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PEAT UTILIZATION AND THE RED LAKE INDIAN RESERVATION

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PEAT UTILIZATION AND THE RED LAKE INDIAN RESERVATION

Submitted to:

THE MINNESOTA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF MINERALS
FEBRUARY, 1978

Submitted by:

THE WALTER BUTLER COMPANY
175 AURORA AVENUE
ST. PAUL, MINNESOTA 55103

"This Technical Assistance Study was accomplished by professional consultants under contract with the Minnesota Department of Natural Resources." The statements, findings, conclusions, recommendations and other data contained in this report are solely those of the Contractor and do not necessarily reflect the views of the Minnesota Department of Natural Resources.

"The work represented by this report was conducted in 1977 and 1978 under the terms of Requisition Number 13657 by and between the State of Minnesota, Department of Natural Resources and the Walter Butler Company, 175 Aurora Avenue, St. Paul, Minnesota 55103"

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PREFACE

A Summary of Findings does not appear at the beginning of this report. Such a summary would require selecting the most important aspects of this report. We anticipate a broad range of readers each with a different concept of what is important in this report. As a result, we have adopted a different summary format. At the beginning of each section, a brief summary appears in capitalized sentences. A summary of report findings can be obtained by reading through these section summaries. If the summary of a particular section invokes further interest, the background material is immediately available in the following narrative.

INTRODUCTION

STUDY GOALS

ASSEMBLE SITE-SPECIFIC BASE-LINE DATA ABOUT THE PEAT RESOURCE IN THE RED LAKE AREA.

IDENTIFY AND ELABORATE UPON THE KEY ENVIRONMENTAL, SOCIAL AND ECONOMIC ISSUES OF PEAT UTILIZATION AFFECTING THE RED LAKE INDIAN RESERVATION.

CONDUCT A PRELIMINARY REVIEW OF THE POSSIBLE IMPACT OF PEAT UTILIZATION ON RESERVATION RESOURCES, ENTERPRISES AND LIFESTYLE.

DISSEMINATE THE INFORMATION GENERATED BY THIS STUDY TO THE RED LAKE RESERVATION RESIDENTS.

INVENTORY THE ATTITUDES AND OPINIONS OF RESERVATION RESIDENTS TOWARD PEAT UTILIZATION.

The purpose of this study is to identify and elaborate upon the key environmental, social and economic issues of the use, or non-use, of the peat resource on, or adjacent to, the Red Lake Indian Reservation. The study has three focuses. The first is acquisition of specific information about Peat Utilization on the Reservation. The second focus is the communication of information to the Reservation residents. The third focus is to compile an inventory of opinions and attitudes of Red Lake residents toward peat development. This approach will allow the residents to formulate their opinions on peat use based on information specific to their environment. Consideration of the resulting informed attitudes and opinions is essential to any development of the peat resource in the area.

Another goal of this study is to conduct a preliminary review of the possible impact of peat utilization in the Red Lake area. The impact review is limited to the topics on which sufficient information is available for analysis. This report does not intend to serve as an Environmental Impact Statement. A specific development proposal must exist before a complete environmental study can be made. However, a preliminary impact review can be based on a general concept of peat utilization and the environment of the Red Lake area.

There are several sub-goals of this study. This report is designed to be easily understood by the broadest possible range of readers. The material is presented with a minimum of technical terms. A glossary is provided at the end of this report for the technical terms that remain. It is a sub-goal of this study to involve the Red Lakers in the peat development study process. Likewise, this report will present information that should increase the sensitivy of non-residents to the concerns of Red Lake Indian Reservation residents. This study will present baseline information that would be essential to any further study of the area. The extensive bibliography and list of resource people found at the end of this report will prove valuable to future study efforts. Therefore, the sub-goals of this study are to produce a readable report that opens communication between the Red Lakers and people studying peat development, and to provide sufficient base-line information to be of service to future research in the area.

REASONS FOR THIS STUDY

THE INCREASING SCARCITY OF PETROLEUM HAS INTENSIFIED THE SEARCH FOR ALTERNATIVE SOURCES OF ENERGY, CHEMICALS AND AGRICULTURAL PRODUCTS. THE PEAT RESOURCE HAS GREAT POTENTIAL FOR PROVIDING THESE AND OTHER PRODUCTS.

MINNESOTA HAS OVER 28% OF ALL PEAT LANDS IN THE CONTINENTAL UNITED STATES. NEARLY ONE THIRD OF MINNESOTA'S PEAT IS ON, OR NEAR, THE RED LAKE INDIAN RESERVATION. ANY SUBSTANTIAL PROGRAM TO UTILIZE THIS PORTION OF MINNESOTA'S PEAT RESOURCE WILL IMPACT THE RED LAKE INDIAN LANDS AND WATERS.

THE MINNESOTA DEPARTMENT OF NATURAL RESOURCES IS CURRENTLY CONDUCTING A STATE-WIDE STUDY OF PEAT UTILIZATION. THE UNIQUE SOCIAL, CULTURAL, ECONOMIC AND LEGAL STATUS OF THE RESERVATION AND THE HIGH PROBABILITY OF MAJOR IMPACT WARRANTS AN IN-DEPTH STUDY OF THE RED LAKE AREA.

REGULATORY AGENCIES WILL REQUIRE AREA-SPECIFIC, BASE-LINE INFORMATION ABOUT PEAT DEVELOPMENT TO FORMULATE AN EFFECTIVE PEAT UTILIZATION POLICY.

In addition to traditional horticultural uses, peat has been a source of energy for many years in Europe and elsewhere. The increasing scarcity of petroleum has intensified the search for alternative resources for the production of energy, chemicals, and agricultural petrochemical products. The United States is just beginning to realize the potential value of its peat resources.

Minnesota is estimated to have 28.1% of all the peat lands in the Continental United States. In the entire State there are an estimated 7.2 million acres of peatlands having a potential yield of 16.1 billion tons of peat. This represents a major resource for Minnesota, a State with no other fossil fuel resources. However, because of the nature of peat utilization technology and the great amounts of land involved, the potential social, economic and environmental impacts are enormous.

The long lead-time required to develop a peat resource, and pending peat utilization permit requests, have created an immediate need for the State of Minnesota to be in a position to formulate an effective policy on peat utilization. In July of 1975, the Minnesota Gas Company (Minnegasco) applied to the Minnesota Department of Natural Resources for a twenty-five year lease to take and remove peats from approximately 200,000 acres of state-owned lands of Northern Minnesota. The entire area to be developed by Minnegasco is outlined on Figure 2 and includes lands in the Lake of the Woods, Koochiching and Beltrami counties. The proposed area of peat development is immediately adjacent to the Red Lake Indian Reservation. The policy formulation process requires accurate information on the resource, its impact, and methods to control its development and use.

The Minnesota Department of Natural Resources (DNR), with support from the Upper Great Lakes Regional Commission (UGLRC), has undertaken a two phase study of the peat resources of Minnesota. The principal objective of the study is to compile information which will be used to formulate a State peatland policy.

Phase I of the study involved gathering information on present peat utilization and the technology employed in producing peat products. Another aspect of this first phase was the dissemination of information about large scale peat development to interested parties throughout Minnesota.

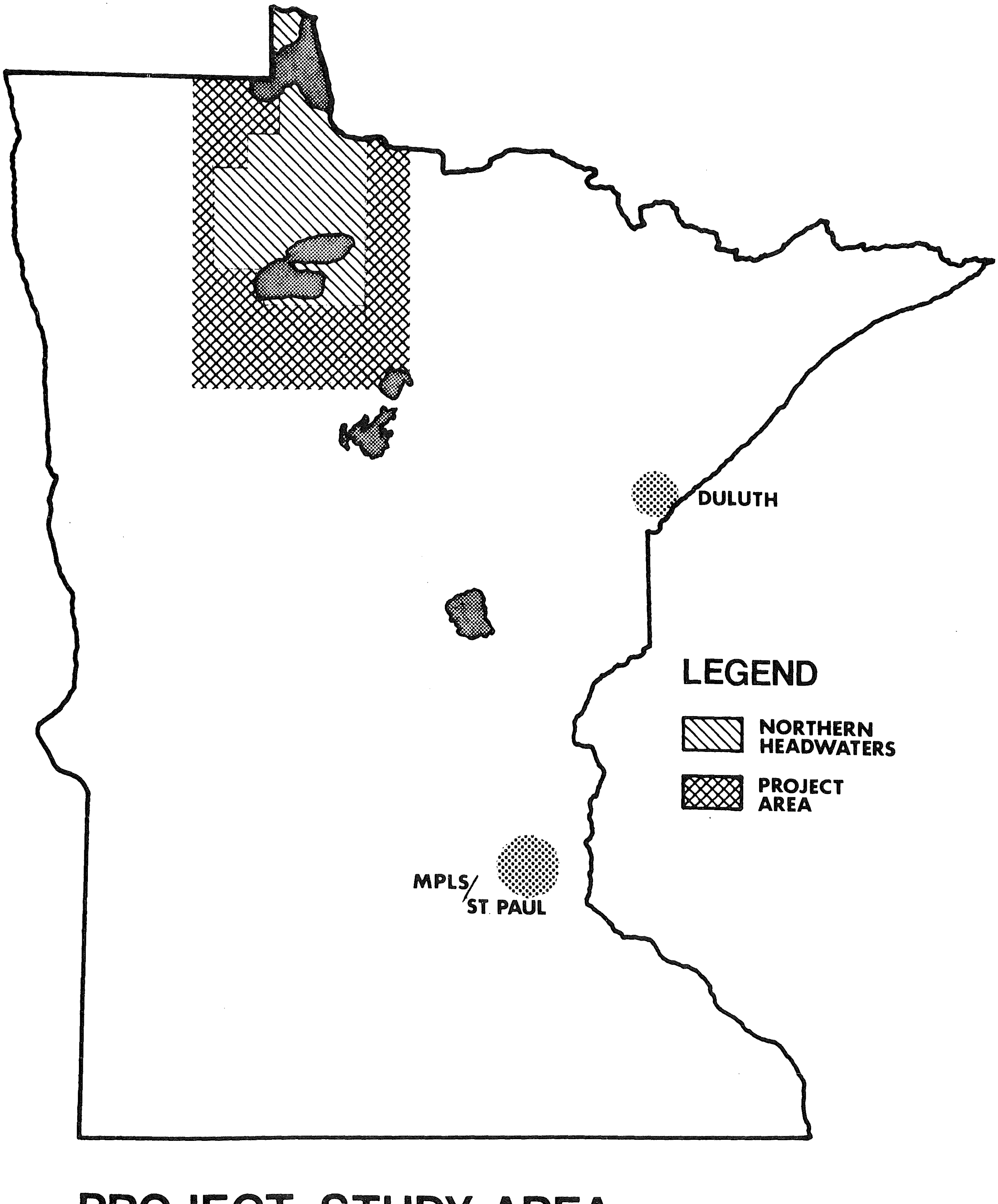
Efforts of the Department of Natural Resources in Phase II center on gathering and analyzing socio-economic and environmental base-line data. The results of this data-gathering will be used to identify peatland development opportunities and constraints. Information exchange has been a key component of both phases of the State study.

The principal vehicle for information exchange has been the Peat Advisory Committee appointed by the Minnesota Commissioner of Natural Resources. The committee is to provide advice and guidance to the groups preparing reports for Phase I and Phase II of the DNR's on-going peat program. The committee includes representatives of state and local government, Minnesota State Agencies, Minnesota Universities, Regional Development Commissions and the Federal Government. The committee has held public meetings throughout the State. At these meetings information generated by the State-wide study is presented to committee memebers.

As part of obtaining preliminary information about peat, the Minnesota Land Management Information System (MLMIS) demarcated three peat study areas in the northern part of Minnesota.

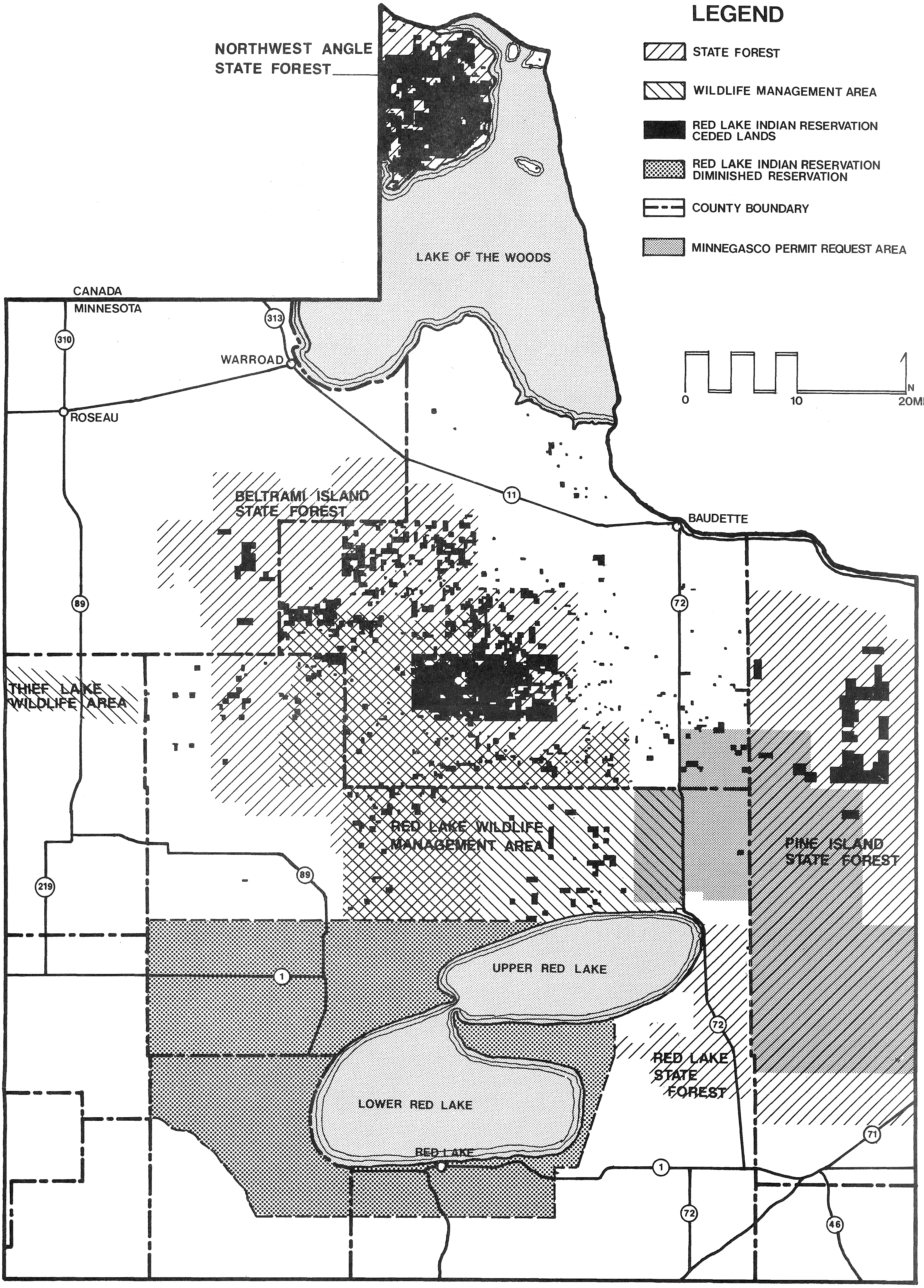
The MLMIS Northern Headwaters Region Peat Study Area includes all of Lake of the Woods County and the northern half of Beltrami County (see Figure 1). This area includes 1.8 million acres of land, excluding the Lake of the Woods and the Upper and Lower Red Lakes. This area contains approximately 900,000 acres of peat with energy potential. This represents nearly one-sixth of all peat with energy potential estimated to be in the Upper Great Lakes States of Minnesota, Wisconsin, and Michigan. The Northern Headwaters Region also contains several hundred thousand acres of peat considered to have potential for agricultural and horticultural uses. Public entities hold or administer 94% of all peat lands in this region. The State holds 68% and the Federal Government 25% of these peat lands. Virtually all of the Federally administered land is represented by the Red Lake Indian Reservation. Consequently, other than the State, the Red Lake Band of Chippewa Indians are the largest holder of peat land in the Northern Headwaters region. In fact, the Red Lake Indians are the largest non-state holder of peatland in the entire Upper Great Lakes region.

The land owned by the Red Lake Indians consists of the Dimminished Reservation and the Ceded Lands. The Diminished Reservation consists of a 636,964 acre solid block of land bordering the Upper and Lower Red Lakes. The Ceded Lands consist of 156,690 acres of scattered tracts which extend northward to the Lake of the Woods (see Figure 2). As a result, any attempt to utilize peat resources on State lands in this region would rarely be more than a few miles from Indian land. Also, the greatest concentration of high energy potential peatland is directly north of the Upper Red Lake. Because of the nature of peat utilization technology, any major development of peat in this region would impact the Reservation Lands. The environmental effects of changes in air and water quality are of particular concern.



PROJECT STUDY AREA

FIGURE 1



STUDY AREA; DESIGNATED LAND USE

FIGURE 2

The Red Lake Reservation has unique legal status as a Closed Reservation. Essentially, this means that the land is communally owned by the Tribe with the Title held in trust by the United States Department of Interior. All legal, social and economic development aspects of Reservation life are managed by the Red Lake Tribal Council with the assistance of the Bureau of Indian Affairs.

The State has no jurisdiction over activities on the Reservation. As a result, the Tribal Council is the dominant political force over a major portion of the peatland in the area. Their participation in the formulation of a peat policy is essential to the effectiveness of this policy.

The non-public economic activities of the Tribe are forestry, fishing and wild rice harvesting. Another principle activity of the Red Lakers is the hunting of wildlife. All of these activities can be greatly affected by attempts to utilize the peat resource in the Northern Headwaters Region.

Poor communication between the Reservation residents and organizations interested in peat utilization has resulted in great apprehension by the Indians of any peat programs. Consequently, it was advantageous to have an independent third party conduct a study to specifically address the impact of peat development on, or adjacent to, the Reservation.

PROJECT AREA

THE STUDY AREA WAS DETERMINED BY THE RANGE OF IMPACTS ON RED LAKE RESERVATION BY PEAT UTILIZATION.

This study does not have a set geographic study area. The object of the study is to determine the range of impacts affecting the Reservation. To study surface water impacts, the study area was extended to the appropriate watershed boundaries. Where Reservation lands cross partially into another county, the study area is extended to include these lands. Since impacts can be highly localized, the study area is site specific to the effect being studied.

The general project area is the Northern Headwaters Region as defined by the MLMIS. Portions of ten other counties were added to include the Red Lake Diminshed Reservation and all Tribal Ceded Lands. The project area and the Northern Headwaters Region are outlined on Figure 2.

ABOUT THE REPORT

PROJECT TEAM

THE PROJECT TEAM CONSISTED OF TWELVE PROFESSIONALS ASSIGNED TO STUDY AREAS ACCORDING TO THEIR PARTICULAR FIELD OF EXPERTISE.

Twelve professionals participated in various phases of this study. Several individuals combined their expertise in the critical areas of Hydrology and Forestry. The combined experience of the personnel participating directly in this project exceeds 150 years. Several of these individuals are recognized experts in their respective fields and have authored several publications. The following lists the participants in this study and their area of participation:

Robert Butler	Economic Impact-Opinion Survey
Walter Butler	Tribal Relations-Project Coordination
Sigard Dolgaard	Forestry
Glenn Eckstrom	Graphics
Tarell Friedley	Community Development-Report Writing
Ralph Graves	Forestry
Rudolph Hogberg	Geology-Topography-Groundwater
Richard Murphy	Community Planning-Environmental
Daniel Russell	General Research
Duane Temple	Hydrology-Surfacewater
Steve Young	Hydrology-Environmental
Z.A. Zasada	Forestry

Also, several support personnel aided general research and report formulation.

CONSULTANT QUALIFICATIONS

THIS REPORT REPRESENTS SEVEN MONTHS OF RESEARCH BY THE WALTER BUTLER COMPANY.

SINCE 1966, THE WALTER BUTLER COMPANY HAS CONDUCTED NEARLY 200 INDUSTRIAL PARK DEVELOMENT, ECONOMIC, SOCIAL AND ENVIRONMENTAL IMPACT, MARKETING, COMMUNITY DEVELOPMENT AND TECHNICAL ASSISTANCE STUDIES.

THE WALTER BUTLER COMPANY CONDUCTED IT'S FIRST STUDY ON THE RED LAKE RESERVATION IN 1966. TWO RECENTLY COMPLETED STUDIES HAVE GREATLY EXPANDED THE COMPANY'S KNOWLEDGE OF THE RED LAKE COMMUNITY AND IT'S NATURAL RESOURCES.

The Walter Butler Company has acquired considerable knowledge about the Red Lake Reservation. The Company's first study at Red Lake was conducted in 1966 for the Economic Development Administration (EDA), U.S. Department of Commerce. In 1976, the Walter Bulter Company conducted a feasibility study of a planned Housing Component Manufacturing and Training Facility. This entailed extensive review of the social and economic conditions on the Reservation. The Company has recently completed a study to assess the impact of converting existing sawmill operations to a full tree utilization system. This has required a complete review of the Reservation resources and environment. Consequently, the Walter Butler Company is familiar with the social, economic and environmental concerns of the Reservaton.

BACKGROUND RESEARCH

OVER 150 MAJOR REPORTS, STUDIES, PUBLICATIONS AND DOCUMENTS WERE REVIEWED IN THE PREPARATION OF THIS REPORT.

