FORECAST
09/22/86

District: Nothern Minnesota
Site name: Riley Peatland
Site code: 3002 Subsite code: 04

GENERAL INFORMATION
Survey year: 1986
1st production year: 1987
Termination of lease: 9999
Status of landuse: MP
Produces after survey: 0 (cu-m)**

SUBSITE PRODUCTION FORECAST

YEAR	PREDICTED VOLUME** (cu-m)	PROD. ENERGY (MWh)	ENERGY CONTENT** (MWh/cu-m)	PROD. AREA (ha)	OUTMINED AREA (ha/a)	ANNUAL PROD. RATE** (cu-m/ha/a)
1987	102960	100128	0.97	156.0	0.0	660.00
1988	102960	100128	0.97	156.0	0.0	660.00
1989	102960	100128	0.97	156.0	0.0	660.00
1990	102960	100128	0.97	156.0	0.0	660.00
1991	102960	99907	0.97	156.0	0.0	660.00
1992	102960	92973	0.90	156.0	0.0	660.00
1993	102960	92973	0.90	156.0	0.0	660.00
1994	102960	92973	0.90	156.0	0.0	660.00
1995	102960	92973	0.90	156.0	0.0	660.00
1996	102960	92973	0.90	156.0	0.0	660.00
1997	102322	88332	0.86	156.0	2.2	660.00
1998	100704	86414	0.86	153.8	2.5	660.00
1999	99076	85017	0.86	151.3	2.5	660.00
2000	97448	83620	0.86	148.9	2.5	660.00
2001	95820	82223	0.86	146.4	2.5	660.00
2002	94192	80826	0.86	143.9	2.5	660.00
2003	92564	79429	0.86	141.5	2.5	660.00
2004	90936	78032	0.86	139.0	2.5	660.00
2005	89308	76635	0.86	136.5	2.5	660.00
2006	87528	75107	0.86	134.1	5.4	660.00
2007	51107	43855	0.86	128.7	128.7	660.00
2008	0	0	0.00	0.0	0.0	0.00
2009	0	0	0.00	0.0	0.0	0.00
2010	0	0	0.00	0.0	0.0	0.00
2011	0	0	0.00	0.0	0.0	0.00
TOTAI	2030606	1824775	0.90	0	156	

** (cu-m) = Plant door cubic meters

VAPO CO. LTD. RESEARCH
PRMSS II

PRODUCTION FORECAST
09/22/86

District: Nothern Minnesota
Site name: Riley Peatland
Site code: 3002 Subsite code: 05

GENERAL INFORMATION
Survey year: 1986
1st production year: 1987
Termination of lease: 9999
Status of landuse: MP
Produces after survey: 0 (cu-m)**

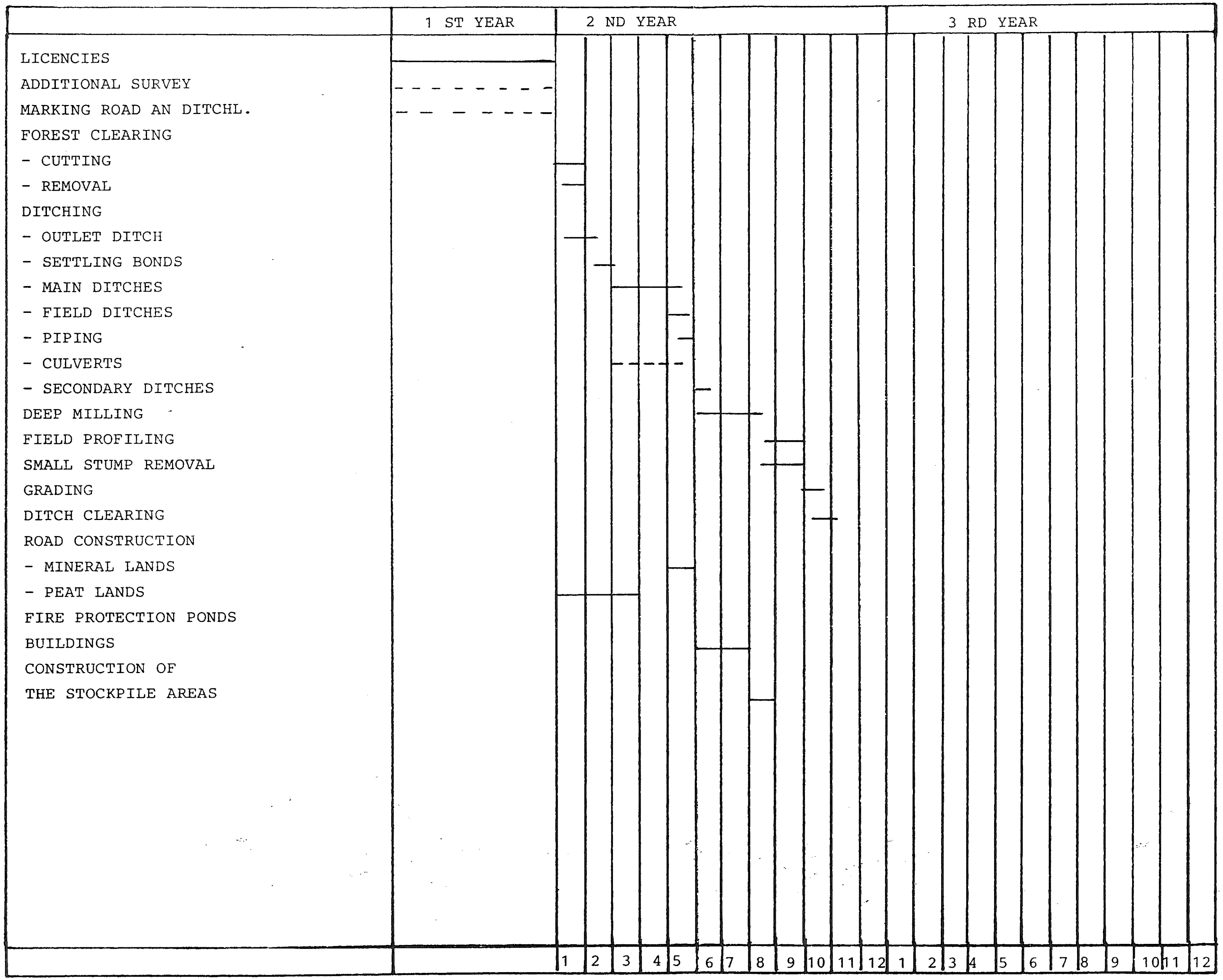
SUBSITE PRODUCTION FORECAST

YEAR	PREDICTED VOLUME** (cu-m)	PROD. ENERGY (MWh)	ENERGY CONTENT ** (MWh/cu-m)	PROD. AREA (ha)	OUTMINED AREA (ha/a)	ANNUAL PROD. RATE ** (cu-m/ha/a)
1987	17820	15291	0.86	27.0	0.0	660.00
1988	17820	15291	0.86	27.0	0.0	660.00
1989	17820	15291	0.86	27.0	0.0	660.00
1990	17820	15291	0.86	27.0	0.0	660.00
1991	17820	15291	0.86	27.0	0.0	660.00
1992	17820	15291	0.86	27.0	0.0	660.00
1993	17820	15291	0.86	27.0	0.0	660.00
1994	17820	15291	0.86	27.0	0.0	660.00
1995	17820	15291	0.86	27.0	0.0	660.00
1996	17820	15291	0.86	27.0	0.0	660.00
1997	17757	15237	0.86	27.0	0.4	660.00
1998	17245	14798	0.86	26.6	0.9	660.00
1999	16646	14284	0.86	25.7	0.9	660.00
2000	16047	13770	0.86	24.8	0.9	660.00
2001	15448	13256	0.86	23.9	0.9	660.00
2002	14849	12742	0.86	23.0	0.9	660.00
2003	14250	12228	0.86	22.0	0.9	660.00
2004	4779	4101	0.86	21.1	21.1	660.00
2005	0	0	0.00	0.0	0.0	0.00
2006	0	0	0.00	0.0	0.0	0.00
2007	0	0	0.00	0.0	0.0	0.00
2008	0	0	0.00	0.0	0.0	0.00
2009	0	0	0.00	0.0	0.0	0.00
2010	0	0	0.00	0.0	0.0	0.00
2011	0	0	0.00	0.0	0.0	0.00
TOTAL	295222	253330	0.86	0	27	