OVER 60 INDIVIDUALS FAMILIAR WITH THE PEAT RESOURCE AND THE RED LAKE AREA WERE CONSULTED TO SUPPLEMENT AVAILABLE LITERATURE.

NEARLY 25 MAN-DAYS WERE SPENT ON THE RESERVATION FORTIFYING EXISTING INFORMATION WITH FIELD RESEARCH.

A substantial number of documents were reviewed and analyzed in the preparation of this report. One of the study goals was to assemble a broad range of site-specific data about the peat resource and the environment of the Red Lake area. The obvious reason for this is to provide a solid foundation for our analysis. Another reason was to provide the base-line data for future peat related research in the area.

There exists a large volume of peat literature, much of which is vague and outdated. As a result, much of the initial research conducted in the State was a review of the peat literature. It remains a challenge of the State-wide program to assimilate existing research into a readily discernable, easily accessable, centrally located source. This is complicated by the fact that much of the research technology is foreign and outdated. However, the research upon which this report is based is comprehensive and will represent existing knowledge on the peat resource. A complete listing of the references is available in the Bibliography of this report.

Academicians, professionals and informed laymen were another vital source of information . Specific information and research related to peat development in the Red Lake area is scarce. Consequently, the knowledge, experience and judgment of many informed individuals was essential to the development of this report. Much of the best information about peat utilization exists outside the published literature. Many of the individuals contacted were found to have private libraries and long kept records of personally gathered information that contributed greatly to this study.

The assemblance of literature and contact with informed individuals was fortified with field research by the Project Team. Several hours were spent flying over and photographing the project area. Comparisons were made between the Project Team's aerial photos and land-use and topography maps. Almost an entire week was spent on the Reservation, verifying resource, employment and other project data. This was in addition to several trips for meetings with Reservation residents. Verifying and updating information on Reservation enterprises and natural resources occupied much of this week of field research. A field trip was made into the Red Lake Bogs to gather samples of the peat to compare with data from previous field research.

The many days of field research conducted on the Red Lake Reservation greatly fortified the information obtained through literature review and consultation with individuals familiar with peat and the Red Lake area.

PROGRESS REPORTS

FOUR PROGRESS REPORTS WERE SUBMITTED TO THE DEPARTMENT OF NATURAL RESOURCES AND DISTRIBUTED TO PEAT ADVISORY COMMITTEE MEMBERS. THE PROGRESS REPORTS WERE INTENDED TO ENCOURAGE INPUT AND FEEDBACK FROM OTHER PARTICIPANTS IN THE STATE-WIDE PEAT INFORMATION PROGRAM.

Monthly progress reports were submitted to the Department of Natural Resources. Each varied in scope and focus as determined by the stage of overall report development. These reports served three purposes. The first purpose was to advise the Department of Natural Resources of the progress toward fulfilling the contractural obligations of the Project Team. The second purpose was to disseminate information as it was developed to other participants in the state-wide peat study. The third purpose was to provide a medium through which interested individuals could provide input into the Red Lake Study. Comments and feedback were solicited and received. Among the recipients of these progress reports were the Tribal Leaders of the Red Lake Indian Reservation. This aided the on-going transfer of information to Red Lake residents conducted throughout this study.

RESERVATION MEETINGS

FOUR GENERAL MEETINGS WERE HELD ON THE RESERVATION WITH TRIBAL LEADERS, AGENCY REPRESENTATIVES AND INTERESTED RESERVATION RESIDENTS. NUMEROUS INDIVIDUAL MEETINGS SUPPLIMENTED THE INFORMATION TRANSFER TO THE RESERVATION. THESE MEETINGS IDENTIFIED ISSUES AND CONCERNS THAT GUIDED THE DEVELOPMENT OF THIS REPORT.

A major thrust of this study has been the transfer of information to and from the Reservation. As information was generated in the preparation of this study, it was disseminated to key individuals on the Reservation.

During the development stages of this report, meetings were held to provide data to interested individuals as it was generated. Occuring at the same time were numerous individual discussions with Tribal leaders and individuals active in the Red Lake community. In addition to providing background information to Reservation residents, many of the local issues and concerns were noted. These locally generated issues and concerns guided the development of this report. The great concern for the impacts on the Upper and Lower Red Lakes and the Tribal forest resulted in focusing upon these areas in the analysis.

ORGANIZATION OF REPORT

THIS REPORT IS ORGANIZED TO FOCUS UPON THE ISSUES AND IMPACTS THAT CONCERN THE RESIDENTS OF THE RED LAKE RESERVATION.

A major challenge of this study is presenting the information in a format that is readable and understandable to a wide variety of readers. The voluminous nature of the peat information, the far-reaching and interrelated impacts of peat utilization and the broadness of the scope of this report require special attention to report organization.

All the possible views and alternative information is not presented. On many occasions the report has relied on the expertise and experience of the Project Team to select the best information available. This narrowing of the scope of the presentation greatly improves the readability of the report. The full range of material is retained in the bibliography for readers who choose to pursue a particular aspect of the research.

The concept of peat utilization is extremely broad, encompassing a wide range of products, technologies, procedures and levels of peat use. Each use of peat may, in itself, have an extremely wide range of interrelated impacts. It would be nearly impossible to pursue each of these utilization strategies and the resultant impacts in one document. Consequently, this report will focus upon the utilization strategies currently under consideration for use in the Red lake area. Also, the report will focus upon the impacts that most directly concern the Red Lake residents. However, the scope of this analysis remains comprehensive. The neglected utilization strategies comprise mostly theoretical uses and undeveloped technologies. The impacts receiving lesser attention are limited to those inappropriate to the area, of only negligable impact, or of no concern to Reservation residents.

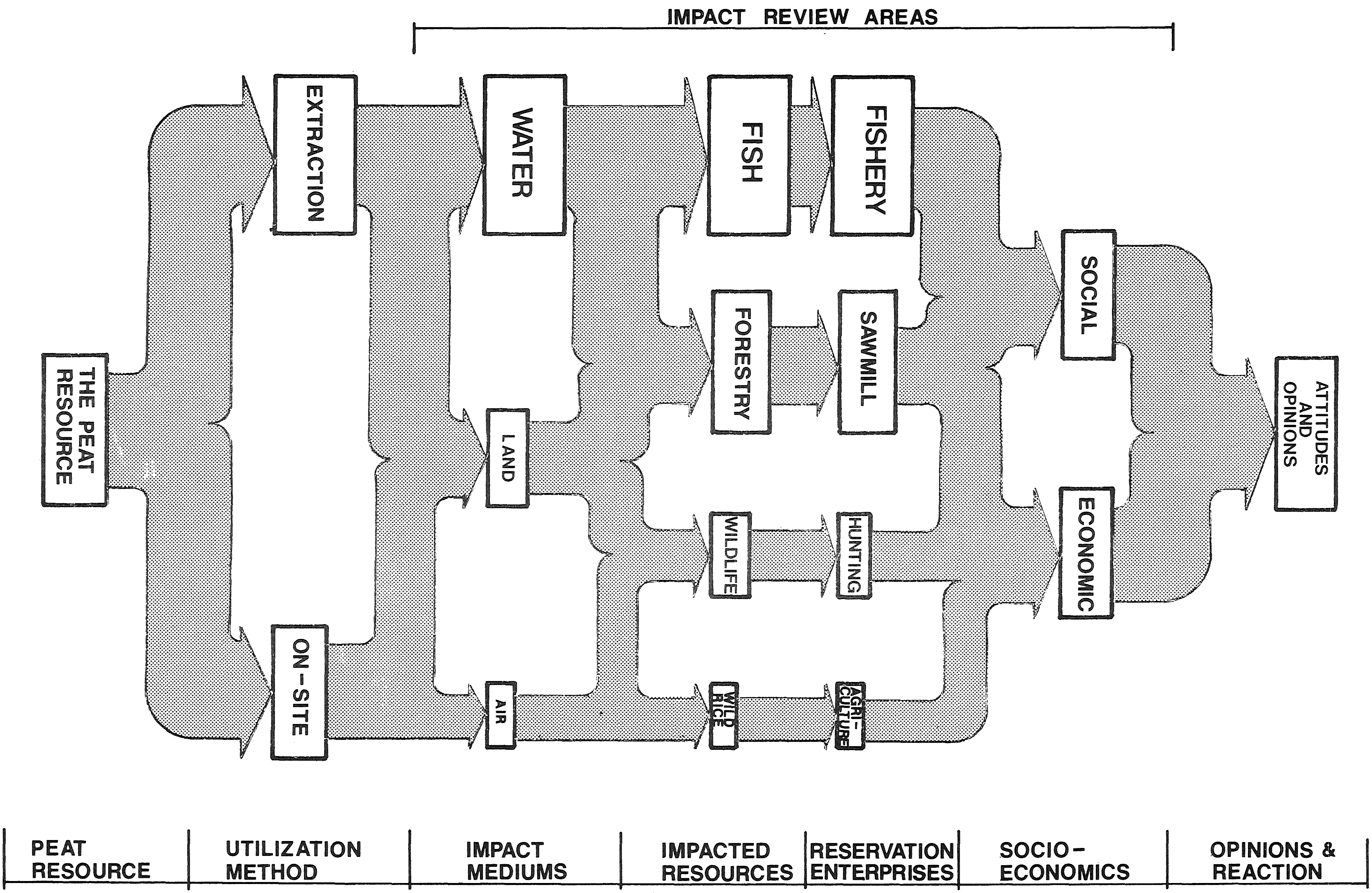
The concern for reaching a varied readership, the need to identify key information and the propriety of focusing upon Red Lake issues and impacts suggests a form of "Critical Path" analysis for this report. The majority of this report will be organized around this Critical Path approach.

The Critical Path approach specifies seven functional areas that identify the mechanisms transfering peat utilization into an impact on the Reservation. These functional areas are: 1) The Peat Resource, 2) Utilization Method, 3) Impact Mediums, 4) Impacted Resources, 5) Reservation Enterprises and Activities, 6) Socio-economics, and 7) Opinions, Attitudes and Reactions. Each of these functional areas is comprised of several components that are specific to peat use and the Red Lake area.

The organization of this report is represented by Figure 3. The Figure shows the seven functional areas of the impact analysis. The boxes represent descriptions of the components of the Reservation that determine the impact. The arrows relate to the process by which the impact is transfered through the area environment. The size of the arrows roughly equate to the magnitude of the impact. This also indicates the attention the process is given in this report.

The Peat Resource Functional Area includes a description of peat, its uses and the history of peat development. This discussion serves as the foundation for evaluating potential peat products.

The Utilization Method is the second functional area and discussess various techniques for converting the raw peat resource into a product. The peat must either be processsed on-site or extracted from the site and further processed. Consequently, the main impact on Red Lake can be



FUNCTIONAL AREAS OF ANALYSIS

FIGURE 3

divided into two classifications: on-site impacts and extractive impacts of peat use.

In addition to the impacts from on-site or extractive uses, there are secondary impacts from further refinement of the peat product. For example, the impact of a peat gassification plant. Large peat utilization facilities have a nearly infinite number of secondary impacts as determined by the multitude of products and technologies possible. These secondary impacts will be reserved for consideration under a specific product development proposal.

The Impact Mediums comprise the third functional area. The impact mediums are the mechanisms that transfer the impact of peat utilization throughout the Reservation environment. These are the components of the Red Lake environment that will be directly impacted by either on-site or extractive uses of peat. The first and most significant Impact Medium is water. It is through changes in the quality and quantity of water that the impact of a peat project is likely to be transferred to the Reservation. The second and third impact mediums are land and air. Peat development is likely to have a direct effect on all three of these components of the Reservation environment. The extent of the impact will be determined by the level and type of peat development.

These Impact Mediums will directly impact Reservation resources. Consequently, the fourth functional area are these Reservation resources. Four resources of concern are identified as fish, forestry, wildlife, and wild rice. Any alterations in these resources will impact the resource based Reservation enterprises.

The fifth functional area is the Tribal Enterprises. These enterprises include the Red Lake Fisheries, Red Lake Sawmills and Red Lake Wild Rice Industry. Hunting, a fourth activity considered under this functional area, is not truly a Reservation enterprise. However, the hunting of game and wild fowl is an important component of the Reservation community. Any effect on Reservation enterprises and hunting will impact the employment, income and lifestyle of the residents. These Reservation impacts make up the sixth functional area. The seventh functional area of Opinions, Attitudes and Reactions of Reservation residents toward peat development is determined by the impact on these socio-economic aspects of the Reservation.

The groundwork has been laid to start the review of the impacts of peat utilization on the Red Lake area. Using the Critical Path format as a guide, the report will begin with the functional area of the peat resource. The analysis will move through the diagram until the impacts and relations to these impacts have been discussed.

THE PEAT RESOURCE

This functional area will provide the background information on peat required to conduct the review of peat use impacts.

PEAT TYPES

PEAT IS THE PARTIALLY DECOMPOSED REMAINS OF PLANTS THAT HAVE ACCUMULATED IN LOWLAND DEPRESSIONS.

THERE ARE THREE TYPES OF PEAT, 1) FIBRIC (PEAT MOSS) WHICH IS FORMED FROM MOSSES, 2) HEMIC (REED-SEDGE) WHICH IS FORMED FROM REEDS AND SWAMP PLANTS, AND 3) SAPRIC (HUMUS) WHICH IS SO DECOMPOSED THAT ITS BIOLOGICAL ORIGINS ARE UNIDENTIFIABLE.

Peat is a reddish-brown to brownish black organic material formed by the partial decay and disintegration of plants and other organic matter. It can be found in lowland areas throughout the world. In general, peat develops within, or near, former marshes, swamps, bogs, and other lowland depressions. Organic materials sink into these depressions and are covered by water which prevents the normal oxidation (decaying) processes. The resulting accumulation eventually forms peat.

The most extensive deposits of peat occur where glaciation (movement of glaciers) has produced topographic depressions or gently sloping lake plains. Peat formation occurs in areas of abundant and well distributed rainfall, high humidity and cool temperatures. This combination of factors tends to retard the decomposition of plant material found in water rich areas.

Peat is generally categorized, for commercial purposes, according to its biological origin and its degree of decomposition. Three broad designations are used: (1) FIBRIC (PEAT MOSS) formed from sphagnum, hypnum and other mosses; (2) HEMIC (REED-SEDGE) formed from reeds, sedges and other swamp plants; and (3) SAPRIC (HUMUS) peat which is so decomposed that all trace of its biological origins are lost. Other plant materials such as ferns, rushes, and woody materials from shurbs and trees comprise lesser amounts of the peats. Sand, silt, and clay-size mineral and rock particles occur as minor portions of all types of peat.

PEAT USES

PEAT IS AN ORGANIC MATERIAL THAT HAS A WIDE VARIETY OF USES. BOTH ITS STRUCTURE AND CHEMICAL COMPOSITION LEND THEMSELVES TO PRODUCT DEVELOPMENT.

PEAT IS USED IN PLACE TO GROW VEGETABLES, GRASS SEED AND SOD. UNREFINED PEAT SERVES AS A SOIL CONDITIONER, PACKAGING MATERIAL, AND BIO-FILTER.

PEAT CAN BE PROCESSED INTO ACTIVITATED CARBON, COKE, TARS, PHENOLIC BY-PRODUCTS AND WAX. PEAT HAS BEEN USED IN PAPER, CARDBOARD, INSULATION, LEATHER TANNING AGENTS AND CATTLE FEED. PEAT CAN BE REFINED INTO SYNTHETIC NATURAL GAS OR BURNED DIRECTLY AS FUEL.

Peat may be utilized in several manners, ranging from the burning of the unrefined, extracted material for electrical generation to cultivation of the on-site material for production of vegetagles. The list of current and potential uses of peat is extensive and the list is lengthening as research continues.

Peat is utilized in a number of ways, depending upon the nature of the material. The fibric and hemic peats are very commonly employed as a source of organic soil matter. Peat readily absorbs liquid manure, and is used in stables as bedding and litter.

The packaging industry has also been influenced by peat. Peat is used as a cushioning agent and its water holding capacity keeps cut flowers and vegetables fresh until they reach market. Peat has been used as a conditioner for commercial fertilizers. The peat helps to absorb moisture from the fertilizer particles which keeps the fertilizer free-flowing. Some of the other products successfully made from peat include textile fibers, paper and cardboard, building materials, tanning agents for leather, mattresses, insulation and cattle feed. Peat can be processed to produce activitated carbon, coke, tars, phenolic by-products and wax. Peat has been used in Norway, where it is used under train beds to control the extent and depth of frost penetration (Skewen-Haug, 1963).

Peat is also being used as an absorbing media. If properly treated, peat can absorb oil from waste water. If peat is heat treated, it will out-perform other absorbants in cleaning up oil spills. In 1976 the United States Federal Water Pollution Control Agency and the Minnesota Iron Range Resources and Rehabilitation Commission (IRRRC) initiated a study of peat as a filter for removing nutrient and organic pollutants in sewage treatment. The United States Forest Service has used this method in Northern Minnesota to treat campground waste.

The Minneapolis Parks and Recreation Department has been cleaning Wirth Lake with a filter system which utilizes peat. An earth box 10 feet deep, containing alternating layers of gravel and peat, filter out algae breeding nutrients. A similar system has worked well in handling feedlot runoff (Wascoe Jr., 1977).

Peat is also used in brickette form, pelleted, or powdered to provide fuel. Finland is presently developing district heating/electricity plants fueled by peat to serve new towns and suburbs.

Peat is used extensively on-site as a fertile soil for vegetable production. Thousands of acres are now under cultivation, often yielding two crops a year. In some respects, the vegetable industry has been revolutionized by the exceedingly favorable nature of these organic soils when adequately drained and properly fertilized. In the Red Lake Area, the peat soils along the Clearwater River support vegetable, grass seed and sod operations.

All sorts of vegetable crops may be grown on peat soils. Vegetables presently grown on peat soils are celery, lettuce, spinach, onions, potatoes, beets, carrots, asparagus, and cabbage. Specialized crops, such as peppermint, have done well on peat soil. In some cases, peat is used for field crops such as sugar beets, corn, oats, rye, buckwheat, flax, clover, and timothy. Moreover, certain nursery stocks thrive on peat. In Europe, peat soils are used extensively for pasture and meadows.

The use or products of a specified bog is determined by the characteristics of the peat in the bog. Properties which are assessed to determine the appropriate utilization of peat include water holding capacity, ash content, fiber content, pH, BTU potential, organic and inorganic content. The American Society for Testing Materials (1969) has published standards for the testing of these properties.

According to Soper (1919) the BTU content of Beltrami County peat ranges from about 7070 to 10,900 BTUs on a moisture-free basis. Passer (1956a) presented data that indicated that commercial air-dried peat, which contains about 30 percent moisture, has a calorific value of about one-half that of coal, or about 7000 BTUs/lb. For purposes of computing the possible energy value of Minnesota peats, Farnham (1975) suggests a calorific value of 6000 BTUs/lb. for peat with a 35 percent moisture content.

Heinselman (1963) found that Minnesota peats in general were composed of a variable mixture of complex organic compounds including celluloses, lignins, entins, waxes, resins, alkaloids, pectins, fats, proteins, sugars, startches, and their respective decomposition products. Passer (1956b) presented information on methods of analyzing the organic content of Minnesota peats and found that there was an increase in the quantity of holo-celluloses and celluloses with decomposition of moss peats. Frederick M. Swain (oral communication, 1977), reported that little has been done to date on the analyses of the organic constituents of specific types of peats for possible chemical extraction, such as for alcohol and associated products.

The peats of the Red Lake Bog are typical of all Minnesota peats. The sapric and hemic peats have a sufficiently high BTU content for extraction for energy uses. The less decomposed fibric and hemic peats have water holding and an organic composition characteristics that suggest horticultural and agricultural uses.

PEAT UTILIZATION HISTORY

PEAT IS UTILIZED FOR A WIDE VARIETY OF PRODUCTS IN 10 FOREIGN COUNTRIES.

THE EARLIEST USE OF PEAT MAY HAVE BEEN AS AN ENERGY SOURCE.

RUSSIA INITIATED THE LARGE SCALE UTILIZATION OF PEAT.

PEAT HAS BEEN USED AS AN ALTERNATE SOURCE OF ENERGY IN THE UNITED STATES DURING WAR TIMES.

Although peat is found world wide, only the following countries have utilized this highly versatile resource to any great extent:

Finland	Germany
The Netherlands	Norway
Sweden	Russia
Poland	Ireland
England	Scotland

The earliest utilization of peat may have been as an energy source. The Romans first observed its usage by the peoples of northern and western Europe. The local people dug soil from marshlands with their hands, dried it, and then burned it to cook food and provide heat. As coal and oil became readily available, peat usage diminished, except among the very poor. Near the end of the nineteenth century, peat use became more competitive with coal and oil when the Germans developed a machine which kneaded and shaped the peat, freeing it from hand harvesting.

Russia was the first country to begin utilizing peat on a large scale. In 1927, the development a peat milling process by Russian engineers greatly advanced peat harvesting technology.

Russia, Ireland and Finland are the only countries which are using quantities of peat as a fuel for electrical power generation. In Germany, Great Britain, Sweden, Canada and the U.S. most of the peat harvested is used for horticultural purposes. Peat is also being used to distill Scotch Whiskey in Scotland and to produce activated carbon and coke in West Germany and the Netherlands.

In the 1940's, Ireland became the second country to develop an extensive peat utilization industry. It was, and in some areas still is, a common adjunct to farming to cut peat bricks to heat and cook with during the winter. A typical farmer working for 2-3 weeks could harvest enough peat bricks to last the winter. Approximately 30% of Ireland's energy supply is provided by peat. In Russia, peat provides only 2% of their total energy.