** (cu-m) = Plant door cubic meters

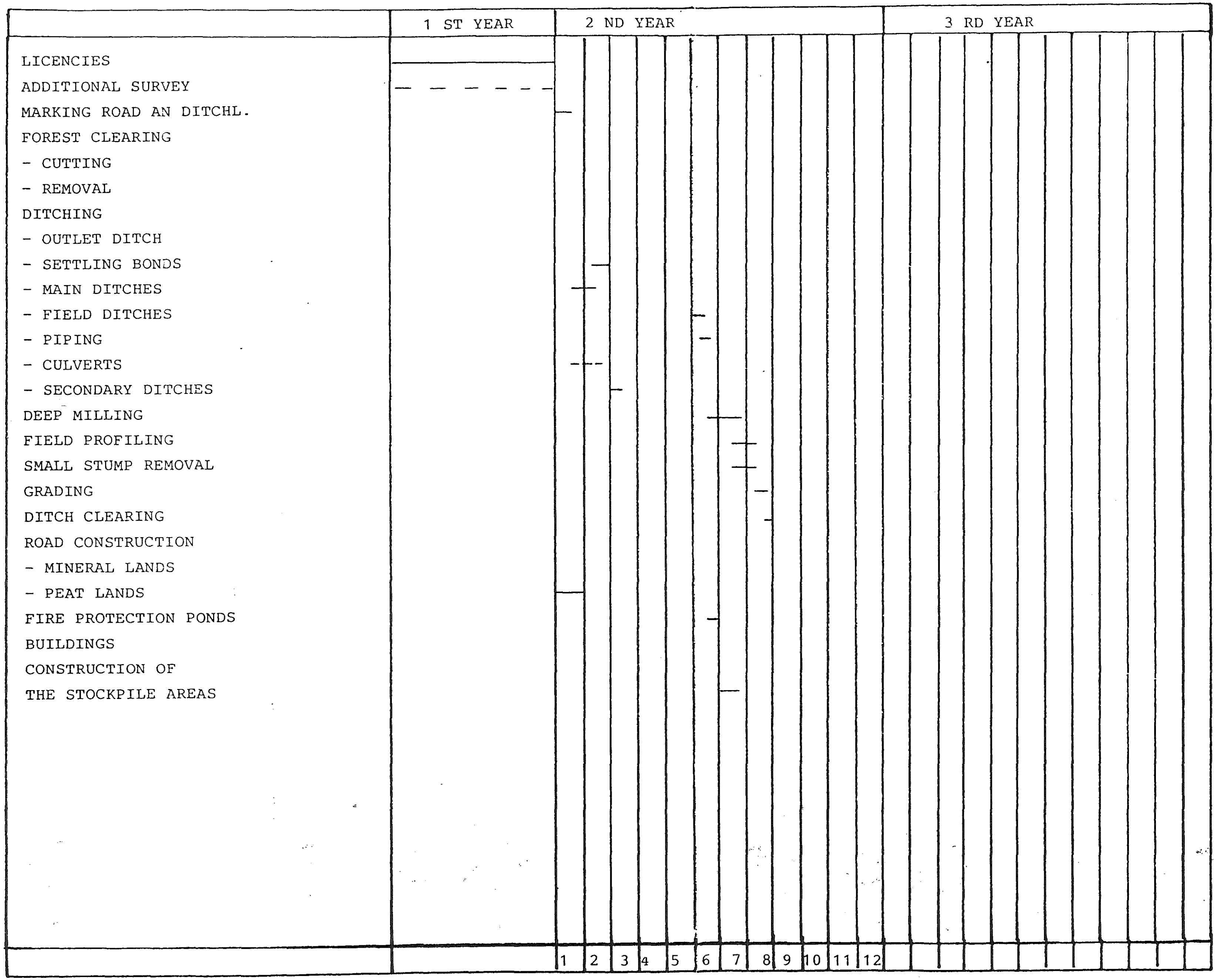
RILEY PEATLAND 215 HA

SCHEDULE



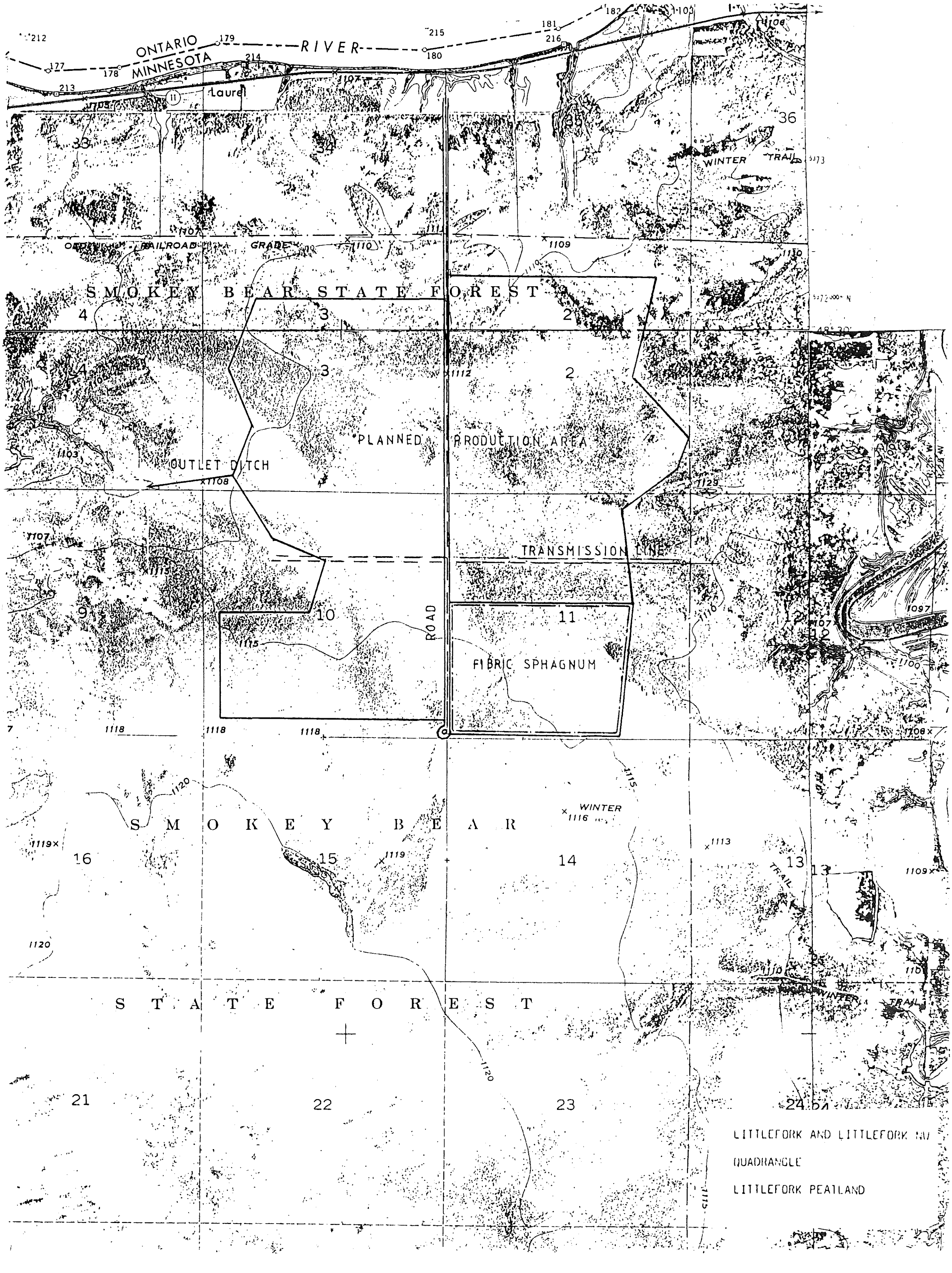
RILEY PEATLAND 300 HA

SCHEDULE



APPENDIX III.2.

LITTLEFORK



LITTLEFORK AND LITTLEFORK NW
QUADRANGLE
LITTLEFORK PEATLAND

LABORATORY ANALYSIS - LITTLEFORK NW PEATLAND

Site A (A-1800-400)

Depth (cm)	Bulk Density (g/cc)	Ash Cont. (%)	Btu/lb. (dry peat)	MJ/Kg (dry peat)	Moisture Cont. (%)	Sulfur (%)
5-20	0.06	7.8	8240	19.2	91.1	0.2
20-35	0.11	9.1	8332	19.4	87.9	0.2
35-50	0.16	8.3	8384	19.5	83.7	0.2
50-65	0.15	5.7	8706	20.2	85.1	0.2
65-80	0.17	7.6	8550	19.9	84.5	0.2
80-95	0.15	7.5	8366	19.5	85.7	0.2
95-110	0.17	9.2	8183	19.0	84.5	0.4
110-125	0.16	7.6	8342	19.4	85.1	0.9
115-130	0.16	6.7	8565	19.9	85.4	1.0
130-145	0.16	7.7	8452	19.7	85.1	1.2
145-160	0.17	9.1	7316	17.0	85.0	1.3

Site B (A0-2200)

Depth (cm)	Bulk Density (g/cc)	Ash Cont. (%)	Btu/lb. (dry peat)	MJ/Kg (dry peat)	Moisture Cont. (%)	Sulfur (%)
0-15	0.04	5.1	7517	17.5	93.0	1.0
15-30	0.08	6.5	7805	18.2	90.2	0.2
30-45	0.09	5.8	8074	18.8	89.7	0.2
45-60	0.10	3.5	8125	18.9	89.6	0.2
60-75	0.10	5.0	8289	19.3	90.1	0.3
75-90	0.10	6.0	8516	19.8	89.9	0.4
90-105	0.11	8.5	8413	19.6	89.1	0.3
105-120	0.14	10.7	7205	16.8	87.5	0.2
120-135	0.11	7.7	7903	18.4	89.1	0.2
135-150	0.09	7.0	7801	18.1	90.6	0.2
150-165	0.09	6.6	7578	17.6	90.6	0.2
165-180	0.11	6.9	8120	18.9	89.4	0.3
180-195	0.15	9.9	7825	18.2	86.1	0.2

ASH FUSION ANALYSIS*

Depth (cm)	Initial Deformation Temp. (°F)	Softening Temp. (°F)	Hemispherical Temp. (°F)	Fluid Temp. (°F)
0-30	2100	2160	2430	2640
30-60	2140	2210	2250	2310
60-90	2180	2260	2290	2320

* Samples from sites A and B were combined for this analysis.