Peat development in the United States began during colonization when peat was used as a fuel. Since then, peat development has been relatively slow. The most active development has occured during wars, coal strikes, and at times when fossil fuels were in short supply. Peat utilization as an industry did not exist in the United States until the early 1900's. The first serious attempt to utilize peat as fuel in the United States occured in 1903, when striking anthracite coal miners caused a severe fuel shortage. (Sheridan & DeCarlo, 1957).

Minnesota has studied peat on and off since the 1870's when a legislative committee recommended a study on the use of peat as a fuel for locomotives (Passer, 1956). Extensive studies of the peat resource of the United States were conducted during the early 1900's. In 1919, E.K. Soper published the first large scale inventory of Minnesota peat bogs. This document remains one of the most authoritative sources of basic information on Minnesota's peat resource.

PEAT RESOURCES

THE CONTINENTAL UNITED STATES HAS AN ESTIMATED 25.6 MILLION ACRES OF PEAT OF WHICH 67% IS IN MINNESOTA, WISCONSIN, MICHIGAN AND FLORIDA.

MINNESOTA HAS AN ESTIMATED 7.2 MILLION ACRES OF ALL THREE MAJOR TYPES OF PEAT.

Peatlands cover approximately 400 million acres of the worlds' land surface. Eighty percent (80%) of the known peat resources in the world lie within the borders of the Soviet Union, Finland and Canada. Current estimates indicate that United States peatlands total 25.6 million acres (exclusive of Alaska) of which 67% is located in the states of Minnesota, Wisconsin, Michigan and Florida.

Table 1

ESTIMATED RESERVES OF PEAT IN SELECTED GEOGRAPHICAL AREAS*

Geographic Area	Acres (millions)	Quantity (billion tons)
World	408.8	915.7
Russia	228.0	510.7
U.S. (including Alaska)	52.6	117.8
U.S. (minus Alaska)	25.6	57.3
Midwest Region U.S.	15.2	34.0
Southern Region U.S.	6.7	15.0
Northeast Region U.S.	2.7	6.0
Western Region U.S.	1.0	2.2
Minnesota	7.2	16.1
Michigan	4.5	10.1
Florida	3.0	6.7
Wisconsin	2.8	6.3
Louisiana	1.8	4.0
North Carolina	1.2	2.7
Maine	0.77	1.7
New York	0.65	1.4
Hawaii	0.48	0.9
Koochiching Co. Minn.	1.15	2.6
St. Louis Co. Minn.	0.81	1.8
Beltrami	0.78	1.7

Source: Soil Science Department, University of Minnesota 1977.

*Estimates from published survey data of known peat resources. Basis of reserves and potential energy: peat contains 35% moisture, bulk density equals 15 lbs/cu ft, and one acre of peat 7' deep equals 2,240 tons.

Minnesota has approximately 7.2 million acres of peatland with tonnage estimates of 16.1 billion tons. This is only a general estimate based upon an inventory of 2-3% of Minnesota peatlands.

THE RED LAKE PEATLANDS

PEAT FORMATION IN THIS AREA PROBABLY BEGAN ABOUT 6,700 YEARS AGO.

THE PRESENT LANDSCAPE OF THE RED LAKE PEATLAND IS THE RESULT OF A SERIES OF GEOLOGICAL EVENTS. THE GLACIAL ICE ADVANCE DEPOSITED TILL WHICH WAS FLOODED BY GLACIAL LAKE AGASSIZ. AFTER THE DRAINING OF LAKE AGASSIZ, THE LOWLAND DEPRESSIONS WHICH REMAINED WERE IDEAL SITES FOR PEAT FORMATION.

THE PRESENT LAND SURFACE IS COMPRISED OF UPLAND, GLACIAL TILL AREAS, AND LOWLAND PEAT BEARING AREAS.

The history of the formation of Red Lake peats provides base-line information on the extent and composition of the peat resource.

The substrate surfaces of the Lake of the Woods and Red Lake River Watersheds, upon which the lowermost peat layers accumulated, are the result of a long series of geologic events. The most recent of these events was the draining of Glacial Lake Agassiz about 9,900 Carbon 14 Dated (C^{14}) years ago (Moran, and Clayton, 1972a and 1972b). Lake Agassiz innundated, at its maximum extent, several thousand square miles in parts of what is now northwestern Minnesota and the adjacent parts of North and South Dakota, Ontario, Manitoba and Saskatchewan.

One of the legacies from Lake Agassiz was a large number of depressions left within the relatively flat-lying plain. These later served as sites for peat accumulation. However, several events occurred between the draining of the lake and the initiation of peat development. It is probable that isostatic compensation, similar to that described by Farrand (1962) in the Lake Huron area, differentially elevated the former lake plain during a period of a few thousand years following lake drainage and ice melting. Grigal, Severson, and Goltz (1976) present evidence for a period of sand dune development and vegetative change between 8,000 and 5,000 C^{14} years ago. Finney and Farnham (1968) estimate that initial peat formation began about 6,700 C^{14} years ago.

The edges of the depressions and the lake bottoms of the shallow lakes became sites for the growth of pond weeds, reeds and other grasses, sedges, shrubs, trees, and other vegetation. The landscape evolution necessary to form peat from these organic materials are described by Cameron (1975): (1) initial through flow of water; (2) collection of a mass of floating peat with sub-peat water movement; (3) water movement marginal to large mass of peat; (4) additional accumulation of peat with resulting hydrologic effects from the raising and lowering of water levels; and (5) control of water levels partly or wholly by peat materials.

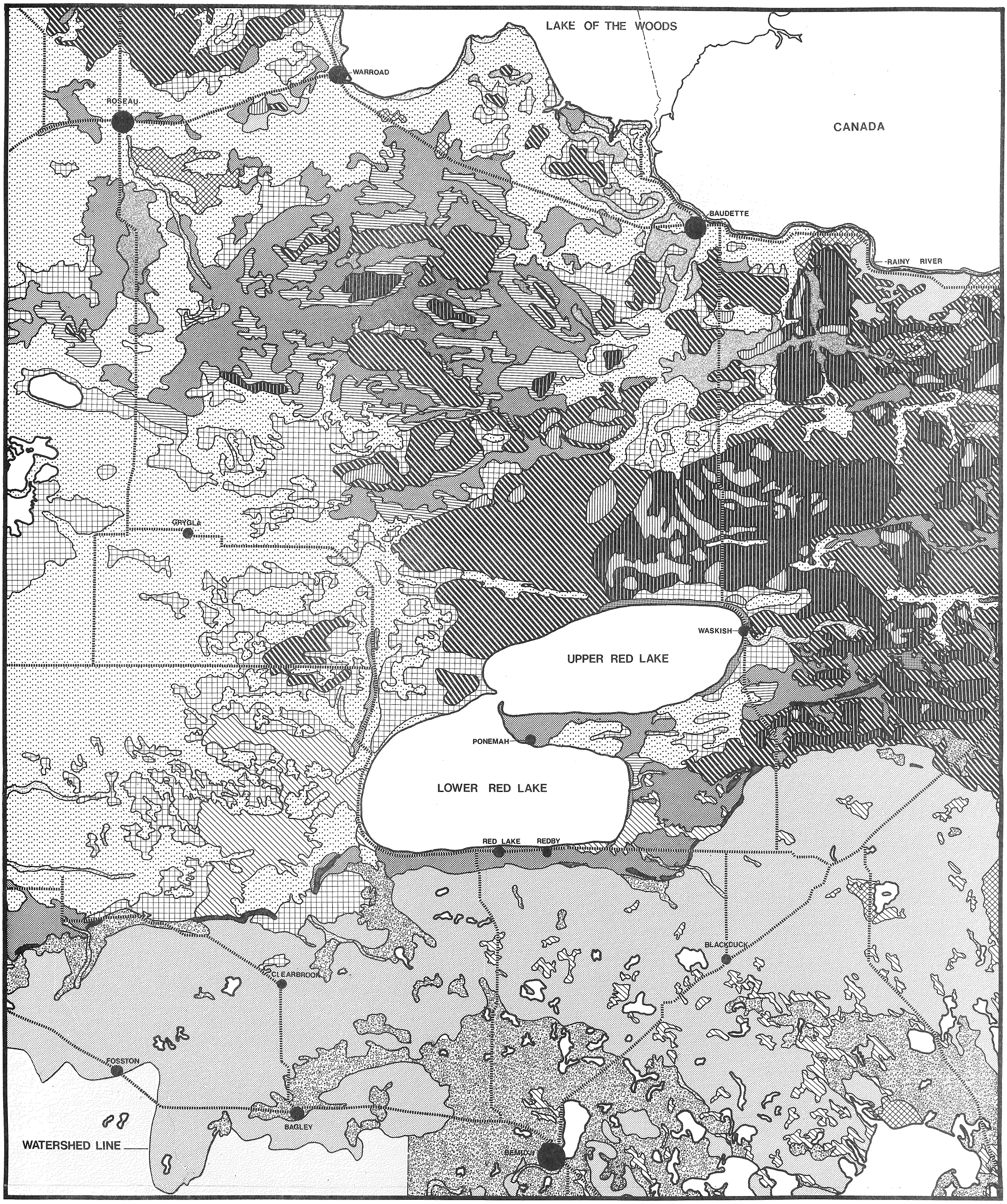
In some localities, the basin filled with peat expands by a process of paludification. This refers to peat growth outward from the limits of the depression by maintaining its water level as it extends horizontally and vertically. Decay of the organic materials is accomplished by fungi, anerobic bacteria, and algal and certain other types of microscopic aquatic organisms which break down the organic materials, liberate gaseous constituents, and develop humus.

The topography and composition of the rock materials beneath the substrate surfaces have had and continue to have an effect on local hydrology. This controls the location as well as the composition of the peat resources. Helgeson, Lindholm, and Ericson (1975) describe the regional bedrock surface as a highly irregular surface composed of intrusive (igneous) rocks (Sims, 1970).

The bedrock surface, which encompasses about 150 feet of regional relief and about 50 feet of local relief, is overlain by as little as 50 to as much as 150 feet of glacial and other unconsolidated rock materials. Late Cretaceous-age rock units have been reported in the northern part of the Lake of the Woods Watershed, but these sedimentary rocks have not been reported within the project area.

The near-surface glacial deposits shown on Figure 4 except in peat covered areas, are chiefly till, with lesser volumes of sand; clay and silt deposits confined to the northern parts of the area. The unconsolidated deposits accumulated during three geologic time intervals: (1) Middle to Late Wisconsin Stage, Pleistocene Epoch, (2) Lake Agassiz time, and (3) Holocene Epoch (Figure 5). For a description of the despositional environment and materials associated with the galcial sediments, refer to Hogberg, 1977.

Harris, Moran, and Clayton (1974) investigated the Red River Valley and portions of west-central Minnesota and describe the deposits remaining



LEGEND

WALTER BUTLER COMPANY
ST. PAUL, MINNESOTA

MOSS PEAT (fibric) dominantly of slightly decomposed sphagnum and hypnum mosses; in raised bogs; more than 3.3 and as much as 10 feet thick

REED-SEDGE AND PEAT HUMUS (Qhr-sb, Qhr-sa) (hemic to sapric) dominantly of slightly-to-well decomposed reed-sedges, with grasses, shrubs and other plants; may be highly decomposed at base; as thick as 20 feet; Qhr-sb more than 5.0 ph, Qhr-sa less than 5.0 ph

MOSS, REED-SEDGE AND PEAT HUMUS (Qpls-p, Qplt-p, Qplc-p) (fibric to sapric) moss and/or reed-sedge and/or peat humus; less than 3.3 feet thick; on lake-modified sand or outwash Qpls-p; on lake-modified till Qplt-p, and on lacustrine clay Qplc-p

LAKE-MODIFIED AND LACUSTRINE SAND dominantly sand-size particles with lesser pebble size particles

TILL DEPOSITS composed of sand, silt and clay size particles will lesser amounts of pebble to boulder-size materials

LAKE-MODIFIED TILL sand-rich surface deposits grading downward into sand with clay, silt, and pebble size particles beneath

OUTWASH AND ESKERINE DEPOSITS dominantly sand size particles, commonly with gravel size materials

LACUSTRINE CLAY clay and silt-size particles; customarily in layered sequences

BEACH RIDGE OF GLACIAL LAKE AGASSIZ

ACTIVE PROCESSES DEPOSITS (stream alluvium)

R. K. HOGBERG
E.K. Lehmann and Associates
Minneapolis, Minnesota

PEAT AND OTHER SURFACE DEPOSITS, LAKE OF THE WOODS AND RED LAKE RIVER WATERSHEDS, NORTH-WESTERN, MINNESOTA

0 1 5 10 MI.

n

MODIFIED FROM PRELIMINARY SOIL LANDSCAPE GEOMORPHIC MAPS, BEMIDJI AND ROSEAU SHEETS, MINNESOTA SOIL ATLAS.

FIGURE 4

SUGGESTED GEOCHRONOLOGY FOR THE MOST RECENT GLACIATION

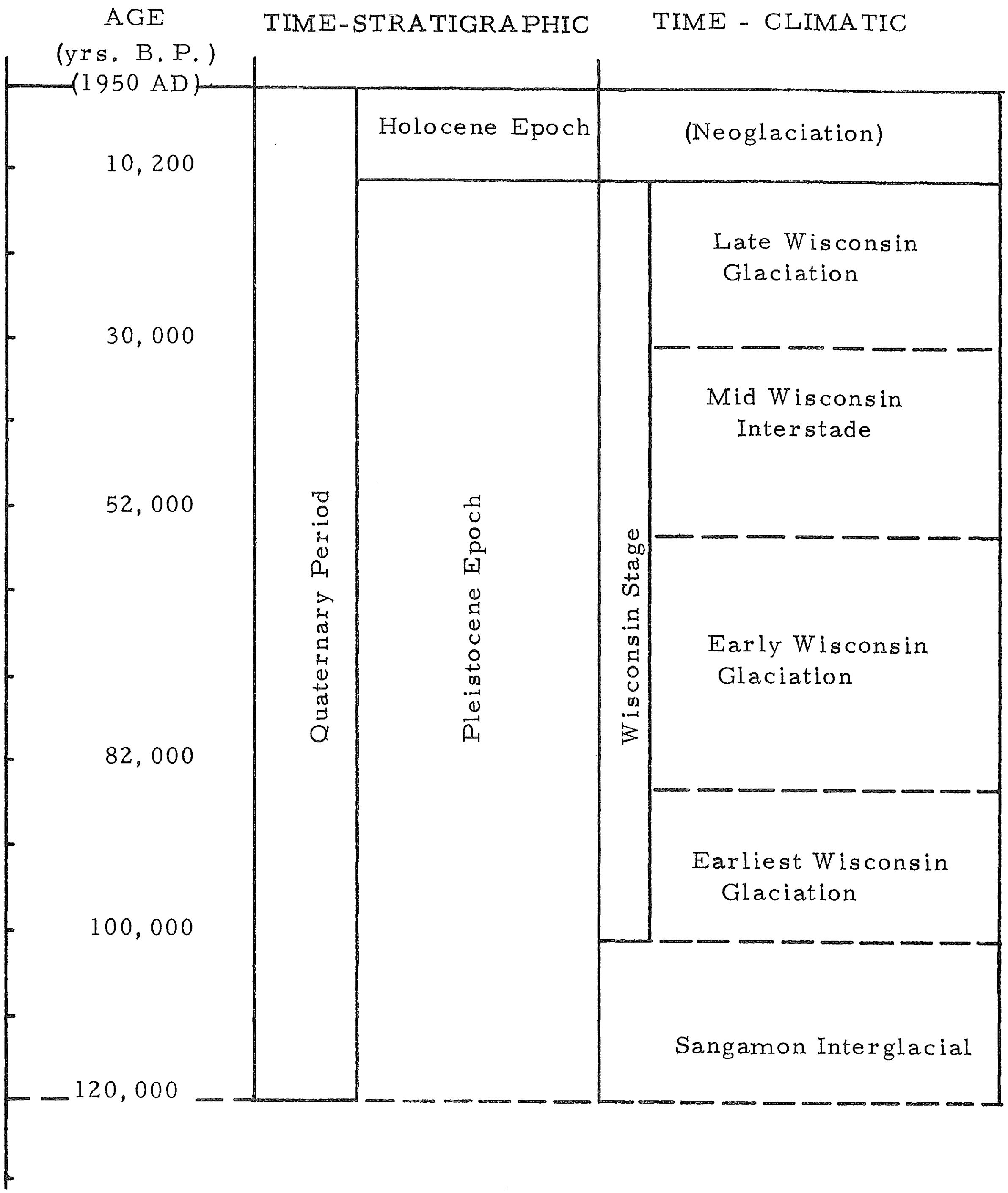


FIGURE 5

from glacial events occurring from about 40,000 to 14,000 C^{14} years ago. The Mid- to Late-Wisconsin age sediments consist mostly of till with lesser quantities of outwash sand, and range from 100 to 150 feet in thickness. The stratigraphic succession consists of a lower, 20 to 50-foot thick, carbonate-poor till overlain by several distinct carbonate-bearing tills. Outwash sands occur between some of the till sheets.

The Lake Agassiz deposits are of three types: (1) lake-modified till, (2) lake-modified sand and lacustrine sand, and (3) lacustrine clays. The near-surface section of the lake-modified till is a think residual layer of sand that remained when the finer silt- and clay-size particles were carried into depositional basins. The thickness and extent of the lake-modified outwash sand and its relationship to lacustrine sand is unknown, and these materials are therefore considered as one unit on Figure 4. The largest areal extent of these deposits is in the Beltrami Island area in southeastern Roseau County and western Lake of the Woods County. The most easily recognized features of Glacial Lake Agassiz are the beach bars (see Figure 4) that mark the former lake levels (Leverett and Sardeson, 1932). A combination of primary deposits can occur in any one area depending on its location with regard to the former configuration of the bottom of the glacial lake. For example, we encountered a substrate consisting of very silty sand with medium-size sand beneath the peat sequence in the NW 1/4 section 24, T55N R32W, within the Red Lake Bog (see Figure 6).

Post-Lake Agassiz or Holocene Epoch deposits consist mostly of alluvial sand developed within former stream courses. Similar age deposits consist of minor amounts of colluvial or slope-wash deposits. Alluvial sands also occur in stream courses within morainal terrane.

The present landscape features result from the interplay of episodic ice advance and deposition of sediments therefrom, and the several stages of Glacial Lake Agassiz as well as the post-Lake Agassiz events. The resulting land surfaces of the Lake of the Woods and Red Lake River watersheds may be classified as either upland, which are not peat-bearing, or lowlands, which are peat-bearing.

The upland environments are mostly confined to the easterly to northeasterly trending range of morainal hills that forms the southern divide of the Red Lake River watershed. Altitudes of the moraine range from about 1250 feet, the approximate altitude of the highest beach of the Glacial Lake Agassiz, to a maximum of about 1600 feet at the hill crests. The unconsolidated materials that form the hills are mostly till-sheet deposits. Scattered irregular areas of eskerine deposits (sand and gravel) interrupt the hillslopes and grade outward into outwash deposits (sand, and sand and gravel). This succession can be seen in the southern part of Beltrami County and in the southwestern part of Itasca County. Small areas of peat accumulation of unknown thickness occur within former ice-block depressions.