LITTLEFORK NW PEATLAND - PROFILE DESCRIPTIONS

Sample Site A (A-1800-1400)

DEPTH (CM)	DEGREE OF DECOMPOSITION	BOTANICAL ORIGIN
0-15	H2	$(C)S_6$
15-40	H4/H5	$(L)C_1S_1Dg_4$
40-125	H5	$(CS)L_2Dg_4$
125-160	H4	C_3Dg_3
160-185	H6	C_1Dg_5
185+	Bottom	Silty Clay

Peat fuel quality: 0-15 cm poor; 125-160 cm fair; rest is good quality.

Sample Site B (A±0-2200)

DEPTH (CM)	DEGREE OF DECOMPOSITION	BOTANICAL ORIGIN
0-50	H4	Dg_2S_4
50-90	H4/H5	$S_1C_1Dg_4$
90-160	H5	$(S)L_1Dg_5$
160-200	H5	$(S)L_2Dg_4$
200+	Bu	

Peat fuel quality: fair (marginal) 0-50 cm; good quality below.

LITTLEFORK NW PEATLAND - PROFILE DESCRIPTIONS

Site 1 (A-800-600)

DEPTH (CM)	DEGREE OF DECOMPOSITION	BOTANICAL ORIGIN
0-35	H2	S_6
35-75	H4	$(L,C)S_3Dg_3$
75-100	H6	$S_1L_1Dg_4$
100-200	H6	L_1Dg_5
200+	Bu	

Peat fuel quality: 35 cm fibric cap; 35-75 cm marginal fuel quality; below 75 cm good fuel quality.

Site 2 (A+600-1000)

DEPTH (CM)	DEGREE OF DECOMPOSITION	BOTANICAL ORIGIN
0-25	H3	$(C)S_6$
25-60	H4/H5	$(SN)C_2Dg_4$
60-85	H5/H6	$(L)C_1Dg_5$
85-140	H7	$(C)L_2Dg_4$
140-165	H6	$(C)L_2Dg_4$
165-180	H6	$(C)L_1Dg_5$
180+	B	Clay

Peat fuel quality: good below 25 cm fibric cap.

Site 3 (A-1000-1800)

DEPTH (CM)	DEGREE OF DECOMPOSITION	BOTANICAL ORIGIN
0-25	H3	Dg_1S_5
25-90	H6	$(SLC)Dg_6$
90-130	H5/H6	C_1Dg_5
130-170	H5	$(S)(C)L_2Dg_4$
170-200	H4 dry rub	$S_1L_2Dg_3$
200+	Bu	

Peat fuel quality: good below 25 cm fibric cap.

LITTLEFORK NW PEATLAND - PROFILE DESCRIPTIONS

Site 4 (A-1400-3000)

DEPTH (CM)	DEGREE OF DECOMPOSITION	BOTANICAL ORIGIN
0-20	H2	$(NC)S_6$
20-55	H4/H5	$(N)C_1S_2Dg_3$
55-70	H5	$C_1S_1Dg_4$
70-105	H6	$(LS)C_2Dg_4$
105-150	H6	$(S)L_1C_1Dg_4$
150-200	H7	$(SC)L_2Dg_4$
200+	Bu	

Peat fuel quality: good below 20 cm fibric cap.

Site 5 (A-200-2600)

DEPTH (CM)	DEGREE OF DECOMPOSITION	BOTANICAL ORIGIN
0-40	H3	$(C)Dg_2S_4$
40-75	H5	$(C)(L)S_2Dg_4$
75-170	H3/H4	$(C)(L)Dg_2S_4$
170-200	H4/H5	$(C)L_1S_2Dg_3$
200+	Bu	

Peat fuel quality: Poor except 40-75 cm.

Site 6 (A±0-2600)

DEPTH (CM)	DEGREE OF DECOMPOSITION	BOTANICAL ORIGIN
0-30	H3/H4	$(C)S_3Dg_3$
30-45	H4/H5	$S_1C_1Dg_4$
45-95	H4	$(N)(C)S_3Dg_3$
95-125	H3	$(N)(C)Dg_2S_4$
125-160	H5	$(S)L_2Dg_4$
160-180	H2	$(Dg)S_6$
180-200	H5	$(S)L_2Dg_4$
200+	Bu	

Peat fuel quality: generally poor throughout profile.

LITTLEFORK NW PEATLAND - PROFILE DESCRIPTIONS

Site 7 (A+200-2600)

DEPTH (CM)	DEGREE OF DECOMPOSITION	BOTANICAL ORIGIN
0-25	H2/H3	Dg_2S_4
25-45	H5	$(N)(C)S_1Dg_5$
45-55	H2/H3	Dg_2S_4
55-70	H4/H5	$(L)S_1C_1Dg_4$
70-105	H5	$S_1C_1Dg_4$
105-200	H2/H3	$(L)Dg_2S_4$
200+	Bu	

Peat fuel quality: Generally is poor except for few small layers.

Site 8 (A+400-2600)

DEPTH (CM)	DEGREE OF DECOMPOSITION	BOTANICAL ORIGIN
0-20	H2/H3	Dg_1S_5
20-100	H3	Dg_2S_4
100-200	H4 dry rub	$S_1L_2Dg_3$
200+	Bu	

Peat fuel quality: poor throughout profile.

Site 9 (A-200-3000)

DEPTH (CM)	DEGREE OF DECOMPOSITION	BOTANICAL ORIGIN
0-40	H3	$C_1Dg_1S_4$
40-70	H5	$C_1S_2Dg_3$
70-90	H4	$C_1Dg_2S_3$
90-125	H5	$C_1S_1Dg_4$
125-170	H3/H4	$(N)(C)Dg_3S_3$
170-200	H2	$(C)Dg_1S_5$
200+	Bu	

Peat fuel quality: Generally is poor except for 40-70 cm and 90-125 cm.

LITTLEFORK NW PEATLAND - PROFILE DESCRIPTIONS

Site 10 (A0-3000)

DEPTH (CM)	DEGREE OF DECOMPOSITION	BOTANICAL ORIGIN
0-40	H3	$(C)Dg_1S_5$
40-50	H4/H5	S_2Dg_4
50-125	H5	$(S)(L)C_1Dg_5$
125-150	H3	$(LC)Dg_1S_5$
150-200	H4	$(L)Dg_2S_4$
200+	Bu	

Peat fuel quality: Good between 40-125 cm, undecomposed sphagnum above and below.

Site 11 (A+200-3000)

DEPTH (CM)	DEGREE OF DECOMPOSITION	BOTANICAL ORIGIN
0-40	H3	$(C)Dg_1S_5$
40-75	H4	$(C)(L)Dg_3S_3$
75-90	H5/H6	S_1Dg_5
90-100	H3/H4	Dg_1S_5
100-115	H5 dry rub	$(S)C_1L_1Dg_4$
115-140	H3/H4	$(LC)Dg_2S_4$
140-200	H3	$(L)Dg_1S_5$
200+	Bu	

Peat fuel quality: Generally poor - mostly undecomposed sphagnum.

Site 12 (A+400-3000)

DEPTH (CM)	DEGREE OF DECOMPOSITION	BOTANICAL ORIGIN
0-40	H2/H3	$(CDg)S_6$
40-65	H5	$(CL)S_1Dg_5$
65-90	H4/H5	$(LC)S_3Dg_3$
90-100	H6	S_1Dg_5
100-180	H3	$(CL)Dg_1S_5$
180-200	H3/H4	$L_1Dg_1S_4$
200+	Bu	

Peat fuel quality: Poor - mostly fibric sphagnum except is good quality between 40-100 cm.

VAPO CO. LTD. RESEARCH
PRMSS II

PRODUCTION FORECAST
09/22/86

District: Nothern Minnesota
Site name: Littlefork
Site code: 3003 Subsite code: 01

GENERAL INFORMATION
Survey year: 1986
1st production year: 1987
Termination of lease: 9999
Status of landuse: MP
Produces after survey: 0 (cu-m)**

SUBSITE PRODUCTION FORECAST

YEAR	PREDICTED VOLUME** (cu-m)	PROD. ENERGY (MWh)	ENERGY CONTENT ** (MWh/cu-m)	PROD. AREA (ha)	OUTMINED AREA (ha/a)	ANNUAL PROD. RATE ** (cu-m/ha/a)
1987	165000	132843	0.81	250.0	0.0	660.00
1988	165000	132843	0.81	250.0	0.0	660.00
1989	165000	132843	0.81	250.0	0.0	660.00
1990	165000	132843	0.81	250.0	0.0	660.00
1991	165000	132843	0.81	250.0	0.0	660.00
1992	165000	135438	0.82	250.0	0.0	660.00
1993	165000	140023	0.85	250.0	0.0	660.00
1994	165000	140023	0.85	250.0	0.0	660.00
1995	165000	140023	0.85	250.0	0.0	660.00
1996	165000	140023	0.85	250.0	0.0	660.00
1997	165000	140023	0.85	250.0	0.0	660.00
1998	163679	135896	0.83	250.0	6.1	660.00
1999	157910	129569	0.82	243.9	9.3	660.00
2000	151779	124538	0.82	234.6	9.3	660.00
2001	145648	119508	0.82	225.3	9.3	660.00
2002	139518	114477	0.82	216.0	9.3	660.00
2003	133387	109446	0.82	206.7	9.3	660.00
2004	127256	104416	0.82	197.5	9.3	660.00
2005	121125	99385	0.82	188.2	9.3	660.00
2006	114994	94355	0.82	178.9	9.3	660.00
2007	108863	89324	0.82	169.6	9.3	660.00
2008	100440	82413	0.82	160.3	22.2	660.00
2009	80125	65744	0.82	138.1	33.4	660.00
2010	58109	47680	0.82	104.7	33.4	660.00
2011	36093	29615	0.82	71.4	33.4	660.00
TOTAL	3453925	2846136	0.82	38	212	