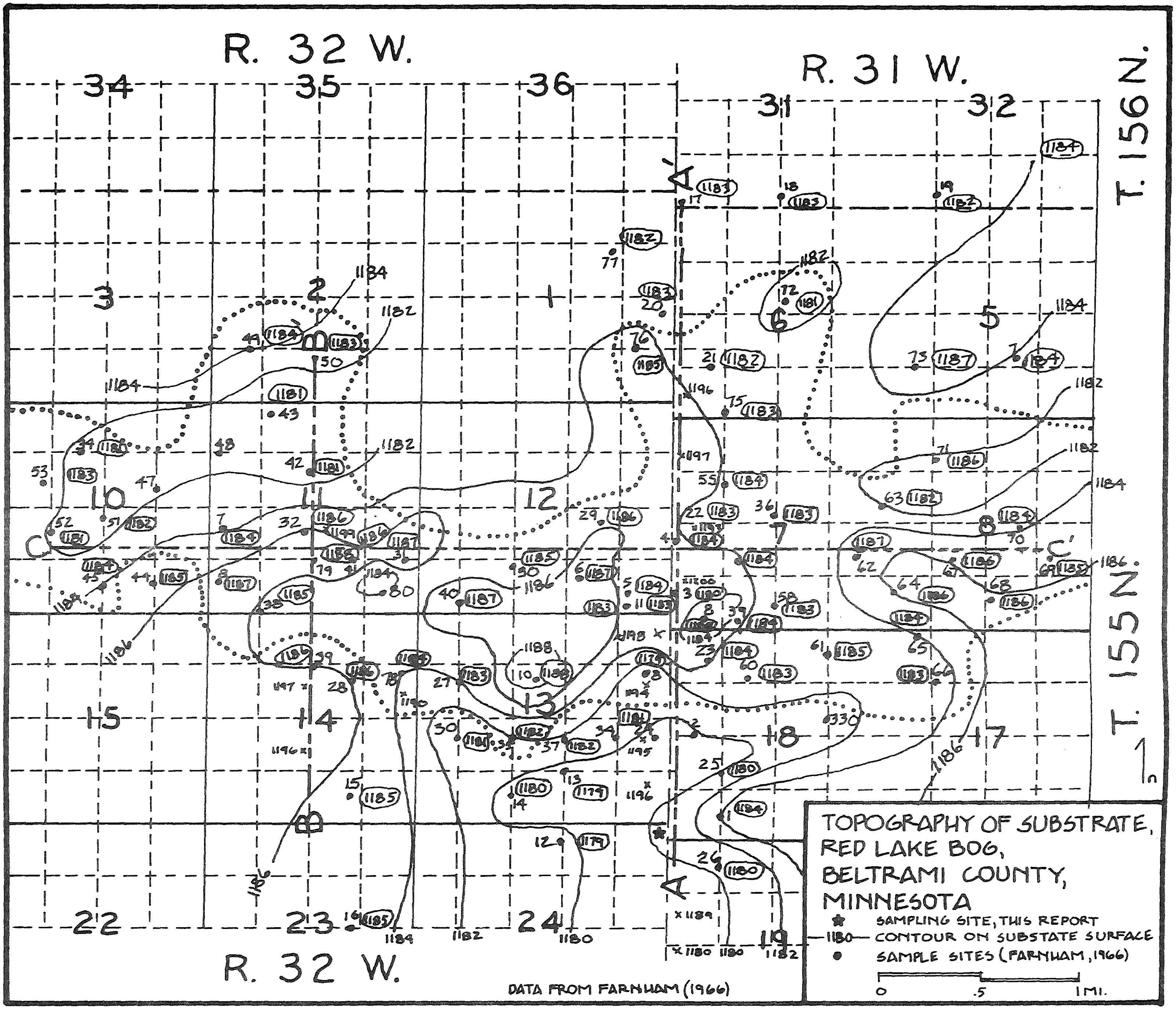

R. 32 W.
R. 31 W.
T. 156 N.
T. 155 N.
R. 32 W.
TOPOGRAPHY OF SUBSTRATE, RED LAKE BOG, BELTRAMI COUNTY, MINNESOTA
SAMPLING SITE, THIS REPORT
1180 CONTOUR ON SUBSTATE SURFACE
SAMPLE SITES (FARNHAM, 1966)
0 .5 1 MI.
DATA FROM FARNHAM (1966)

FIGURE 6

The lowlands are the peat bearing landscapes and comprise the lands lying north of the morainal hills (see Figure 4). Altitudes range from about 1140 feet in the western limit to about 1250 the highest beach-bar level of Glacial Lake Agassiz, near the eastern limits of the project area. The most extensive accumulations of peat occur within large complexes of filled depressions immediately north of Upper Red Lake. The remainder of the area consists of relatively thin (less than 3.3 feet) peat accumulations. A thin irregular covering of peat deposits overlies Beltrami Island in the northern part of the Lake Agassiz plain.

BOG TYPES

PEAT MAY BE FOUND IN TWO BASIC BOG TYPES: 1) RAISED BOG (OMBROTROPHIC) AND 2) GROUND WATER BOG (MINEROTROPHIC).

Raised Bogs

The Red Lake peatland consists of raised (perched) bogs, and depression filled (groundwater) bogs.(Farnham 1966, Heinselman, M. 1963) Raised bogs are the result of the accumulation of sphagnum mosses in a dome shape over deposits of sapric and hemic peat. In Minnesota, the raised bogs may vary in area and contain as much as 1 to 10 feet of fibric peat cover. Raised bogs are normally the result of elevated water table conditions. The water table in the dome will tend to rise with the growth of the sphagnum mosses. As a result, the water table in a raised bog may be as much as 10 feet higher than the water table in the adjacent depression-filled bogs. The water table in a raised bog is normally within 2 feet of the dome surface, but seasonal fluctuations in water table levels are normal.

In terms of outflow and evapotranspiration, raised bogs exhibit seasonal variations in runoff due to seasonal precipitation and snowmelt. The relatively high porosity of fibric peats allows high bog evapotranspiration and interflow losses. As much as 60-80% of the annual streamflow out of Northern Minnesota bogs occurs in the April and May time periods.(USGS 1970) The quality of water in raised bogs is termed ombrotrophic (ion poor), due to its source (i.e., precipitation), as opposed to sub-water table groundwaters, which are mineral rich (minertrophic) due to their flow through unconsolidated glacial deposits. Ion poor water of a raised bog tends to have low calcium content and is acidic with ph values less than 5.0. An important property of sphagnum moss is its capacity of cation exchange (see Glossary) particularly the concentration of heavy metals. The acidity of a raised bog typically is less in the deeper layers of the dome.(Jaowich and Farnham)

The normal tree cover for a raised bog is Black Spruce, which tends to increase slightly the interception losses, and thus raises the rate of evapotranspiration.

Although, ditching in depression filled bogs has generally been unsuccessful, ditching in raised bogs has met with greater success.

Results of ditching indicate that draining of the fibric layers of peat will cause lowering of the water table, for a distance of 50 meters from the ditch, with the greatest reduction within 20 meters of the ditch. Water movement in fibric peats are rapid and the water table surfaces are relatively flat within a 50 meter transect. A typical midsummer drawdown at an experimental ditch showed that the water table was 2.5 feet lower at 5 meters than at 50 meters. This ability to drain these bogs may be enhanced by the fact that the perimeters of the raised bogs have a relatively steep slope for wetlands. (Jongedyk 1954, Boelter, D.H, and State of Minnesota 1968)

Depression Filled Bogs

Depression filled bogs develop within lows on the former glacial Lake Agassiz basin and in ice block depressions. Water table surfaces in these bogs generally reflect the regional water table, but may be slightly higher than the underlying and adjacent glacial sediments. These bogs are minerotrophic and develop under saturated conditions. Depression filled bogs exhibit low conductivity (see Glossary) values due to the typically low conductivity of the hemic and sapric peats. Water is recharged to the bogs by precipitation and from groundwater flows within the underlying glacial drift. Depression filled bogs, or grass covered parts of a bog surface, tend to show annual runoff rates of about 70%.

Groundwaters, prior to entering a bog, are minerotropic (ion-rich). They are usually relatively high in calcium and range from 6 to 7 pH.

Due to the near normal pH and somewhat higher nutrient levels in groundwater bogs, as compared to raised bogs, there is usually a wide variety of plant life. For example, the best timbered peatlands occur on depression filled bog sites. However, high water levels and saturation conditions generally result in stunted to slow growing conditions because of difficulties in establishing adequate root systems. Vegetation will reflect changes in topography.

Drainage of groundwater bogs may not cause any significant change in the water table. Because of low conductivity values through hemic and sapric peats, the effects of ditching are minimized. Minimal water level reductions have been noted in experimental plots as close as 5 meters to the ditch. The low water yield coefficients indicate that the lateral flow will be small. In fact, the drop in water elevation was credited more to evapotranspiration than ditching. The primary benefit of ditching in these peats may be to improve access to these bogs and make the surfaces acceptably dry for certain harvesting techniques.

The Red Lake Bog

The type and areal extent of the peat deposits within the Lake of the Woods and Red Lake River watersheds are delineated on Figure 4. The extensive area of peatlands bordering the Upper Red Lake is referred to as the Red Lake Bog. The Red Lake Bog deserves special consideration. The size and composition of this bog make it a prime contender for commercial peat development.

A number of raised bogs that contain considerable reserves of moss peat (fibric) occur within the extensive areas of depression-filled-type bogs. Figure 4 also depicts the areal extent of the two categories of reed-sedge (hemic) and peat humus (sapric), namely the calcite-deficient and non-calcite-deficient types. Peat deposits averaging less than 3.3 feet in thickness are also mapped on Figure 4.

During a field visit, the Project Team observed the bog and adjacent peatlands from a fixed-wing aircraft. Also, a sample of 10.5 feet of the peat sequence and 1.5 feet of the substrate materials was taken with a McCalaey sampler.

The substrate topography and thickness of the reed-sedge and peat-humus sequences are shown on Figures 6 and 7. The surface altitudes were estimated from the U.S. Geological Survey topographic maps and the data for the sequence and thickness of the peats are from Farnham (1966).

A visual interpretation of the various contrasting vegetative sites on a composite layup of orthophoto maps of the U.S. Geological Survey 1:24,000-scale topographic quadrangles strongly suggests a basic control of the vegetation by the types and areal extent of glacial material or lake sediments at the substrate surface. For example, the pattern of raised bogs that appear to be related to former shoreline features of Glacial Lake Agassiz, are dramatically shown on the map of the Red Lakes peatlands (see Figure 4). Also, the boundary between the calcite-deficient and non- calcite-deficient depression-filled bogs can be easily drawn.

In addition to the area of greater than 5 feet of moss peat, shown by Farnham (1966), Figures 6 and 7 show an extensive area, consisting of a number of filled depressions, that has an average of greater than 6 feet of reed-sedge and peat humus reserves. According to Soper (1919) the average of 7 sampling holes that reached 10 feet in depth within the Red Lake Bog contained about 26 percent ash on a 8 percent moisture basis, about 0.08 percent sulphus, and 1.98 percent nitrogen, and had an energy content of about 7075 BUTs/lb. on a moisture-free basis.

Other large depression-filled bogs, not in the Red Lake Bog, occur within the Reservation area. The work of Soper (1916) indicates similar thicknesses and calorific values of about 7000 BTUs/lb., on a moisture-free basis, for these deposits. We were unable to find more detailed information, other than that given in Figure 4.

The following analyses are from the work of Farnham (1966) on the Red Lake Bog. The ash content of the moss peat averages about 4 percent. The reed-sedge and peat humus water-holding capacity varied from 800 to 1500 percent and the ash content ranges from 4 to 12 percent with the highest contents from samples near the base.

Finney and Farnham (1968) found, in peat samples from the Red Lake bog, that two-thirds of the inorganic materials was insoluble and consisted mostly of opal and lesser quantities of feldspar, quartz, mica, and other rock and mineral fragments. The opal was of biologic origin and most was hypothesized to have been carried into the bog by winds. Of the soluble materials, elemental analysis indicates contents (in percent) of: Calcium (Ca)=0.3 to 0.9, Magnesium (Mg)=0.01, Phosphorous (P)=0.3 to 0.9, and Sodium (Na)=0.6 to 0.7.

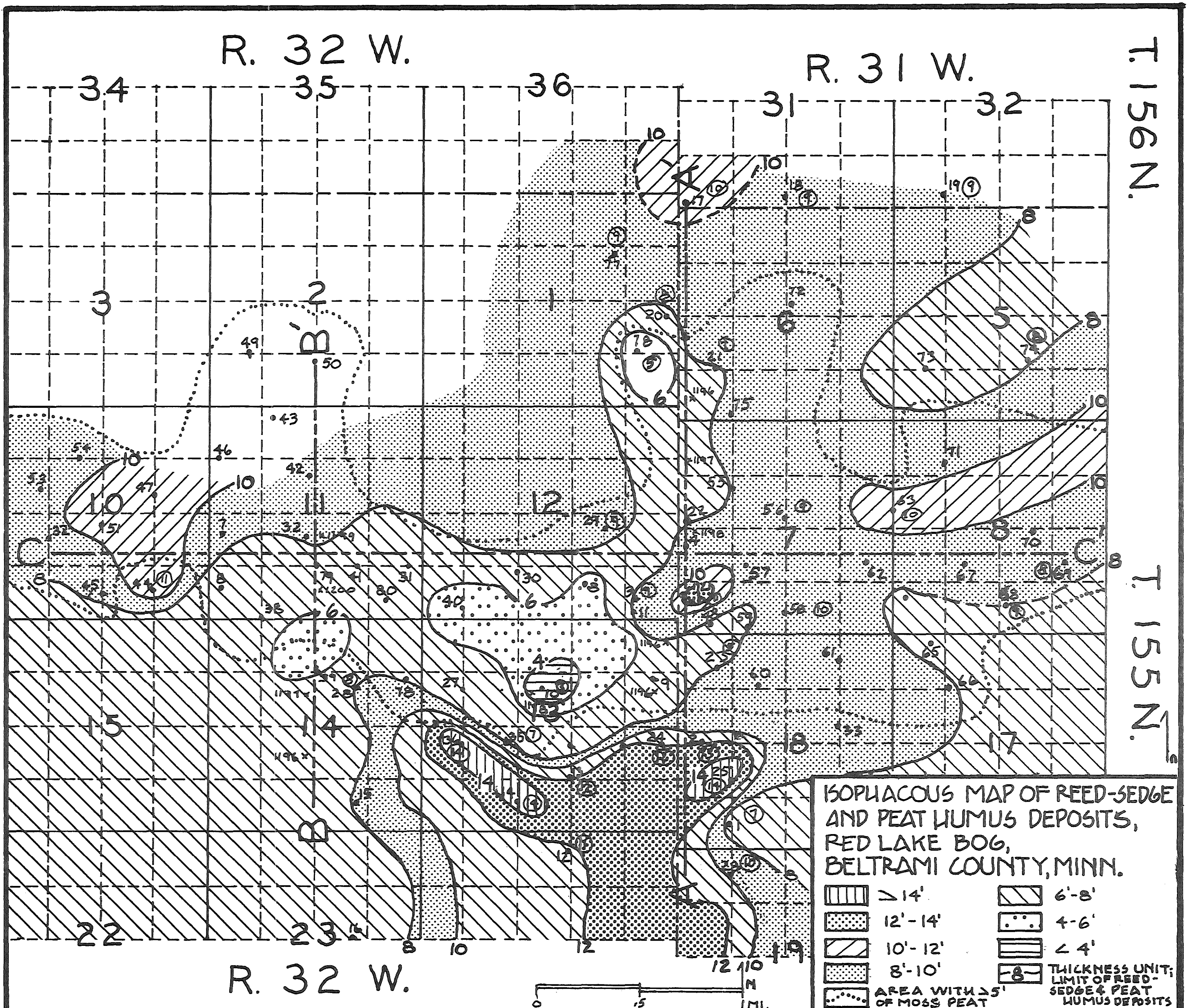
Table 2 presents the results of tests on a peat sample taken from the Red Lake bog in 1977 by the Project Team. The location from which the sample was taken is shown on Figure 6. The date in the table may be compared with the published data of previous studies described above. The differences in water holding capacity are probably due to drying of the sample during transport prior to analysis.

Table 2

RED LAKE BOG SAMPLE*
(Approximately 200 Feet Southwest of Northeast Corner Section 24, T155N, R32W, Beltrami County, Minnesota)

Sample No.	Depth (in ft.)	Peat type	pH	Ash Content** (%)	H_2O Holding Capacity+ (%)
1-a	1.5 - 3.5	hemic	5.4	4.44	698
1-b	3.5 - 5.5	hemic (fibrous)	4.6	4.48	895
1-c	5.5 - 11.0	hemic & fibric	5.6	10.4	660
(base)	11.0	(sandy silt)	-	-	-

* Analyzed by Soil Department, University of Minnesota
** On a dry basis
\+ On a saturated basis



DATA FROM FARNHAM (1966)

FIGURE 7

UTILIZATION METHOD

THE PEAT PRODUCT DESIRED DETERMINES THE UTILIZATION METHOD.

VIRTUALLY ALL TYPES OF PEAT UTILIZATION REQUIRE SURVEYING THE SITE, CLEARING SURFACE VEGETATION, BUILDING ROADS TO THE SITE, PROVIDING DRAINAGE SYSTEMS AND PROVIDING FOR SITE RECLAMATION.

ON-SITE UTILIZATION METODS INVOLVE REMOVING THE SURFACE LAYER OF PEAT, LANDSCAPNG, FERTILIZATION AND A WATER LEVEL CONTROL SYSTEM.

EXTRACTIVE UTILIZATION METHODS INCLUDE SOD PEAT METHODS, PEAT MILLING, AND HYDROLIC PROCESSES. THESE ARE THE MOST USED MECHANICAL HARVESTING PROCESSES.

The functional area of utilization methods describes the various peat harvesting techniques. These methods are classified as extractive and on-site uses. The method used will be determined by the peat product desired. However, there are procedures common to both extractive and on-site utilization mehtods. These procedures include surveying, road construction, vegetation removal, drainage and reclamation.

A detailed site survey should be made before a bog is drained and prepared for use. The survey should identify the surface vegetation, determine the basal and surficial elevations of the deposit, and assess the mineral soil substration. This survey should include such items as the depth of the deposit, degree of decomposition, moisture content, and hydraulic conductivity. If the peat is to be used for fuel purposes, density, mineral content and calorific value are also analyzed.

One of the most important aspects of the survey is the determination of the bog stratigraphy for hydrologic purposes. The hydraulic conductivity of the more fibrous surficial peat is higher than that of the basal, highly decomposed peat. This difference will influence the drainage and water level draw-down rates and determine the design of the drainage system.

In addition to the bog analysis, a detailed survey is usually made of all the minor streams and rivers which carry the drainage and draw-down water from the bog. This aids in assessing the practicality of using gravity drainage. This is particularily important in Minnesota were many of the bogs are located in areas of a high water table and there are no nearby rivers for disposing of the bog water through gravity drainage. Once the survey is completed and all the data analyzed, the method of clearing, draining and harvesting can be selected.

The clearing of the bog follows as the next major step in the utilization of a peat bog. The surface vegetation, buried stumps and large wood fragments are removed. The clearing is often carried out in the winter months when the surface is frozen. Depending upon the survey results, the bog may be preliminarily ditched to eliminate water immediately below the surface of the bog. This drainage will improve the soils' ability to support the clearing equipment. This requires the removal of 10-15% of the volumetric water content of the saturated peat.

Conventional excavating and earth-moving equipment is used in the United States for the clearing of bogs. In contrast, the Europeans have designed clearing machines specifically suited to this purpose. For example, a multi-purpose machine has been developed by the Finns which can be equipped for leveling, grubbing, ditching and harvesting. The Russians have also developed a universal excavator which can clear timber and harvest peat with various attachments.

With the surface of the bog clean, extensive development of the drainage system can begin. The use of peat chosen will determine the type of drainage layout and the drainage impacts. Ditching would probably be done in two stages, with the fibric peats being drained, then removed, and the hemic and sapric peats being ditched later.

Preliminary drainage of the peats would involve ditching around the perimeter of the proposed site and within the peat areas. The perimeter ditching acts as a dike to limit inflow from and outflow through the peats surrounding the work site. Interior ditching would normally be spaced to allow the highest rate of outflow due to gravity. The site would probably be drained through a single control point.

This draining and removal process would most effectively be carried out during the months of July through November, avoiding the high precipitation and snowmelt of Spring. This would allow the removal of the peat prior to freezing and snowfall. The timing of the peat removal will have a definite effect upon the impact which this activity has upon the surrounding areas.

Transportation systems, for the removal of products grown on the bogs or for the delivery of extracted peats to processing facilities, must be constructed. One of the significant aspects of road construction in peat areas relates to the daming effect of roads on the established surface runoff and interflow routes. (USGS 1967) Daming, resulting in a small change (10-12 inches), will have a negative impact upon tree growth adjacent to the road. Uphill from the road, flooding of tree root zones may occur if inadequate culvert systems are not installed. Conversely, downhill from the road a lower water table will accelerate plant growth.

Reclamation is usually the last harvesting step in peat utilization. Many of the European peatlands, from which energy peats have been extracted, have been transformed into productive land. They have been used for agricultural and forestry production, or reclaimed for fish and wildlife habitat areas and recreation. In the Soviet Union, most of the harvested peatlands are being reclaimed for agricultural and forestry uses. Presently, all Soviet bogs 5 feet or less in depth are set aside for agricultural or forestry purposes. The Russians have also found that the bog drainage system can perform two functions: lowering the water level for harvesting, and control the supply of water to the area.

The Finns are reclaiming their peatlands principally for tree production. Also, twenty (20) harvested and reclaimed bogs are being used as municipal waste treatment sites.

The Irish have reclaimed 3.5 million acres of peatland for grass and crop production. They have conducted extensive research into reclamation techniques and the type of land use most appropriate to each site. Numerous experiments are being conducted to match reclamation practices to the subsoil conditions below the peat. This will aid in the determination of which harvesting methods will not deter cultivation of the harvested bog.

Although reclamation techniques may differ from site to site, some general principles can be established. After the peat is removed, a harvested bog is often in an over-drained condition. In order to provide sufficient moisture for cultivation, an adjustment to the existing drainage must be made. Backfilling of the old ditches is a common technique.

Most mined bogs need leveling and some cambering between the ditches to encourage sufficient surface runoff of rain water. Many bogs also require an initial fertilizer treatment in order to adjust for phosphorous and potassium deficiencies. If the peat has a pH below 5.0, lime is usually required. Depending upon which crops are to be grown, additions of certain minor trace elements and weed control chemicals are necessary.

In high water table areas, such as Red Lake, harvesting sites are usually allowed to form ponds. Ponding portions of the bog area may provide a wildlife habitat area. Warner (oral communication, 1977) has speculated that some migratory birds which live in Canadian bogs may use the Northern Minnesota peatlands as a pre-migratory fattening site. These ponds could conceivably act as a wildlife refuge for these migratory birds and such mammals as the beaver and muskrat. Ponding could conceivably occur independently of peat utilization operations or as a reclamation project on previously mined peatlands. Either a raised or depression filled bog could be used for ponding. In a depression filled bog, once the peat is removed, the groundwater forms a pond.

In either case, future precipitation will fill the depression until a pond is formed with a surface elevation approximating the adjacent bog elevations.

Following the formation of a pond in either a depression filled or surface bog, the runoff would closely approximate the seasonal precipitation. When the peat was in place, the runoff was slightly delayed due to the temporary storage of the peat layers. The result to the Red Lakes water would depend upon how much area had been ponded. Large scale ponding could cause large quantities of runoff to enter the Red Lakes without the delay caused by temporary storage of peatlands. The quality of water would most likely be similar to non-ponded areas but the additional quantities of bog water may present further problems to the fish production. Drainage quantity estimates must be further refined before the effects can be measured.

ON-SITE USE METHODS

Development strategies for peat utilization which enable the peats to be prepared and utilized in the bog include a variety of agricultural land uses. The best crops for the Red Lake area are those that have short growing seasons or can withstand light frosts.

The surficial layer of fibric peat can not adequately support large scale agricultural product growth and must be removed to expose hemic peats, an organic soil suitable for cultivation.

This exposed soil surface must be carefully prepared for cultivation and must be landscaped to support the equipment used for planting and harvesting the vegetables.

After surface preparation of the peat soils for agricultural use, large quantities of fertilizers, and other important soil additives which encourage high crop productivity, must be added to the soil. This additional nutrient load of potash, phosphorous, and other micronutrients may create some problems in runoff. Studies indicate that the outflow of nutrients into drainage basins is similar to that of undeveloped bogs of similar peat types.(Farnham, R.S.) Weed and pest controlling chemicals and methods vary widely. The herbicides and pesticides which may be added to the soil or sprayed on the plants could remain in the peat environment for some time. Ongoing use of peats for croplands may reduce the depth of peats over time due to oxidation.

Grass crop production, including the growing of sod and the raising of seed producing grasses such as wild rice and wheat, requires much the same land preparation and control as the growing of vegetable crops.

Extensive commercial forestation of a bog area requires the development of an intricate, well integrated water level control system which allows the regulation of the quantity and quality of the water reaching the root zones of the trees.

EXTRACTIVE USE METHODS

Extractive uses of peat necessitate the removal of peats from the bog. Methods for removal of peat from bogs include: the sod peat process, the milled peat process, and the hydraulic mining process.

The sod peat method excavates the peat from a deep vertical trench by some type of bucket-dredging machine. In Ireland, this machine, known as a "bagger", scoops up the peat, compresses it and extrudes it into long ribbons, where cutting discs follow. The peat is cut into approximately 14 inches long by 5 inches square sods. The sods are left in the field to dry until they reach 35% water content (total weight basis), after which they are collected and shipped. An average season in Ireland yields two harvests per field.

Most European countries have found that sod peat production is hampered by high labor costs and short harvesting seasons. The Finns only use the sod peat method when it is found that milled peat is unfeasible. European operators have also found that the milled peat process can be totally mechanized and thus has lower capital and labor costs.

The milled method is principally surficial and involves the removal of 1/4-1/2 inch of peat at a time. It is a multi-step procedure which consists of milling, harrowing, ridging and stockpiling. The peat is milled by a toothed rotating drum and finely shreded. The peat is then deposited on the field to dry. After the peat is dry, it is collected into ridges and then picked up by a mechanical spiral unit. In good weather, a harvest cycle of 2-3 days is possible. The Irish, consider 2,800 acres the smallest production area. Using the milled method they average about 12 harvests per season.

Russian technicians have developed a pneumatic (or vacuum) harvester which collects only the driest peat It has eliminated the need to ridge and excessively harrow the peat. This has reduced the harvesting cycle from 2-3 days to one day.

Other methods used in the extraction of peat include the hydro-peat process, the use of draglines, bucket-wheel excavators, and hydraulic dredging. However, these are not commonly used in peat harvesting.

In hydro-peat, the peat is subjected to high water pressure which reduces it to an aqueous solution. This slurry is then pumped thorugh pipes onto drying fields, or to mechanical dryers. When the water content is less than 85% total weight, the peat may be removed for refining. The process has been used mainly in the Soviet Union where the production season involves a 3 month hydro-separation phase, followed by a 2 month drying period. The hydro-peat method is rarely used because of high labor, power and equipment costs.

Although a dragline is rarely used, it has certain advantages. A dragline can work effectively in small areas and on rough terrain when crawler-mounted. Larger dragline units, when mounted on circular tubs, usually give a lower bearing pressure compared to other heavy excavating equipment. This allows them to drive on the bogs with less difficulty. The bucket-wheel excavator, which is used in bituminous and lignite coal mining, has the advantage of flexibility in operation. It operates on the principal of continuous excavation that excavates and discharges material simultaneously. However, it is not currently in wide spread use.

The United States Bureau of Mines is currently testing a hydraulic dredging process. These systems use a "Mud Cat" dredge and a "Vari-Nip" dewatering press. The barge mounted dredge is intended to float on a water saturated bog, pump the peat slurry into a dewatering machine, where the dewaterer reduces the slurry water content by pressure filtration. In the Fall of 1977, this system was tested near Washisk, Minnesota. Although this test suffered many difficulties, the method holds promise as a system for harvesting and dewatering large quantities of peat in a short time.

IMPACT MEDIUMS

The principle Impact Mediums of peat utilization in the Red Lake area are the water, land and air. Peat utilization, whether extractive or on-site, will impact these components of the environment through these mediums.

IMPACT MEDIUM: WATER

WATER IS THE IMPACT MEDIUM THROUGH WHICH THE EFFECTS OF PEAT UTILIZATION ARE MOST LIKELY TO BE TRANSFERRED THROUGH THE RESERVATION ENVIRONMENT.

THE HYDROLOGY OF THE AREA IS CLASSIFIED INTO TWO CATEGORIES. GROUNDWATER ENCOMPASSES THE ASPECTS OF WATER WITHIN THE MINERAL AND ORGANIC SOILS. SURFACE WATER ENCOMPASSES THE ASPECTS OF WATER TRANSFERRED AT, OR ABOVE, THE SURFACE OF THE SOILS.

THE IMPACT OF PEAT UTILIZATION ON THE AREA'S HYDROLOGY IS COMPLEX AND MULTIFACETED. MANY COMPONENTS OF THE RED LAKE ENVIRONMENT ARE AFFECTED BY ANY CHANGE IN THE AREAS' HYDROLOGY.

Water is the component of the environment which is most likely to be affected by peat development. Through changes in the hydrology of the area, the effects of peat development will be transferred to the Reservation environment.

Water is classified into two categories; groundwater and surface water. Our discussion of groundwater will be concerned with all of the hydrological conditions within mineral and organic soils, such as conductivity, evapotranspiration, and quality. Our discussion of surface water will be concerned with the quantity and quality of waters transported at or above the surface of mineral and organic soils, which include peat. Our discussion will also focus on the methods of water transportation including precipitation, streamflow and evapotranspiration.

The hydrological regimen of the Red Lake area is described in detail below. The hydrological activities involved in peat utilization are then discussed. This will provide the background for a review of the principle water impacts.

Groundwater

THE LEVEL OF GROUNDWATER , THE LEVEL OF SURFACE WATER AND THE GEOLOGY OF THE AREA RESULT IN FREQUENT EXCHANGES OF GROUND AND SURFACE WATER.

WITHIN THE GROUNDWATER CIRCULATION SYSTEM, ABOUT 75% OF THE WATER RECHARGED IS RELEASED TO THE ATMOSPHERE THROUGH EVAPOTRANSPIRATION.

THE RATE OF GROUNDWATER RUNOFF FROM GLACIAL AQUIFERS IS GREATER THAN FROM PEAT AQUIFERS.

THE GROUNDWATER QUALITY IN GLACIAL AQUIFERS IS QUITE DIFFERENT FROM RAISED BOGS. NORMAL SUB-SURFACE WATER HAS A pH OF 6 TO 7, AND CALCITE CONCENTRATIONS GREATER THAN 15 MILLIGRAMS/LITER. RAISED BOGS HAVE A 3.6 pH AND CALCITE CONTENTS OF 4 TO 5 MILLIGRAMS/LITER.

The groundwater analysis is based on the knowledge of area geography described in the Red Lake Peatlands Section. The groundwater resources within the project area modify and are modified by the peat resource. These changes occur during the general circulation of the groundwater through the various sequences and types of peat.

Water from precipitation, snowmelt, and leakage from streams, lakes and ponds percolates down through the unconsolidated organic and inorganic materials. This occurs at widely differing rates to the unconfined water table. The water reaching the water table remains temporarily in storage. The stored waters, depending upon their particular position within the groundwater circulation system, run off to streams, or move as underflows to lower altitude positions upon the water table surface, or are discharged to the atmosphere by evapotranspiration. These relationships can be represented by a groundwater budget such as that suggested by Schicht and Walton (1961). Familiarity with this equation will aid in the understanding of the groundwater processes.

$$PG = Rg + Etg + U + Sg$$

PG = groundwater recharge
Rg = groundwater runoff
Etg = groundwater evapotranspiration
U = subsurface underflow
Sg = change in groundwater storage

During years of normal recharge, runoff, evapotranspiration, and underflow, there would be no annual change in storage or water levels.

Groundwater is stored within porous, organic and inorganic aquifers. These water storage bodies are categorized as shallow and deep. The shallow aquifers include the peat sequences and the unconsolidated rock materials and the deep aquifers include water-bearing strata within the bedrock. Additions to, and subtractions from, the aquifers result in seasonal and other periodic changes in water levels. Furthermore, the chemical and physical qualities of the groundwater change as the water passes from element to element within the general groundwater circulation system. This is particularly true within the upper parts of the shallow aquifers.

The shallow aquifers will be directly affected by peat development. Water stored within the shallow aquifers is mostly under water table pressure conditions. However, the diminished rate of flow or hydraulic conductivity through the highly decomposed peat sequences, as well as the presence of confining layers of till within the glacial deposits, result in artesian conditions in some localities.

The near-surface peat accumulations and the underlying 50 to 200 feet of glacial materials are water saturated below the water table and the peat sequence and glacial materials vary in the relative amount of porosity and therefore in the quantity of water that can be held in storage. The rate of additions to or release from storage is governed by this relative hydraulic conductivity.

Porosity values within the peat sequences range from a high of 95 percent in the near-surface deposits to a low of about 70 percent in the basal, highly decomposed peats (Boelter, 1966). Also, according to Boelter (1969), the hydraulic conductivity of the northern Minnesota peats range from greater than 180 x 10^{-5} cm/sec in, non-decomposed near-surface peats to less than 2.1 x 10^{-5} cm/sec in highly decomposed basal peats.

A general range of porosity values for the glacial materials that underlie the peats in the project area can range from about 50 percent in coarse sand to a low of about 30 percent in the heterogeneous mixture of particle sizes that are commonly found in till. However, to the Project Team's knowledge, no specific measurements have been made. Hydraulic conductivities in some of the glacial deposits would have ranges similar to peat. But unlike peat, glacial deposits may have large differentials in hydraulic conductivity between contiguous deposits, such as between a till and a coarse sand. This difference results where favorable environmental conditions hold, in confined or artesian flow.

The work of Boelter and Verry (1976) indicates that the annual evapotranspiration from forested peatlands is, in general, similar to the potential evapotranspiration calculated by the Thornthwaite method. A study conducted on a northern Minnesota forested bog from May 1 to November 1 during six calendar years measured actual evapotranspiration levels of about 18.3 to 20.7 inches. Thus, within the groundwater circulation system, about 75 percent of the water recharged is released to the atmosphere by evapotranspiration.

Within the so-called "zone of rapid circulation" (Piper, 1969), groundwater flows by gravity from high to low positions within the aquifers. The recharge from precipitation and snowmelt within the project area, during normal years, about equals the losses to evapotranspiration and to groundwater runoff. But seasonally, the water levels may vary considerably, particularly during periods of drought.

Two types of shallow aquifers occur within the project area, those within the peat sequences and those within the glacial materials. Also, two distinct types of storage occur within the peat aquifers, raised bogs containing perched aquifers and depression-filled bogs.

The water stored in the raised bogs is recharged directly from and is dependent upon hydrometeorologic events (Bay, 1970). Some water, however, is probably obtained from underlying water table surfaces by capillary action. Thus discharge to surface streams from these perched water bodies is more or less independent of groundwater levels. The discharge from depression-filled bogs is, on the other hand, directly dependent on groundwater levels. Figures 8 and 9 show the monthly streamflow increment from raised and depression-filled bogs. Maximum runoff from both types of storage reservoirs is during April when the snow is melting and early spring rainfall and low levels of evapotranspiration occur. The rate of flow from the near-surface moss peats in depression-filled bogs may be as high as 119 feet/day while the rate of flow from the highly decomposed peat humus is as low as 0.016 feet/day (Boelter, 1977) (as based on a 100 percent hydraulic gradient). Boelter and Verry (1976) found that in 1969 only about 1.6 inches or about 8 percent of the 21.5 inches of the water budget was released as runoff from two northern Minnesota bogs.

The rate of groundwater runoff from glacial aquifers is probably somewhat greater than that from peat aquifers. This is shown, at least in part, by the average runoff rate of about 6 inches or about 23 percent of the

MONTHLY STREAMFLOW FROM BOGS

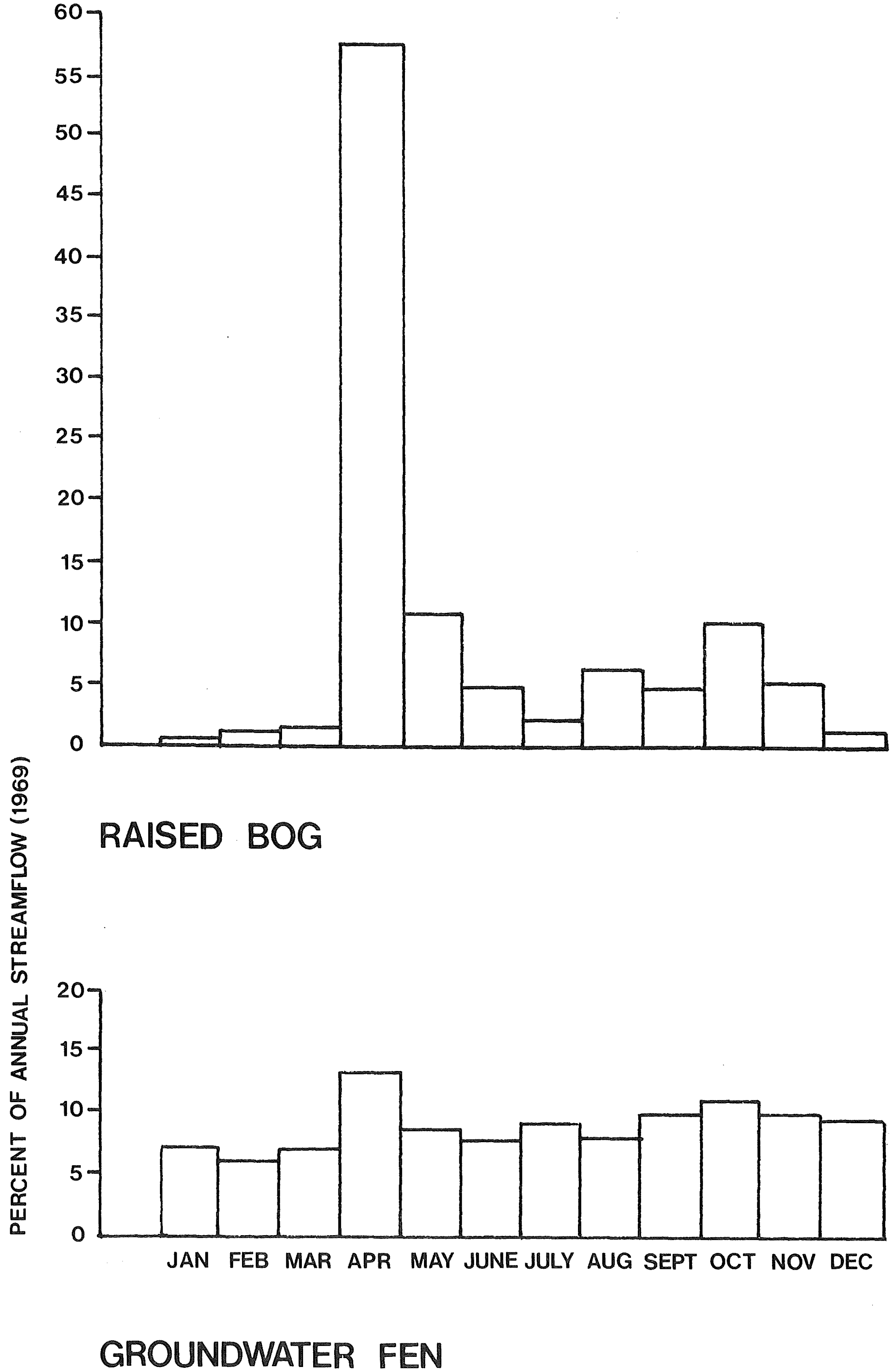


FIGURE 8

MONTHLY PRECIPITATION-POTENTIAL EVAPOTRANSPIRATION-RUNOFF RELATIONSHIPS FOR A RAISED BOG

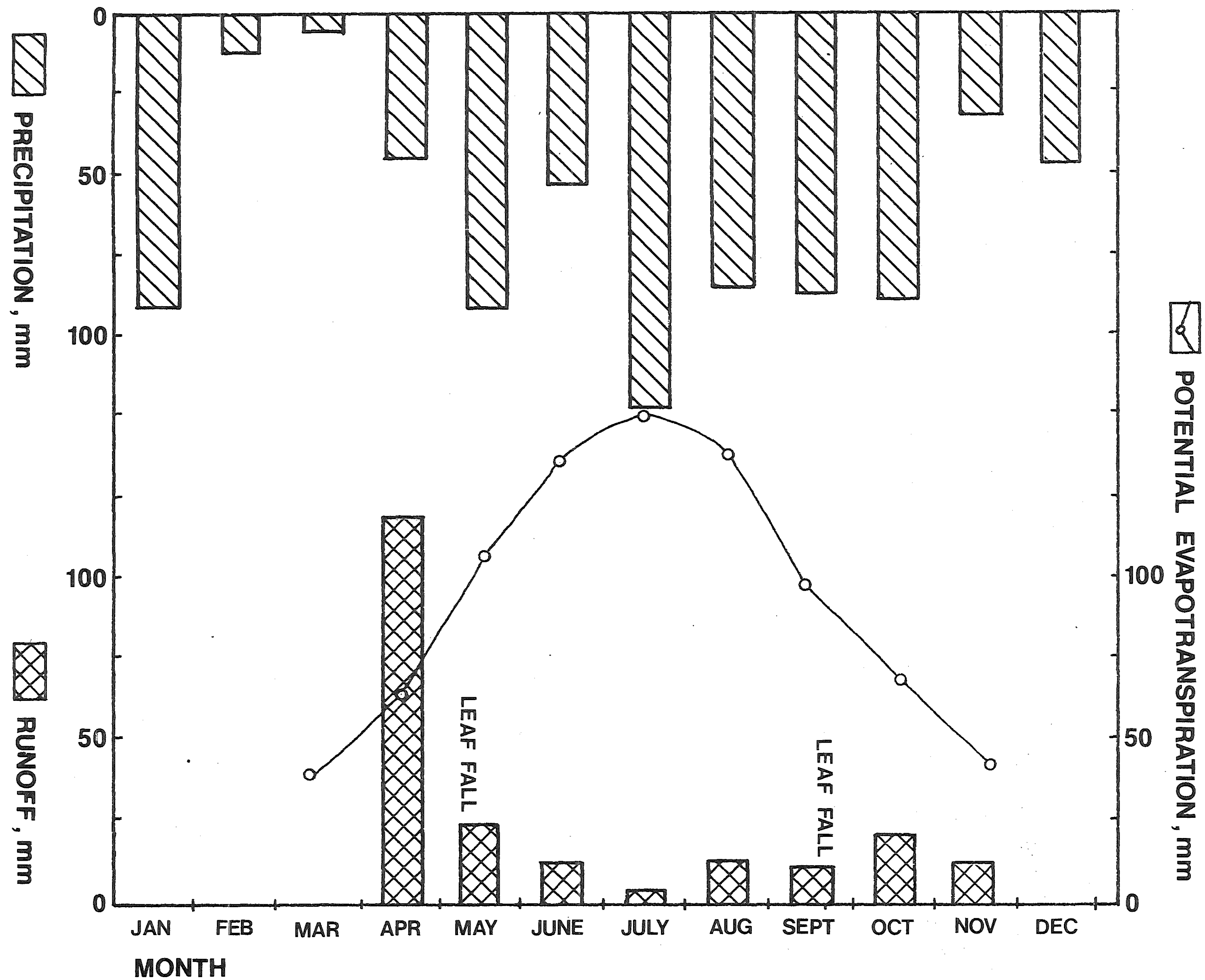


FIGURE 9

water budget from the Lake of the Woods Watershed (Helgeson, Lindholm, and Ericson, 1975) as compared to the 8 percent measured by Boelter and Verry (1976) from two peat bog aquifers.

The rate and volume of groundwater movement within the subsurface glacial materials is difficult to measure. However, subsurface flows have formed groundwater mounds in certain localities within the peatlands adjacent to Upper Red Lake, including the Red Lake Bog. These mounds are marked at the land surface by areas of vegetation that are in contrast to the surrounding bog vegetation. Heinselman (1963) attributes the existence of these vegetative sites to groundwater movement and consequent changes in water chemistry.

The quality of water in the shallow groundwater circulation system, ranges quite widely within the project area. The largest differences are between the waters in the glacial deposits and those in the raised bogs. In general, the quality of the groundwater reflects the residence time, types of materials, and the physical and chemical environments within which it moves.

According to Boelter and Verry (1976) the waters of raised bogs have characteristic 3.6 pH, specific conductances of 80 umhos/cm @ $25^{o}C$, and calcite contents of 4 to 5 mg/l, and sulphate is the predominant anion and hydrogen the predominant cation. In contrast, the normal subsurface water within glacial deposits have pH of 6 to 7, conductances of

100 umhos/cm, and calcite concentrations of greater than 15 mg/l (often 20 to 30 X are common), and bicarbonate is the predominant anion calcium the predominant cation.