** (cu-m) = Plant door cubic meters

VAPO CO. LTD. RESEARCH
PRMSS II

PRODUCTION FORECAST
09/22/86

District: Nothern Minnesota
Site name: Littlefork
Site code: 3003 Subsite code: 02

GENERAL INFORMATION
Survey year: 1986
1st production year: 1987
Termination of lease: 9999
Status of landuse: MP
Produces after survey: 0 (cu-m)**

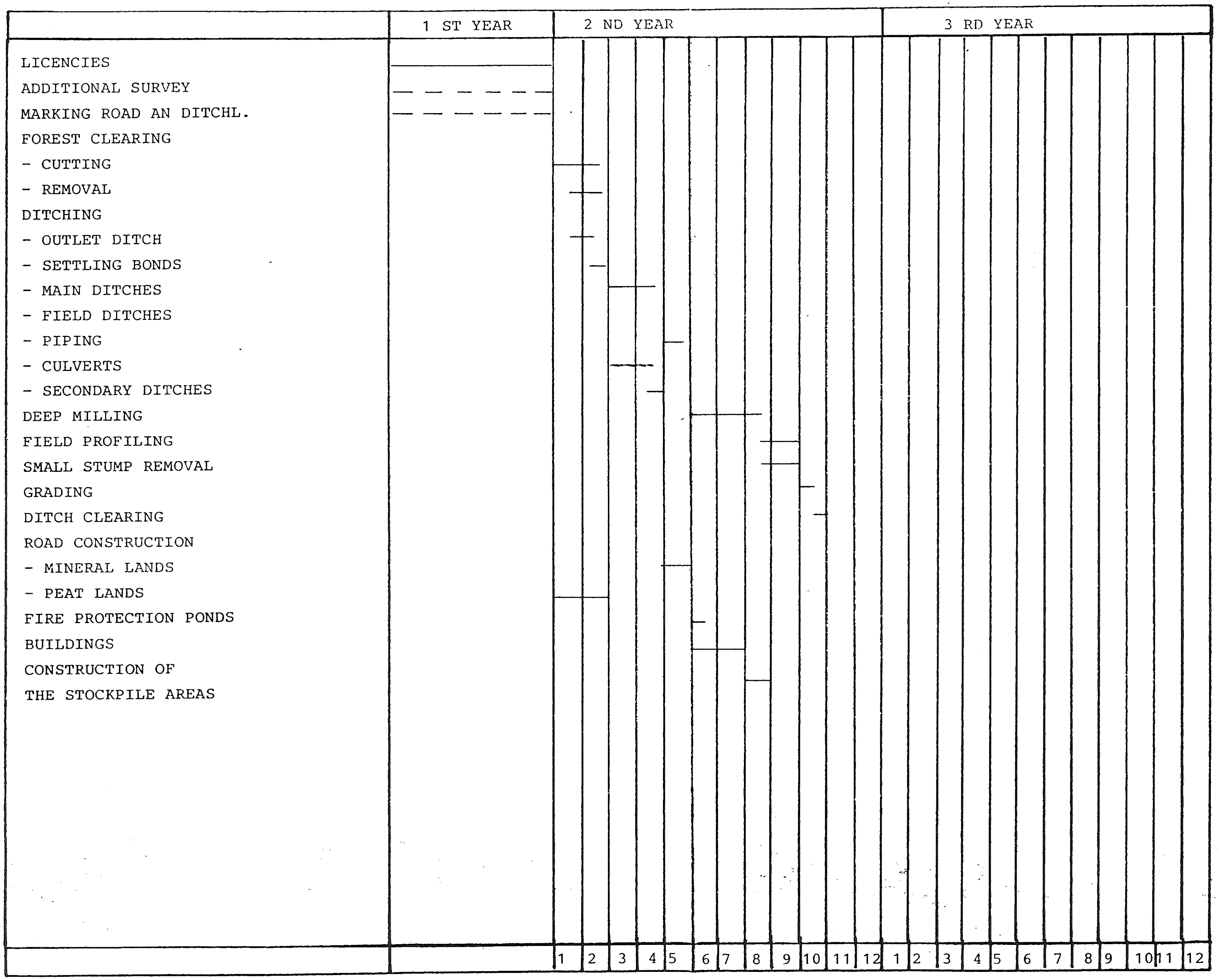
SUBSITE PRODUCTION FORECAST

YEAR	PREDICTED VOLUME** (cu-m)	PROD. ENERGY (MWh)	ENERGY CONTENT** (MWh/cu-m)	PROD. AREA (ha)	OUTMINED AREA (ha/a)	ANNUAL PROD. RATE** (cu-m/ha/a)
1987	220440	177478	0.81	334.0	0.0	660.00
1988	220440	177478	0.81	334.0	0.0	660.00
1989	220440	177478	0.81	334.0	0.0	660.00
1990	220440	177478	0.81	334.0	0.0	660.00
1991	220440	177478	0.81	334.0	0.0	660.00
1992	220440	180945	0.82	334.0	0.0	660.00
1993	220440	187071	0.85	334.0	0.0	660.00
1994	220440	187071	0.85	334.0	0.0	660.00
1995	220440	187071	0.85	334.0	0.0	660.00
1996	220440	187071	0.85	334.0	0.0	660.00
1997	220440	187071	0.85	334.0	0.0	660.00
1998	220157	182772	0.83	334.0	1.3	660.00
1999	218920	179628	0.82	332.7	2.0	660.00
2000	217605	178550	0.82	330.7	2.0	660.00
2001	216291	177471	0.82	328.7	2.0	660.00
2002	214976	176392	0.82	326.7	2.0	660.00
2003	213661	175314	0.82	324.7	2.0	660.00
2004	212347	174235	0.82	322.7	2.0	660.00
2005	211032	173156	0.82	320.7	2.0	660.00
2006	209718	172078	0.82	318.7	2.0	660.00
2007	208403	170999	0.82	316.8	2.0	660.00
2008	207088	169920	0.82	314.8	2.0	660.00
2009	205774	168842	0.82	312.8	2.0	660.00
2010	199783	163926	0.82	310.8	25.3	660.00
2011	175054	143635	0.82	285.5	40.4	660.00
TOTAL	5355648	4410610	0.82	245	89	

** (cu-m) = Plant door cubic meters

LITTLEFORK PEATLAND 215 HA

SCHEDULE



LITTLEFORK PEATLAND 585 HA

SCHEDULE

	1 ST YEAR	2 ND YEAR												3 RD YEAR