The highly acid waters of the raised bogs are due to the high ratio of organic materials to exchangeable metallic ions (Ca, Mg, Na, K). According to Heinselman (1970), during the decomposition of the organic materials, when the total organic content reaches about 85 percent on a dry weight basis, the waters reach pH levels of 5 and lower as the cation balance continues to shift toward hydrogen. The low pH values indicate a deficiency in calcium. These waters normally are also very deficient in nitrogen and phosphorous. In fact, the water in the raised bogs reflect to a considerable degree the chemistry of normal rainwater, that is, a pH of about 5.6 (Hem, 1970) and a 0.3 to 2.0 mg/l calcium content (Boelter and Verry, 1976).

Groundwater in the depression filled bogs have pHs ranging from about 6 to 7 (Bay, 1967) and have calcium contents ranging from 2.0 to 16.0 (see Table 3).

Table 3

AVERAGE CONCENTRATION OF THE CONSTITUTENTS OF STREAMFLOW OF RAISED AND GROUNDWATER PEAT BOG AQUIFERS

Water Characteristics	Raised Bog Watersheds				Groundwater Fen Watershed			
	X	+/-	SD	N	X	+/-	SD	N
Color units	336	+/-	145	170	100	+/-	64	22
pH units	3.6	+/-	0.3	93	6.5	+/-	0.28	15
Specific conductance (umho at 25^{o}C)	51	+/-	13	104	125	+/-	48	16
	mg/liter							
Total acidity (as $CaCO_3$)	48.2	+/-	24	132	--	+/-	--	--
Total alkalinity (as $CaCO_3$)	--	+/-	--	--	54.2	+/-	28.0	18
Total-N	1.34	+/-	0.64	167	0.58	+/-	0.29	21
Organic-N	0.69	+/-	0.40	165	0.33	+/-	0.22	21
Ammonia-N	0.45	+/-	0.39	165	0.15	+/-	0.14	21
Nitrate-N	0.20	+/-	0.25	168	0.10	+/-	0.07	21
Nitrite-N	0.003	+/-	0.003	166	0.003	+/-	0.003	21
Total-P	0.06	+/-	0.06	136	0.03	+/-	0.01	17
Cl	0.7	+/-	0.8	172	0.4	+/-	0.4	22
SO_4	4.6	+/-	2.2	73	6.0	+/-	4.2	7
Fe	1.35	+/-	0.8	166	0.98	+/-	0.48	21
Ca	2.4	+/-	1.0	170	16.6	+/-	9.0	22
Na	0.6	+/-	0.3	164	2.0	+/-	1.0	22
Mg	0.97	+/-	0.36	136	2.88	+/-	0.93	15
Mn	0.06	+/-	0.05	136	0.08	+/-	0.06	14
K	1.3	+/-	0.6	128	1.1	+/-	0.4	22
Al	0.79	+/-	0.43	135	0.16	+/-	0.06	14
Cu	0.04	+/-	0.07	121	0.18	+/-	0.36	11
Pb*	**0.05	+/-	--	116	**0.05	+/-	--	12
Zn	0.08	+/-	0.11	123	0.11	+/-	0.17	12
Si	2.7	+/-	2.1	49	4.9	+/-	4.0	3

*Usually below detection limit of .05 mg/liter.
**Less than.
Source: Boelter and Verry, 1976

Boelter and Verry (1976) suggest that the quality of streams draining peatlands is dependent on the relative volume and quality of the runoff from the dominant glacial deposits. Also, in general, water draining from raised bogs does not have a significant effect on the composition of streams draining large area peatlands. Heinselman (1970) finds that bog waters (Table 3), after joining the surface streams, increase about one point in pH and increase in calcium content 3 to 4 times. Lundberg and Trieby found fairly consistent, slightly basic, 8.0 to 8.01 pH, water draining from wild rice paddies and peatland bordering the Clearwater River. Crawford (written communication, 1977) finds that streams draining bogs contain very little dissolved organic matter and relatively small amounts of inorganic nutrients, such as nitrogen and phosphorous.

The mixing of the tea-colored stream waters from the bogs with the waters of Upper and Lower Red Lakes can be easily seen from the air and in colored pictures. A partial chemical analysis of water from Lower Red Lake (Lloyd Smith, oral communication, 1977) is given in Table 4; the predominant effects of the glacial drift aquifers can be readily seen in the water quality constituents given for Lower Red Lake which consist of the equivalent of slightly hard (Hem, 1970) calcium-magnesium-biocarbonate type water. These characteristics are similar to the characteristics of water in glacial drift aquifers.

Table 4

CHEMICAL CONSTITUENTS OF A WATER ANALYSIS OF LOWER RED LAKE, BELTRAMI COUNTY, MINNESOTA*

Constituent	Quantity (in mg/l)
P	0.08 - 0.85
Na	1.6 - 2.0
TDS as $CaCO_3$	160 - 221
Conductivity	256 - 295 microhms per cm @ 25^oC
pH	7.5 - 7.8

*Reported by Lloyd, Smith (oral communication, October 1977).

It is important to note that the level of groundwater, the level of the surface water, and the geology of this area results in frequent exhanges of groundwater and surface water.

Surface Water

SURFACE WATER AND GROUNDWATER EXCHANGE FREQUENTLY IN THE HYDROLOGICAL SYSTEM OF THE RED LAKE AREA.

WATER ENTERS THE SURFACE WATER REGIME FROM PRECIPITATION, RUNOFF AND GROUNDWATER DISCHARGE. WATER LEAVES THE SURFACE WATER REGIME THROUGH EVAPOTRANSPIRATION, GROUNDWATER ABSORPTION, STREAM OUTFLOW AND HUMAN AND ANIMAL CONSUMPTION.

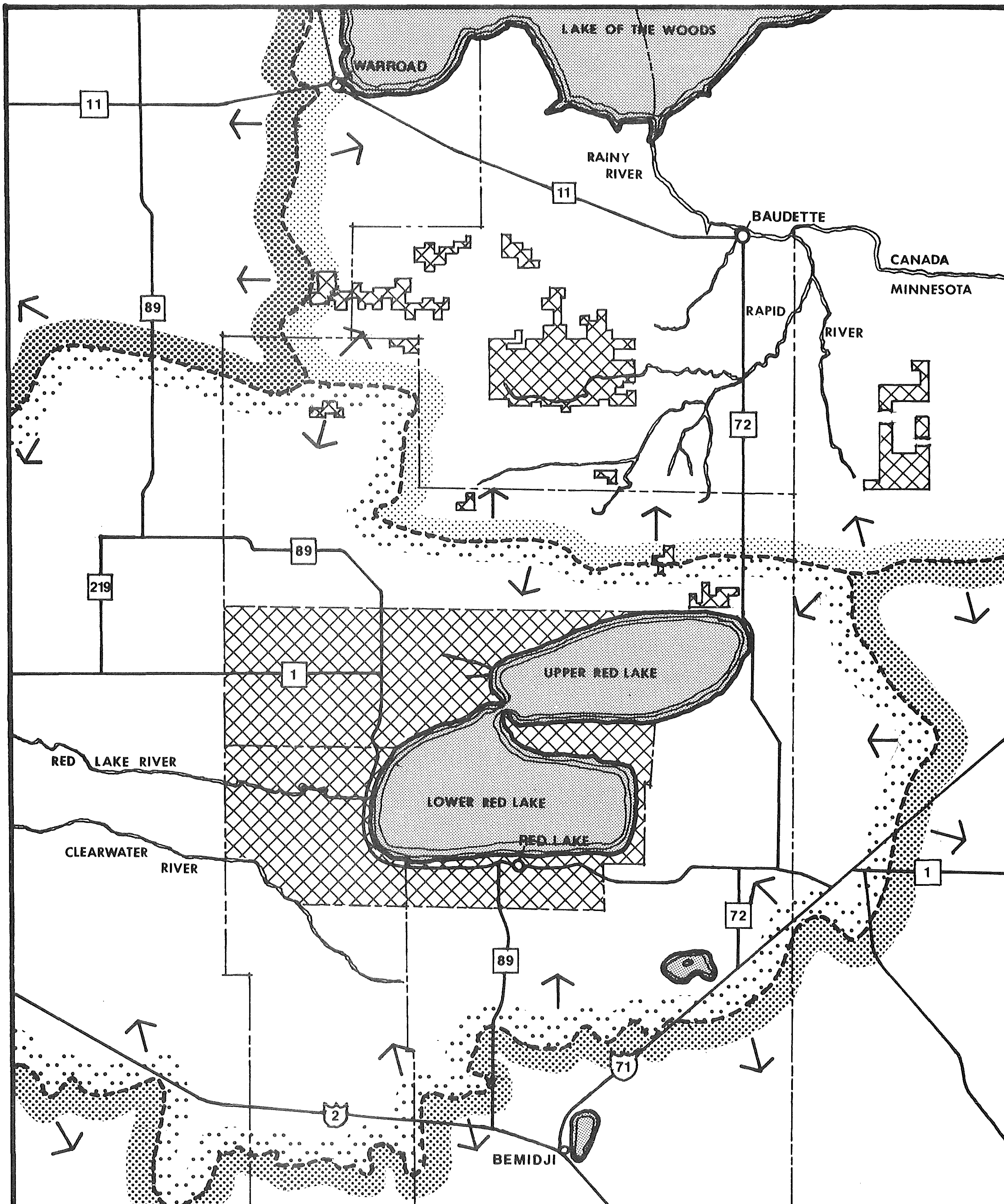
THE MAJORITY OF THE AREA IS DRAINED THROUGH THE RED LAKE RIVER BASIN. THE RAPID RIVER AND WINTER ROAD RIVER BASINS DRAIN THE REMAINDER OF THE AREA. APPROXIMATELY 26% OF THE ANNUAL WATER BUDGET IS LOST THROUGH STREAMFLOW.

This section describes the conditions of existing surface water resources of both the Red Lake Watershed and the Lake of the Woods Watershed (see Figure 10). The physical settings and water budget for each watershed are also described in this section. The physical setting includes the location, area, geography, and principal lakes and streams. The water budget is a description of the water coming into and leaving this area. The water gains are from precipitation, runoff and groundwater. Losses out of an area are due to evapotranspiration, groundwater, stream outflow and human and animal consumption. The difference is the net gain or loss for any past year.

The existing surface water resources adjacent to the Red Lake Bog are from two watershed basins, the Red Lake River Watershed, and the Lake of the Woods Watershed.(USGS 1970) The Red Lake River Watershed lies within the southern half of the study area with general drainage toward the west into the Red River Valley. The Lake of the Woods Watershed occupies the northern half of the study region and has drainage to the north and east.

The Red Lake Bog is located north of the Upper Red Lake and is situated in such a manner that it is almost evenly divided in area between the Red Lake River Watershed and the Lake of the Woods Watershed.(IRRRC 1968, Boelter, D.H.) The particular conditions within each watershed are described in greater deatil in the following sections.

The portion of the Red Lake River Watershed which lies within the study area occupies approximately 900,000 acres. The total watershed area is 3.8 million acres (5,990 square miles). The principle lakes in the watershed are the Upper and Lower Red Lakes. The primary stream is the



WATERSHED BASINS

- WATERSHED BOUNDARY
- ROADS
- RESERVATION LANDS
- DRAINAGE INTO WATERSHED

n

FIGURE 10

Red Lake River which flows from the Red Lakes into the Red River, providing the only outflow from the Red Lakes. Numerous small streams flow into the Lower Red Lake from the south and east. Few streams flow into the Red Lakes from the north or west, due to peat bog formations and general topography. The lake surface water elevations are controlled by regulation of outflow through a dam at the head of the Red Lake River.

The two Red Lake basins which comprise the Upper and Lower Red Lakes are connected by a narrow channel, are generally oval in shape and have a total area of 264,000 acres. Smith and Pycha (1961) reported that the lakes have a maximum depth of 35 feet and an average depth of 18 feet. The shorelines are sandy and the thickness of the sand and gravel lake bottom varies from 6 to 9 feet in depth. The lakes are isothermal and the summer water temperatues closely follow the air temperatues. The shallow waters on the south and west shores of both lakes contain large areas of submerged weeds.

The Upper and Lower Red Lakes have a normal surface elevation of 1,174 feet above mean sea level. The Red Lakes drain an area of some 1,950 square miles, with a drainage area to lake surface ratio of 4.7 to 1.

The water budget for the headwaters region of the Red Lake River Watershed has inputs of precipitation, runoff and groundwater. The average annual precipitation is 22 inches, the bulk of which is received during the period from May to October.(USGS 1975) Inflow via surface runoff is primarily from the morainal ridges to the south which have an annual runoff rate of 1 to 2 inches. The peatlands adjacent to the Red Lakes provide a limited lateral inflow with an evenly distributed discharge from the depression filled bogs and highly seasonal inflow from the raised bogs. The raised bog runoff is correspondent with the distribution of precipitation.(Farnham, R.S.)

Water is taken into the groundwater system in the morainal uplands to the south of the Red Lake basin and is flows to the north and west, entering the Red lake basin and adjacent marsh areas where it is stored or lost through other mechanisms.

The Red Lakes and surrounding bog areas are subjected to a high evaporation rate of 1.8 cubic feet per second (cfs)/square mile of water surface. Evapotranspiration is the principle mechanism for the removal of water from the watershed. Approximately 88% of the precipitation received by the system is lost through evapotranspiration. Water loss through streamflow is entirely through the Red Lake River in the portion of the watershed in the study. Outflow on this stream is concentrated during the spring snowmelt and early summer periods with the mean monthly discharge rate peaking at 0.62 cfs/square mile of lake surface in April. The rate of discharge recorded for the Red Lake River since 1934 ranges from 0 to 3,600 cfs., with an average of 404 cfs. The water quality of the River in the upper reaches is typically the same as that of the Red Lakes. The present removal of surface waters for commercial and domestic uses has a negligible effect upon the water budget of the area.

The Lake of the Woods Watershed consists of an area of 2,900 square miles (1.86 million acres) with approximately 900,000 acres within the peat study region.(Boelter 1968) The principle body of water in the watershed is the Lake of the Woods which forms the northern limit of the study area. The bulk of the outflow from the watershed enters the lake by way of the Rainy River. The general drainage direction of the watershed is to the north and east. The principle streams in the study area are those within the Rapid River and Winter Road River basins. The stream basin most closely affecting the Red Lake bog area is the Rapid River basin. Several smaller streams empty directly into the Lake of the Woods, but do not significantly affect the main peat areas.

The Lake of the Woods functions as a discharge basin for the area with outflow from it draining north toward Hudson's Bay. The area of the Lake of the Woods extends beyond this watershed and acts as a drainage way for other adjoining watersheds. As a result, only a portion of the lake is included in the study area figures. The surface area of the lake within this area is approximately 300,000 acres (470 square miles). This is nearly a third of the total lake surface area. The lake is contolled at its outlet and has a typical fluctuation of 2 feet to 4 feet annually. The surface elevation is normally 1059 to 1060 feet above mean sea level with the rise in surface elevation peaking in July. This coincides with the levels of the Rainy River. The drainage area for the lake is 2900 square miles and the lake has a usable storage capacity of approximately 6,117,600 acre-feet. Water quality in the Lake of the Woods and the

Lower Rainy River is described as suitable for most uses, with disinfection and clarification needed for municipal and domestic uses. The water is the sodium biocarbonate type due to cation exchange as the water moves through clay-rich soils. Water is softest near the Lake of the Woods and the Rainy River headwaters.

The stream complex which drains the Red Lake bog in the Lake of the Woods Watershed is the Rapid River basin. This basin drains principally peat covered land, with an area of 543 square miles. The elevation of the basin ranges from 1200 to 1250 feet above mean sea level at the head of the Rapid River to 1050 to 1100 feet above mean sea level where it enters the Rainy River. The rivers and streams have eroded through the overlaying peat deposits and are primarily draining through stratas of clay and silt. Peatland surface accounts for 75% of the drainage basin area.

The water budget for the Lake of the Woods Watershed has an input from average annual precipitation of 21 inches at the western extreme to 23 inches near Koochiching County. Inflow via surface runoff is through peatlands to the south and west with stream basins extending to within 5 to 15 miles of the watershed limits. Main racharge areas are in the southern peat areas and in the Beltrami Island area.

Loss in the water budget is principally from evapotranspiration, which accounts for the removal of 17 inches of the average annual mositure (23 inches) or 74% of the water budget. The water budget, during the July-November period, exhibits a net loss through high evapotranspiration and declining rates of precipitation. This net loss is maintained until October, when evapotranspiration rates drop rapidly.

Streamflow losses account for the other 6 inches (26%) of the average annual water budget. Stream runoff is usually greatest during spring snowmelts, 8 to 15 of the annual peak flows on the Rapid River occur during this period. The main streams in the basin rarely go dry, but streamflow can be very low in late winter and during prolonged dry spells. Streams draining less than 100 square miles usually have no flow at times in most years, with the minimum flow recorded on the Rapid River being 0.1 cfs. Despite this the Rapid River has the largest annual runoff of all gauged streams in or adjacent to the Lake of the Woods watershed, except for the Rainy River. Runoff ranges from 26% in April to 0.2% in February. April-July runoff accounts for 75% of the average annual total. Groundflow is assumed to balance out over a long period of time and is discounted in this water budget.

The amount of water used for municipal supplies or domestic uses is a minor percentage of the total water budget. The total water use from groundwater wells in the Lake of the Woods Watershed is about 439 million gallons per year. Only two cities (Warroad and Baudette) have municipal water supplies. The two municipal supplies account for 256 million gallons of this amount. There are no developed surface water sources in the Reservation portion of the Red Lake River Watershed, all developed water resources are from groundwater reservoirs. Commercial and farming activities in the study region have low consumption rates and draw water supplies from local sources. Recreational activities require the greatest amount of water (for non-consumption use). Farming in the area, either rice or dry-land, appears to be limited in scope. Rice farms adjacent to the north edge of the Upper Red Lake appear to rely upon runoff and precipitation with ditches draining the adjacent bogs running near them, perhaps as auxiliary resources.(USGS 1970)

Fishing is a major industry for the Tribal population and the industry depends upon the quality as well as the quantity of the water. The streams in the Lake of the Woods Watershed and the Lake of the Woods itself are used primarily for recreational rather than commercial fishing.

The quality of the waters in the Red Lakes can be described by dissolved oxygen content, pH levels, dissolved solids, suspended solids, color and toxic levels.

The Red Lakes are oxygenated from top to bottom and maintain a dissolved oxygen concentration of approximately 80 percent (80%) of saturation depending on the temperature.(Smith 1977b)

The pH level of the Red Lakes varies in the narrow range between 7.8 and 8.0 (Smith, 1977c) The level rarely falls below 7.5.

The calcium content in the Red Lakes is in the range of 31.0 to 38.5 milligrams/liter, and the magnesium from 12.0 to 15.0 milligrams/liter.(MRI, 1976) A description of the water quality for the Red Lakes is contained in Table 5.

Table 5

WATER QUALITY ON LOWER AND UPPER RED LAKES: 1972

	Lower Red Lake October 20, 1972		Upper Red Lake October 21, 1972		
Characteristic	Mouth of Red Lake River	Redby	Cutoff Road	Shotley Brook	Waskish
Specific conductance (micromhos per cm)	295.0	256.0	272.0	247.0	240.0
Alkalinity	123.0	121.0	128.0	132.0	141.0
Hardness (Ca-Mg)	146.0	151.0	149.0	137.0	135.0
Calcium ion	38.0	39.0	39.0	35.0	35.0
Magnesium ion	12.5	13.0	12.5	12.0	11.5
Potassium ion	2.8	2.8	2.8	2.3	2.2
Turbidity (J.T.U.)	15.0	19.0	10.5	8.7	7.3
pH (pH units)	7.0	8.1	8.1	8.0	8.1
Total solids	154.0	176.0	174.0	174.0	163.0
Suspended solids	14.0	16.0	13.0	25.0	18.0
Nonvolatile solids	64.0	86.0	93.0	79.0	106.0
Organic solids	90.0	90.0	81.0	95.0	57.0
N-nitrate	0.05	0.05	0.15	0.05	0.1

Table 5 (Continued)

WATER QUALITY ON LOWER AND UPPER RED LAKES: 1972

	Lower Red Lake October 20, 1972		Upper Red Lake October 21, 1972		
Characteristic	Mouth of Red Lake River	Redby	Cutoff Road	Shotley Brook	Waskish
N-ammonia	0.15	0.15	0.15	0.06	0.09
P-phosphate (soluble)	0.028	0.044	0.047	0.032	0.032
P-phosphate (total)	0.080	0.085	0.085	0.082	0.082
N-total Kjeldahl nitrogen	2.00	1.60	1.70	1.70	1.40
Temperature (^{o}C)	4.0	3.5	4.0	2.0	2.0

Neither the Red Lakes nor the Red Lake peatland bogs have been monitored for suspended solids. Visual inspection has shown the lakes to be relatively free of suspended solids.

Smith (1977a) reported that the Lakes are isothermal and the water temperature closely follows the air temperature.

No investigations into the existence of heavy metals or other toxic substances has been made to date for the Red Lakes.

The only data available on water quality in significant river basins within the Lake of The Woods Watershed is for the Rapid River near Carp Minnesota. The information in Table 6 was recorded during 1972.

Table 6

SURFACE WATER QUALITY, RAPID RIVER NEAR CARP, MINNESOTA (1972)

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1. Discharge = 30 cfs.
2. Dissolved silica = 6.6 milligrams/liter
3. Iron = .29 milligrams/liter
4. Manganese = .07 milligrams/liter
5. Calcium = 30 milligrams/liter
6. Mangnesium = 9.6 milligrams/liter
7. Dissolved sodium = 2.2 milligrams/liter
8. Dissolved potassium = .7 milligrams/liter
9. Bicarbonate = 120 milligrams/liter
10. Dissolved sulphate = 8.7 milligrams/liter
11. Dissolved chloride = 1.8 milligrams/liter
12. Flouride = .3 milligrams/liter
13. Nitrate + Nitrate as O_2 = .00 milligrams/liter
14. Boron = .16 milligrams/liter
15. Total hardness as $CaCo_3$ = 110 milligrams/liter
16. pH = 7.6
17. Color = 100 (platinum cobalt units)

(USGS 1975)

The ground and surface water information provide the base-line information for an analysis of the impact of peat utilization on the hydrological system of the Red Lake area.

SUMMARY: WATER IMPACTS

PEAT UTILIZATION HAS A DIRECT EFFECT UPON THE QUANTITY OF WATER AND ITS DISTRIBUTION WITHIN THE WATERSHEDS OF THE AREA.

PEAT UTILIZATION NECESSITATES THE TRANSFER OF WATER FROM THE USE SITE TO SOME OTHER SITE FOR STORAGE.

DITCHING OF SOME PEATS MAY RELEASE IN EXCESS OF 1.7 ACRE FEET OF WATER PER ACRE OF PEAT DRAINED.

THE WATER RELEASED FROM PEAT UTILIZATION IS OF A DIFFERENT QUALITY FROM THE WATER OF THE LAKES AND RIVERS OF THE AREA.

EACH UTILIZATION OF PEAT WILL AFFECT THE HYDROLOGY OF THE AREA IN A UNIQUE WAY.

The on site and extractive sections of this report describe certain peat use activities which could occur within the Red Lake peatlands. When the peat use activities are related to the surface and groundwater conditions of the area, many of the water impacts of peat use can be identified.

Water impacts result from clearing existing vegetation, the ditching and draining of peatlands and from the construction of roads. Water will be affected by the preparation of organic soils for on-site use or extraction of peat for processing. Areas of concern include the quantity and quality of water removed, the changes in evapotranspiration rates, changes in runoff patterns, and the effects upon adjacent undeveloped peat areas.

The bogs of the Red Lake area have two characteristic vegetation types. The raised bogs have little vegetation on the portion dominated by fibric peats, but are surrounded by tree stands and brush. The depression filled bogs are entirely covered by trees, brush and grasses. A change in the vegetation on the bog surfaces will alter evapotranspiration rates. This influences water storage potential and affects drainage needs.

Raised (ombrotrophic) bogs within the Red Lake area are typically dominated by low growing bush species with small areas of Black Spruce stands. The percentage of precipitation which does not reach the bog surface due to absorption by trees is referred to as the interception rate. This is nearly 23 percent (23%) of the average annual precipitation for bogs with full spruce stands.(Bay, R.R.)

The removal of the tree stands will cause the previously intercepted water volume to enter the surface water regime and run off. Only a small percentage of the additional water reaching the bog surface will be held in the peats as groundwater.(USDA)

Harvesting of peat requiring removal of black spruce cover may cause a permanent change in water tables.(Boelter, D.H.) The water table in raised bogs, from which the Spruce has been harvested, may more closely reflect the input of precipitation. After removal of vegetation, water tables could average 2 to 4 inches higher than normal during wet seasons and 4 to 6 inches lower during dry periods. The changes in the water table may be due to increased surface exposure to wind and an increase in evapotranspiration from the exposed sedge cover.

Clearing in vegetation covered, depression filled bogs will not affect the water table levels significantly, due to the continued recharge of water from groundwater supplies. Runoff will also maintain a fairly uniform discharge pattern in those bogs.

The hydrological changes occuring as a result of the removal of the minor vegetation from peat bogs without tree cover include decreased interception and absorption. This could result in a more rapid discharge of larger quantities of water from a site of peat utilization. In areas with no tree cover, the removal of the brush and grass cover has little impact upon the water table.

In order for the peats of the Red Lake area to be utilized the bogs must be drained. The heavily saturated, and at times water covered, bogs may be drained by a combination of open diching and drain tile. Drain tiles alone are relatively ineffective under these conditions. However the appropriate combination of the drainage methods has been effective for European and American farmers. If drainage lines are placed approximately 100 feet apart, the greatest quantity of water could be removed through hydraulic conductivity (Boelter, D.H.). To maintain the specific water table level required for some peat uses, a dewatering pump may be required to remove spring snowmelt and rainfall.

The initial ditching of the fibric peat in the Red Lake Bog will result in a water loss through gravity flow of approximately 12 inches.(Boelter, D.H.) This is the outflow from peats 60 inches in depth, with a water content of 48 percent (48%), and a water yield coefficient of 42 percent (42%). This initial drainage can reduce the water content of the fibric peat to approximately 28 percent (28%), (all percentages are based on wet volumes)(Boelter 1964.) The initial drainage releases approximately 1 acre-foot of water from a one acre site.

The draining of the peats within the hemic and sapric layers is more complex. Hemic peats with an average thickness of 30 inches, have an average water content of 60 percent (60%), and a water yield coefficient of 28 percent (28%). They will yield a total of approximately 5 inches of water from ditching alone. The hemic peat after initial draining would have a remaining water content of over 40 percent (40%). The sapric and hemic peats could be drained simultaneously. Draining 30 inches of sapric peat, at 70 percent (70%) or greater water content with a water yield coefficient of 15 percent (15%), would yield about 3 inches of water. The combined water released by gravity draining of 60 inches of the hemic and sapric peats would be about 8 inches, or approximately 0.7 acre-feet for one acre.

Water drained from the raised bog would probably be released in two main blocks. The first would be a sudden, rapid release of a volume of approximately one acre-foot per acre of water with a lower pH, a low mineral content and a low nutrient level (ombrotrophic). The second block of water which would be released more slowly, would be approximately 0.7 acre-feet per acre of a higher pH, highly mineral and nutrient rich water (minerotrophic). This decreased rate of release would be due to the much lower hydraulic conductivity rate of hemic and sapric peats. Accompanying this ditching outflow will be approximately 11 inches of the precipitation which falls from July through November (USGS 1970).

The quantity released into the Red lake basin by ditching may change the capacity of the basin above the Lakes regulated level. The Lake basin is capable of containing over one million acre-feet above the regulated evelation of 1174 feet.

This drainage is necessary for either on-site development or extractive development by the sod peat process and peat milling process. However, hydraulic extraction methods require only perimeter ditching in order to retain water within the work site.

The drained bog areas would not behave as capturing or delaying areas, but merely transfer the inflow to lower terrain. Spring snowmelt and rainfall runoff would be reduced only by the amount of storage capacity available in the surface peats at the end of the previous harvesting season. Runoff would exhibit sharp seasonal variations at the outlet of the mining area.

Initial retention of spring runoff water in the basins created by peat utilization could prevent water from entering the Lake basins in normal quantities. This water normally enters the reservoir during the spring and early summer, when the water levels of the Red Lakes are highest.

The concentrated outflow from a development site may cause localized changes in water tables along the drainage route to the Lakes. This should cause no major changes if the outflow is carried in an adequately constructed drainage system. The water tables adjacent to the ditch will rise during drainage, and will act as a drain away from adjacent peats when no water is being released from the site.

Adequate surface drainage routes away from the developed sites must be provided to protect adjacent undisturbed bogs. If the normal outflow is blocked, the water tables of these bogs can be expected to rise causing vegetation damage and a loss of storage capacities for storm water in the upper layers of the peats.

The hydrological effects of peat utilization could be significant without site reclamation. If the peat area was diked to prevent crossflow to and from adjacent peats, subsequent inflow could be trapped in the newly formed basin. This would occur only if the basin had a base that prevented surface water's entry into the groundwater system.

Areas from which peat has been removed could convert to shallow lakes and wetlands without the construction of adequate drainage from these areas. The newly formed basin could contain as much as 40 percent (40%) more water than would be present in existing saturated peats. Spring runoff and storm flows could be of greater intensity and seasonal outputs will more closely match precipitation curves. During periods of low precipitation or high evaporation, these water filled basin may tend to have lower water levels than the water table level in surrounding bog lands. Runoff would not be discharged into the existing Lake basins until these newly created basins were full. These basins would hold water until the stored water level reached the top of their outflow control structures.

The construction of a specialized drainage system for crop lands is required. This system must isolate the area from surrounding bogs and be capable of removing spring snow melt and summer stormflows. The drainage system must be capable of preventing flooding of root systems of the vegetation which could be killed by flooding. An adequately drained peat surface prevents root damage, high lime concentration and oxygen shortages.

The replanting of other species, notably hardwoods, would require substantial lowering of the water table in a plantation site. This would entail isolation of the site from surrounding groundwaters and controlled drainage of the peats to reduce the water level.

Utilization of peatlands for biomass production, chiefly reeds, sedges and low-growing brush, would not involve any direct changes in the local hydrology. Biomass production is best developed on existing, open bogland. This activity would be less efficient on the raised bog lands due to the required clearcutting and artificial maintenance of grasslands in less saturated soils.

The reduction of water in the bog for on-site developments can result in the reduction of the total groundwater storage capacity of a developed area. In the Red Lake area where the water table is at, or near, the level of the bogs surface, the water table would be lowered to drain 2 feet of the peats for plant root systems. This would release up to 2 acre-feet of water from a one acre site. (Ferda, J.)

The Red Lake basin could absorb the quantity of runoff resulting from limited on-site peat use with no difficulty. However, water quality at the discharge point would need further study. Runoff patterns due to on-site use will be similar to non-peat areas in that there will be little, if any, retention of significant amounts of stormwater.

The quantity of water which must be removed for extractive peat use is dictated by the extraction procedure used. The quality of water removed from the bogs is influenced by the type of peat being extracted.

Removal of peat by the sod peat process requires a smaller area to be drained at any one time than for peat milling or hydro-peat extraction.(Farnham, R.S.) This is true for these types of operations in Europe and the Soviet Union.

Initial outflow from fibric peat removal in a sod peat operation of 1000 acres or less would have no critical volumetric impact upon the Red Lakes. This would release only 1000 acre feet of water from the site.

It is highly unlikely that the entire quantity of water released from this drainage would reach the lake basin.

The critical facet of drainage for peat milling is the ability of the peats to support milling equipment and to obtain a water content appropriate for this process. The saturation at the surface should, ideally, be 55 percent (55%) or less. Ditching could possibly result in dehydration to this percentage of water in the upper layers of the peats, but either intense long-term drainage efforts (Farnham, R.S.) or mechanical dewatering may be required.

The drainage of the more decomposed peats may cause them to become more permeable at the surface, therefore precipitation will tend to be captured in them more readily.(Jongedyk 1954) The maintenance of lowered water tables under these conditions may require pumping or mechanical water removal. After the initial drainage required for peat milling, any additional inflow from precipitation would need to be removed immediately.

Hydraulic peat extraction would entail the isolation of a work site by ditching and the construction of several ponding areas near the site.

Ponding areas should be designed to permit normal outflow rates to continue. If the normal outflow is interupted, higher water tables and reduced storage capacity may occur in adjacent bog lands.

If the slurry peats are dried mechanically or by pressure, some runoff might be expected. Air-drying of these peats will result in very low outflows from the drying process and would not present any significant hydrological problems. This process can take up to two months and would be significantly affected by precipitation during the time required.(Farnham, R.S.)

The piping of slurry in the hydro-peat process may result in a rise in water tables in peatlands adjacent to the area through which the peat is piped due to overflows and leakage.(Minnesota Peat Mission to Europe) This could result in a lower storage capacity for stormflow retention and damage to vegetation in the area near the inflow.

The constant utilization of high quantities of water for removal and the maintained saturation of the work area would have direct effects upon the local hydrology. Precipitation would not be captured or delayed in the work sites through retention by the peat, and outflows in these areas will show seasonal variation to a higher degree than undeveloped bogs. The volumes of water left in an area at the end of the mining season may increase the spring runoff rates.

The processing of extracted peats often requires additional dehydration to bring the peats to optimal saturation levels. This dewatering of the peat may occur either at the bog site or at a processing facility.

The extracted hemic and sapric peats require additional water removal in order to reach an optimal saturation for combustion of 35 percent (35%) or less, would probably be processed on-site by mechanical drying, open-air drying or by hydraulic pressure.

Water released by mechanical dewatering, released through the same system which drains the bog, should have no critical on water volume. If all of the water from a one hundred (100) acre extraction area were released in a total block over a short period of time, the total volume would be approximately two hundred and fifty (250) acre-feet. An amount which should have little impact upon the storage capacity of the basin as a whole, amounting to less than .25% of the Lake basin capacity above the regulated level.

The drying of the milled peat to the required level would probably be accomplished by air drying. Mechanical drying would not accelerate production of milled peat to any great extent unless the peats had been saturated by rainfall, etc. The use of air drying would eliminate the outflow associated with other forms of dewatering.

Drying the peats in a rotary kiln or in the open air would result in little, if any, additional surface runoff. Hydraulic compression of peats could, however, cause the release of up to 8 acre-feet of water (for one acre) over the period of time required to process the peats. This water could possibly be contaminated by oils and chemicals during processing.

Limited data about the magnitude of changes in water quality as a result of peat utilization can be presented at the present time. Some general statements regarding the water quality characteristics which may be changed can be made. This generalized information may assist the evaluation of specific proposals for peat utilization.

The quality of the water removed for peat utilization is as important as the quantity. The water removed initially from the fibric peats will tend to be ombrotrophic, i.e., low pH water with low mineral and low nutrient contents. While the pH level of this peat is low near the surface of the peat, the pH levels tend to rise in deeper layers, and a pH level of 5.0 can be assumed as an average for fibric peats.(Farnham, R.S.)

The removal of acidic waters, the reduction of water tables in the exposed peats due to evaporation and a change in ground cover can all affect the composition of the upper layers of these more decomposed peats. Some change in the pH level may occur, and oxidation and exposure to sunlight may cause organic decomposition and may reduce peat thickness.

If the water drained from fibric peats were released into the Lake basin at this level of acidity there would be no overall change in the pH of the basin. The Lake water can neutralize acidic waters. In order to buffer the acidic runoff, the ratio of lake water to fibric peat runoff should be approximately one-to-one. This ratio was obtained using Lake of the Woods water, which is very similar in chemical composition to that of the Red Lakes.(Crawford, verbal communication, 1977) The Lake area immediately adjacent to the discharge point may experience some increased acidity, but tests would have to be made to verify the extent of this localized problem. There should be no mineral and nutrient pollution problems since this runoff would be relatively free of such components.

Changes in water quality may occur due to increased biological activity and exposure of peats to sunlight. This activity tends to increase the nutrient components of the water saturating the peat, especially iron, manganese, phosphorus and potassium.

The utilization of fertilizer in large quantities in the bog may result in nutrient pollution of both the stored groundwater and that water which is drained from the site.

The quality of bog water due to removal of existing vegetation would not change to any degree unless cut materials were left to decompose on the site. Decomposition may cause a slight rise in the nutrient levels of the water but the low pH of a raised bog will tend to minimize the decomposition of organic components. pH levels will not change to any significant degree.

The pH levels of water released from hemic and sapric peats should cause no problems when added to existing surface water. The inflow of water with higher nutrient and mineral contents would probably be greatest immediately after the snowmelt period. The addition of nutrients, especially phosphates and nitrates, may cause algae bloom during warm weather. Research conducted by Dr. Ronald Crawford, of the Freshwater Biological Institute for Phase II of the Department of Natural Resources' Peat Program, relveals that small additions of bog waters to nutrient poor northern lakes may result in large increases in algae productivity. This problem, as well as the possible release of heavy metals captured in bogs, has not been fully investigated, and more work should be done on these topics. Peat in the bogs may contain from less than 1 part per million (ppm) to 3 ppm per mercury.(Crawford, 1978)

Suspended solids in water can be expected as a by-product of peat utilization. The quantity and nature of suspended solids in the water depends upon the utilization method selected, the location and the site configuration.

Suspended solids in released waters may create a problem at the discharge point into the Lake. The rate of settlement of suspended solids during outflow is not accurately known. Sediment ponds adjacent to the mining area and processing area could eliminate suspended solid contamination of the Lake basin.

The removal of suspended solids will be the most difficult during spring snowmelt and runoff when higher volumes of water would have to be retained to remove them.

The mechanical dewatering of peat may introduce elements of oils and chemicals into the outflow, and appropriate measures would need to be taken to reduce this problem if it occurs.

The characteristics of the quantity and quality of the impact medium, water, in the Red Lake and Lake of the Woods watersheds have been described and evaluated above.

The discussion of the quantity of both groundwater resources and surface water resources centered on the existing volume of water in the area and on changes in the components of the water budget. The water budget for the area includes precipitation, inflow and groundwater transfer as components of water gain. Components of water loss in the groundwater budget include evapotranspiration, outflow, groundwater loss and consumption.

The discussion of water quality addresses the water's characteristics in terms of its pH, suspended solids, dissolved solids, dissolved oxygen, hardness, color and temperature.

The utilization of peat land for either on-site or extractive uses has direct effects upon the quantity of water and its distribution within both watersheds. The information compiled for this study coupled with on-site investigation leads to several conclusions.

The quantity of water released through on site or extractive land use would probably have no significant impact upon storage capacity of the Upper and Lower Red Lake basins if normal hydrological conditions existed. However, if these activities were carried out during periods of flooding from natural causes such as rapid snowmelt, the addition of a large volume of water may approach or exceed the capacity of the basins. The effects of these activities upon the Lake of the Woods Watershed may have more negative impact as drainage would most likely occur through the Rapid River prior to entering the Lake of The Woods. The river's capacity is not known at present and the addition of drainage waters during normal high water periods could cause flooding of adjacent lowlands and create erosion problems. No storage figures for this system have been derived so the specific effects cannot be evaluated.

The quality of water entering present water systems has been estimated but the consequent effects cannot be accurately evaluated. The existing hydrological regimes would likely be sensitive to the introduction of a wide range of pollutants and any peat uses could affect the entire watersheds. pH levels would probably not be greatly affected within the Red Lakes as these waters can buffer acidic inflows with relative ease. The capabilities of the Rapid River system to neutralize these inflows is not known. It is assumed that water adjacent to outflow points from peat utilization areas would become more acidic and consequently affect the existing plant and fish life. Other areas of concern involve the effects of the introduction of suspended solids and nutrients into existing water sources. The addition of these elements may cause silting and algae growth which could negatively impact fish growth and spawning. The impact of several pollutants, such as heavy metals, has not been evaluated. These issues require furthur investigation and attention.

Consequences of the changes in quantity and quality of existing water resource depends upon the specific activities involved, their scope and development timing. If these activities are proposed in a more specific manner the general items of concern discussed in this report should be more fully evaluated, as the exact nature of these activities may have varying impacts upon the watersheds.

Local impacts of peat utilization could be great if adequate safeguards are not developed. The water tables and existing outflow patterns could be disrupted for various time periods creating negative effects upon tree and plant growth, natural land development and wildlife. Again the specific nature of the peat use will define the intensity of the expected impact. Peat lands and mineral lands adjacent to the peat areas suitable for peat development may experience direct effects even though they are not directly involved in any peat use process.

IMPACT MEDIUM: LAND

PEAT UTILIZATION WILL EFFECT LAND USE THROUGH THE ALTERATION OF THE WATER RESOURCES OF THE AREA.

THE REMOVAL OF VEGETATION FOR PEAT USE AFFECTS LAND BY CHANGING ITS APPEARANCE AND TOPOGRAPHY.

THE DRAINAGE OF WATER FROM PEAT LAND WILL AFFECT LAND BY CHANGING DRAINAGE COURSES AND THE VEGETATION OF THE AREA.

PEAT USE MAY RESULT IN THE FLOODING OF SOME LAND AREAS.

PEAT UTILIZATION MAY CREATE ADDITIONAL RESIDENTIAL AND COMMERCIAL USES OF LAND IN PLACE OF FORESTS, SWAMPS AND LAKES.

Utilizing peat will have a direct impact on the land of the Red Lake area. The use of land may be described in terms of its designated ownership, or in terms of the activities which take place on the surface of the land. Several land effects are so closely interrelated to the water effects they could be presented in either section. The majority of these effects were discussed in the water section and are only briefly considered under land effects.

The peat activities affecting the land include vegetation removal, ponding of water, and changing the soil characteristics. Other activities related to peat utilization such as decisions on land ownership or the building of facilities, have a far-reaching impact on land use. The reclamation of areas from which peat has been extracted will have a complex impact on the area. This section will describe the changes in the land as a result of peat use. Alterations of land use for peat utilization will impact the fish, forests, wildlife and wild rice of the Red Lake area.

Conscientious decisions must be made related to both the designated ownership of the land and the activities allowed on the land. To make these decisions, it is essential to have a comprehensive awareness of existing land use and the changes anticipated from peat utilization.

The land of the Northern Headwaters Region is primarily publically owned, with the use of different parcels affected by their designation. Within the area are State Forests, State Game Refuges, State Wildlife Management Areas, a National Natural Landmark Area and an Indian Reservation (see Figure 2). Only small parcels of land scattered throughout the area are privately owned.

The three state forests in the areas are established "for growing, managing, and harvesting timber and other forest crops". The Beltrami Island State Forest, the Pine Island State Forest and the Red Lake State Forest adjoin the Reservation lands. The Minnesota Department of Natural Resources has the responsibility for the management and development of land in these areas.