LICENCIES														
ADDITIONAL SURVEY														
MARKING ROAD AN DITCHL.														
FOREST CLEARING														
- CUTTING														
- REMOVAL														
DITCHING														
- OUTLET DITCH														
- SETTLING BONDS														
- MAIN DITCHES														
- FIELD DITCHES														
- PIPING														
- CULVERTS														
- SECONDARY DITCHES														
DEEP MILLING														
FIELD PROFILING														
SMALL STUMP REMOVAL														
GRADING														
DITCH CLEARING														
ROAD CONSTRUCTION														
- MINERAL LANDS														
- PEAT LANDS														
FIRE PROTECTION PONDS														
BUILDINGS														
CONSTRUCTION OF														
THE STOCKPILE AREAS														
		1	2	3	4	5	6	7	8	9	10	11	12	

TABLE

COMPARISON WITH THE RESULTS OF DNR AND VAPO OY (**Littlefork A-1800-1400**)

Depth (cm)	Bulk Density		Ash Content %		Heating Value MWh/t		Heating Value Btu/lbs		Moisture Content %		Sulphur %	
	DNR	Vapo Oy	DNR	Vapo Oy	DNR	Vapo Oy	DNR	Vapo Oy	DNR	Vapo Oy	DNR	Vapo Oy
18 - 33	0,12	0,137	10,5	8,07	5,389	5,565	8340	8613	87,0	85,5	0,28	
33 - 48	0,15	0,154	9,2	6,40	5,667	5,660	8788	8760	85,5	85,10	0,25	
52 - 67	0,15	0,163	11,6	7,33	5,500	5,744	8495	8890	84,8	84,70	0,20	
67 - 82	0,14	0,148	11,3	5,93	5,416	5,735	8375	8876	86,0	84,90	0,23	
82 - 97	0,13	0,147	11,0	6,51	5,361	5,728	8315	8865	88,0	86,20	0,15	
102 - 117	0,15	0,138	11,2	9,15	5,167	5,395	7985	8350	85,9	87,00	0,48	
117 - 132	0,15	0,144	12,4	6,87	5,528	5,735	8544	8876	86,2	86,90	0,93	
132 - 147	0,15	0,141	11,2	6,38	5,694	5,801	8805	8979	86,3	87,20	1,10	
In average	0,143	0,147	11,05	7,08	5,465	5,670	8455	8776	86,21	85,93	0,45	

1 t = 2204,6 lbs
1 MWh = 3412130 Btu

EKONO

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