The 427,000 acre Red Lake Game Refuge and the Red Lake Wildlife Management Area are parcels of land which provide wildlife habitat. The wildlife management areas are intended to provide lands and waters for the production of wildlife and for public hunting, fishing and trapping. The guidelines of the Department of Natural Resources direct activities in the area including the construction of permanent structures and the harvesting of resources.

The federal government, on May 15, 1975, designated the Upper Red Lake Peatlands as a National Natural Landmark. This designation is reserved for areas exhibiting qualities of "national significance". The Red Lake Bog was is one of the largest examples of a string bog and island vegetation complex in the Continental United States. At present, the Department of Natural Resources is reviewing the invitation of the Secretary of the Interior to register the site.

Participation in the Natural Landmarks program is voluntary for the land owners within the designated area. The principal effect is to increase the public awareness of significant natural areas. This designation may influence future uses of the land. Federal agencies can withhold funding for projects affecting the quality of these areas. (N.N.L., 1975)

The Red Lake Indian land has a unique legal status. The Red Lake Indian Reservation is a "Closed Reservation". The members of the Tribe claim possession of the land by "right of conquest and aboriginal title."(Brill 1974) The land of the Red Lake Indians was never ceded to the Federal government and then set aside as an Indian Reservation under federal jurisdiction. This unique status was further recognized by an act of Congress on August 15, 1953 which transferred to the State of Minnesota both civil and criminal jurisdiction over Indians in the State except the Red lake Reservation. (Dana, et.al.)

Each designated ownership of land has its own effect on present and future patterns of land use. The designation of the land in the area controls the activities on that land and has been a key factor in current land use patterns.

The designated ownership of land in many areas would have to change for the utilization of peat in the project area.

The removal of vegetation from bog surfaces to expose peats for utilization will visibly affect the land. With trees, shrubs and grasses removed, the appearances of the bog will be greatly changed. The exposure of the organic soils will clearly show the surface topography of the bog which may have been hidden by vegetation.

The ditching of peats will take land that may have been vegetation covered and convert it to water courses. The extent of these controlled water flow areas may be substantial and may disrupt existing roadways or animal migration paths.

The construction of access roads into the bogs necessitates changing land from undisturbed wildlife habitat or forests to roadways or railroad lines.

The ponding of water resulting from peat extraction will increase the amount of land that is water covered. The removal of water from the peats which have been cleared of vegetation will expose a new soil surface to the winds. These exposed organic soils will be subjected to entrainment by the moving air if the soils become excessively dry. Air transported particles of dust may affect vegetation and water in the areas adjacent to the peat use site.

After peat has been extracted from an area, new land contours will exist. These contours will resemble the topography of the glacially deposited mineral soils which underly the peats. These exposed mineral soils will support vegetation and have runoff characteristics substantially different from the organic soil deposits which were removed.

The utilization of peat requires development to accomodate man and his machinery. The land use may be altered by the construction of facilities to house the equipment used for peat processes. Construction of residential and business communities around large scale peat operations will substantially alter the ecology of the land.

SUMMARY: LAND IMPACTS

AREAS OF CONCERN RELATED TO THE USE OF LAND AND THE EFFECT OF PEAT UTILIZATION INCLUDE THE REMOVAL OF VEGETATION AND ITS EFFECT ON THE LANDS' APPEARANCE AND TOPOGRAPHY.

OTHER LAND IMPACTS REQUIRING ATTENTION INCLUDE THE CONSTRUCTION, OF DRAINAGE AND TRANSPORTATION SYSTEMS.

THE IMPACT OF RESIDENTIAL, COMMERCIAL AND OTHER DEVELOPMENT TO ACCOMODATE PEAT UTILIZATION TECHNOLOGY MUST BE REVIEWED.

The description of the designated ownership of land and the discussion of existing uses of land provide base-line information for the evaluation of the effects of peat utilization on land. Both the lands ownership designation and the present land use could be changed for peat utilization.

The removal of vegetation and existing surface features to utilize peat will alter the appearance of the land and will reveal a new topography. The drainage of peatlands will require the creation of new water courses from the peat use site to the site of water discharge.

The construction of roads or buildings for peat use may substantially alter the areas' ecology. After peat extraction, the topography exposed may be substantially different from the existing topography.

IMPACT MEDIUM: AIR

THE AIR QUALITY OF THE RED LAKE AREA IS DESCRIBED AS CLEAN, CLEAR AND FREE OF MAN-MADE POLLUTANTS.

EVALUATING AIR QUALITY CHANGES IS COMPLEX AND MUST BE DONE ON A SPECIFIC SITE BASIS.

CHANGES IN VEGETATION MAY ALTER EVAPOTRANSPIRATION RESULTING IN A CHANGE IN THE MOISTURE CONTENT OF THE AREA.

NOISE IS THE COMPONENT OF AIR QUALITY THAT IS THE MOST NOTICEABLE IMPACT OF PEAT UTILIZATION.

THE OPERATION OF MOTORIZED VEHICLES FOR PEAT UTILIZATION MAY RELEASE PARTICULATE MATTER AND FOSSIL FUEL POLLUTANTS INTO THE AIR.

The concept of air quality is extremely complex, covering everything from noise to humidity. This section will focus on characteristics of the Red Lake air that will serve to transfer the results of peat use to impacts on Reservation resources.

Peat utilization will affect the air in the Red Lake area. Air will act as an impact medium for transferring the results of peat use to Reservation resources. Changes in air quality will have far reaching impacts on the area. The concept of air quality in this section refers to the type and amount of substances added to, or taken from, the air from peat use. The impact on Red Lake air quality will depend on the magnitude and type of peat utilization strategy used. Noise from peat development will be considered in this section as a component of air quality.

In the absence of air monitoring information in the Red Lake area, it is difficult to describe the specific composition of the Project Area air. However, the Corps of Engineers Red Lake River Environmental Impact Statement describes the air as clean, clear and mostly free of man made pollutants.

Air quality evaluation includes the analysis of the following constituents of the air:

Particulate matter
Sulfur oxides
Carbon Monoxide
Oxidants
Hydrocarbons
Nitrogen oxides
Hydrogen sulfide
Noise

Limits on the range of concentration of each of these components have been established to maintain an air quality suitable for habitation by man. These ranges may not adequately reflect the air quality required by plants and animals of the Red Lake area.

Trace pollutants that occur world wide are found in Red Lake air. Seasonal pollution occurs as a result of peat and forest fires. One continuing source of pollution does exist in the area. The Red Lake Sawmill operates a "Tee-Pee" burner for Mill wastes. This is the only source of "industrial" pollution in the area. This burner only incinerates wood residues such as bark and sawdust.

Dust may enter the air during many phases of peat utilization. The blowing of winds across a cleared dry bog could pick up particles of the peat. Extensive use of heavy equipment may raise dust which can be transported by the air.

The removal of vegetation from a bog area may cause changes in the evapotranspiration process. The alternate surfaces exposed to the air may not release water into the air in the same manner as existing vegetation. This may result in an overall change in the moisture content of the air and a perceived difference in humidity.

The release of exhaust from vehicles operated as part of peat utilization will alter air quality. The air will transport additional quantities of the elements and compounds, such as lead, produced during combustion of fossil fuels.

A peat gasification plant may release particulate matter into the air with other pollutants which are by-products of the gasification process.

The operation of peat processing machinery will produce sounds foreign to the existing bog environment. Air is the medium through which these sounds will travel to the wildlife and people of the Red Lake area. It is well established that loud noises disrupt wildlife habitat.

SUMMARY: AIR IMPACTS

THE INTRODUCTION OF MAN, VEHICLES, EQUIPMENT, AND ASSOCIATED POLLUTANTS INTO THE RED LAKE PEATLAND ENVIRONMENT IS AN AIR IMPACT OF CONCERN.

THE IMPACT OF VEGETATION CHANGE ON AIR MOISTURE CONTENT AND THE IMPACT OF MOISTURE CONTENT ON OVERALL AIR QUALITY IS OF INTEREST.

THE INTRODUCTION OF ADDITIONAL PARTICULATE MATTER IN THE FORM OF DUST FROM DRY PEATS INTO THE AIR IS A CONCERN TO PEAT DEVELOPMENT.

THE NOISE FROM PEAT UTILIZATION AND ITS EFFECT ON THE BOG ENVIRONMENT IS AN ASPECT OF AIR IMPACT.

The changes in air quality as a result of peat utilization are complex and difficult to quantify. The air will act as a medium transferring some results of peat use to other components of the Red Lake environment. A result of peat use may be an increase in the quantity of trace pollutants in the air to a dangerous level.

The removal of vegetation and the drying of exposed peats may effect the complex evapotranspiration system. The dried peats may allow dust to enter the air more easily.

The release of exhaust pollutants into the air by vehicles and equipment employed in peat utilization and processing may be significant.

The changes in the sounds traveling through the air, as a result of peat utilization, may impact other Reservation resources.

IMPACTED RESERVATION RESOURCES
RESERVATION ENTERPRISES

There are four Reservation resources that are likely to be impacted by peat development. These are also the resources vital to the maintenance of the Reservation community. These resources are fish, forestry, wildlife and wild rice.

The major Reservation enterprises and activities are directly related to these resources. Consequently, after each discussion of a resource, there will follow consideration of the appropriate enterprise. These enterprises are the Red Lake Fisheries Cooperative, the Red Lake Indian Mills (includes Cedar Fence Plant), the wild rice industry and the hunting activities.

IMPACTED RESOURCES: FISH

The many species of fish in the Upper and Lower Red Lakes could be affected by changes in the three impact mediums; air, land or water. However, the impacts of alterations in the land and air are negligible compared to changes in water. Consequently, this section will emphasize the effect on fish of water changes due to peat utilization.

GENERAL DESCRIPTION: FISH

EIGHT SPECIES OF FRESHWATER FISH ARE FOUND IN UPPER AND LOWER RED LAKE IN LARGE ENOUGH POPULATIONS TO ALLOW COMMERCIAL FISHING.

ALTHOUGH FISH YIELDS HAVE VARIED CONSIDERABLY, COMMERCIAL FISHING ON THE RED LAKES HAS GENERALLY PROSPERED FOR MANY YEARS.

ONLY LIMITED RECREATIONAL FISHING OCCURS IN THE RED LAKES.

The Upper and Lower Red Lakes support the growth of many different species of fish. Those fish that have acquired a commercial value are listed below.

Walleye
Yellow perch
Whitefish
Northern pike
Goldeye
Sheepshead
Black bullhead
White Sucker

Records of the annual commercial harvest of the species listed above show wide variations over the past 48 years. This variation is evident in the difference for the walleye and perch catch between 1971 and 1972. The commercial walleye and perch catch for the period 1965-1975 is presented in Table 7.

Table 7

ANNUAL YIELD FROM UPPER AND LOWER RED LAKES
PERCH AND WALLEYE, 1965-1975
(IN THOUSANDS OF POUNDS)

Year	Walleye	Perch
1965	425.5	440.5
1966	734.8	276.5
1967	631.8	204.6
1968	611.1	513.5
1967	1293.7	448.4
1970	1253.1	216.1
1971	1034.0	131.2
1972	429.9	9.7
1973	62.4	9.7
1974	25.8	64.8
1975	158.1	119.0

Source: Smith, L.L., Jr., 1977

The spawning of walleyes occurs in several places throughout the Lake. Spawing generally takes place in shallow water where a sandy bottom exists. One particular area of walleye spawning is the Blackduck River and the Lake area near the mouth of that River. Spawning generally occurs between March 1 and June 1 each year.

The spawning of whitefish takes place in shallow (2-3 feet deep) water in October and November. The young hatch in March. During this time, the eggs need dissolved oxygen and protection from freezing and mechanical damage.

In addition to commercial fishing, described later in this report, limited sport fishing occurs in the Red Lakes and the tributaries leading into the Lakes.

AIR AND LAND IMPACTS: FISH

BOTH AIR AND LAND EFFECT THE FISH POPULATION ONLY AS A SECONDARY EFFECT RESULTING FROM WATER CHANGES.

The impact medium of air would affect the fish resource primarily by transporting materials from the peat development site to the water of Red Lake. Peat use is not expected to result in large scale air impacts. However, exhaust pollutants from harvesting and peat processing plants machinery could increase the amounts of hydro-carbon, sulfur, lead and other pollutants in the air. Increased dust from drained peat areas is another possible air impact. The amount of pollution being transferred from the peat use area to the air and to the water is likely to be extremely small. However, levels of many of these substances safe for fish have not been established. Long term exposure to even minute amounts of pollutants, such as heavy metals, have resulted in accumulation of these substances in fish.

Although the possibility of air impacts on fish are unlikely, they should not be discounted. A complete investigation of the air-water-fish interrelationships should be part of the review of a specific peat proposal.

Land impacts will also affect fish only through changes in the water. Several of the possible impacts discussed in the land and water sections could affect fish. The conversion of peatland to agricultural land could introduce many new chemicals into the Lakes. As mentioned, peatland must be fertilized to be used for agriculture. The adverse effects of chemical fertilizers on fish is well documented. Nitrogen, potassium and phosphates can cause eutrophication of the water which reduces the oxygen available to the fish population. The removal of peat allowing water to pass through the watershed to the Lakes at a higher rate may alter the composition of the Lake water. All these land effects are ultimately passed to the fish through the peat use-land-water relationship discussed in previous sections. Consequently, it is appropriate to concentrate the discussion on water.

WATER IMPACTS: FISH

THE FISH POPULATION IS SENSITIVE TO THE FOLLOWING POSSIBLE PEAT USE INDUCED WATER CHANGES: OXYGEN, pH, DISSOLVED AND SUSPENDED SOLIDS, TEMPERATURE, COLOR AND TOXIC SUBSTANCES.

PRELIMINARY STUDIES INDICATE THE FISH COULD BE ADVERSELY EFFECTED BY ANY ONE OF THE THESE POSSIBLE WATER QUALITY CHANGES.

MORE MONITORING MUST BE COMPLETED BEFORE THE EFFECT OF PEAT USES UPON THE FISH CAN BE DETERMINED.

The existing water quality of the Red Lakes must be safeguarded to insure a continued abundant resource of fish for the area residents. Since utilization of peat could potentially effect the water quality. The existing conditions of the lakes and bogs as they relate to the fish habitat and requirements must be analyzed.

Oxygen is the most important of the dissolved gases affecting fish production and the potential yield of a fishery. The Environmental Protection Agency (EPA) (1973), has set a limit of 4 milligrams/liter for dissolved oxygen. They feel growth limitations are likely to occur below this limit. However, Doudoroff and Shumway (1967) refuse to set minimum amounts of dissolved oxygen necessary to maintain a fishery. They state that the level of dissolved oxygen which will limit fish growth depends on the availability of food and other environmental factors such as temperature. It is apparent, however that any reduction of dissolved oxygen can affect the fishes ability to respond to demands of the environment.

The Red Lakes are oxygenated from top to bottom and maintain a dissolved oxygen concentration of approximately 80 percent (80%) of saturation depending on the temperature.(Smith, 1977b) The bogs adjacent to the Red Lakes are oxygenated at the surface, but the concentrations quickly drop off to a complete lack of oxygen a short distance below the surface. (Crawford, 1977b)

The amount of dissolved oxygen available in the runoff water has not been tested thoroughly enough to judge the effect of the dissolved oxygen on the Lakes. It is known that the bog water is oxygenated at the surface and has no oxygen a short distance below the surface.(Crawford, 1977) It is quite conceivable that the water may become oxygenated before it reaches the Lakes and have no adverse effects on the Lakes. More monitoring of ditch water is necessary before a determination can be made.

The pH of water is an indication of the acidity or alkalinity. The availability of many nutrients are dependent upon pH levels. These nutrient levels, in turn, can affect the production of fish. At low pH levels, some trace metals can become more soluble and at high pH levels iron, which is necessary to some plants, can become scarce. Iron scarcity can affect the entire aquatic community.

Protection of the aquatic environment can range from a maximum level to a low level protection. Since the fishing industry is an essential part of the Red Lake economy, we will examine a maximum level of protection for the fishery area. EPA (1977) defines "Nearly Maximum Level of Protection" as the following:

> *pH not less than 6.5 nor more than 8.5. No change greater than 0.5 units above the estimated natural seasonal maximum, nor below the estimated natural seasonal minimum."*

Some of the known effects on aquatic life in this range are as indicated in Table 8:

Table 8

EFFECTS OF pH ON FISH

pH	Known Effects
8.0 - 8.5	Motality of carp sperm reduced. Partial mortality of burbot (Lota lota) eggs.
7.0 - 8.0	Full fish production. No known harmful effects on adult or immature fish, but 7.0 is near low limit for Gammarus reproduction and perhaps for some other crustaceans.
6.5 - 7.0	Not lethal to fish unless heavy metals or cyanides that are more toxic at low pH are present. Generally full fish production, but for fathead minnow (Pimephales promelas), frequency of spawning and number of eggs are somewhat reduced. Invertebrates except crustaceans relatively normal, including common occurrence of mollusks. Micro-organisms, algae, and higher plants essentially normal.

The pH level of the Red Lakes varies in the narrow range between 7.8 and 8.0.(Smith, 1977c) The level rarely falls below 7.5. The pH of the Red Lake peatlands bog water varies widely but averages 4.0.(Hofstetter, 1969) The pH of streams through the bog averages 7.8 and bog ditches in this area is 7.5.

These bog pH levels tend to be more acidic than Red Lake waters. As was mentioned, a one-to-one ratio of lake to bog water is necessary to neutralize the bog water. A pH level of 6.5 to 8.5 is necessary to provide a nearly maximum level of protection for a fishery (EDA, 1973). Since the Lake pH values rarely fall below 7.5, there is a need to monitor the bog outflows into the Lake at the discharge point to determine the resultant pH values. It is possible that at the discharge points there may be a reduction of pH sufficient to retard fish growth.

Dissolved solids serve as nutrients for aquatic life and thus affects the abundance of aquatic life. Hardness is a component of dissolved solids related to the quantity of magnesium and calcium ions present. Hardness has been directly correlated to biological productivity.(EPA, 1977)

The calcium content in the Red Lakes is in the range of 31.0 to 38.5 milligrams/liter, and the magnesium from 12.0 to 15.0 milligrams/liter. (MRI, 1976) The bog concentrations of calcium and magnesium have been monitored respectively as 4.4 and 0.5 milligrams/liter in the bogs, 20.0 and 4.1 milligrams/liter in the ditches, and 35.6 and 9.4 milligrams/liter in the streams which pass through the bogs in the Red Lake area.

To determine the actual values of hardness which can be anticipated following mining activities, more monitoring of ditches and bogs is necessary. The Red Lakes have been shown to have calcium ion concentrations up to 8 times greater than in the bogs, and magnesium concentrations up to 30 times greater (MRI, 1973). The effect on the fish population from changes in calcium of this magnitude is uncertain. Also uncertain is whether the hardness of the bog water will result in equivalent outflow hardness. The EPA (1973) recommends only that dissolved solids should not change the characteristics of the aquatic life. They also state that bioassays and field studies can determine the tolerable limits of dissolved solids. In other words, with further field testing, the limits of the dissolved solids can be set in order to avoid damaging the aquatic life.

Suspended solids entering fishery areas affect light penetration, temperature, solubility of gasses and minerals. Abrasiveness and clogging of gills are possible detrimental affects upon fish species. Anaerobic (non-aerated) conditions which may produce noxious gases, low dissolved oxygen content, and a decrease in pH levels are possible effects of blanketing the Lake bottom with these suspended solids. (EPA, 1973) This blanketing may also adversely affect the spawning of certain species of fish. An additional effect may be the absorption of light which affects water temperature and plant growth.

EPA (1977) lists the following possible affects of suspended and settleable solids upon freshwater fisheries:

> *There is no evidence that concentrations of suspended solids less than 25 milligrams/liter have any harmful effects on fisheries.*
>
> *It should usually be possible to maintain good or moderate fisheries in waters that normally contain 25 to 80 milligrams/ liter suspended solids; other factors being equal. However, the yield of fish from such waters might be somewhat lower than from those in the preceeding category.*
>
> *Waters normally containing from 80 to 400 milligrams/liter suspended solids are unlikely to support good freshwater fisheries; although fisheries may sometimes be found at the lower concentrations within this range.*
>
> *Only poor fisheries are likely to be found in waters that normally contain more than 400 milligrams/liter suspended solids.*

In general, fish yields are inversely proportional to the amount of suspended solids found in the water (if suspended solids increase, fish yields decrease).

Neither the Red Lakes nor the Red Lake peatland bogs have been monitored for suspended solids. Visual inspection has shown the lakes to be relatively free of suspended solids. The bogs, on the other hand, contain many settled mineral solids which become suspended when the bog water is agitated during drainage to the Lakes. Suspended solids can become a threat to the fishing industry if the concentrations exceed 25 milligrams/liter (EPA, 1973). After disturbing the peat, many solids become suspended.

Abnormal temperature changes may drastically affect aquatic life. Some temperature changes may result from previously mentioned changes in water quality, such as suspended solids. Each peatland bog activity must be examined to determine possible temperature fluctuations on the area waters. Smith (1977a) reported that the Lakes are isothermal and the water temperature closely follows the air temperature.

Color may affect the amount of light penetrating the water which in turn may affect the amount of oxygen produced by aquatic plants. The color of the bog water is dark brown due to heavy mineral concentrations. The rust-colored lake water is a possible effect of mineral rich soil drainage over the years.

At the present time, we can project no change in the Red Lake water color or temperature due to mining of peat. Oils from the mining process may enter the Red Lakes and this problem must be examined when the technology has been determined.

Toxic chemicals present in the water can, and often do, affect fish growth. Crawford (1977a) reported on a potential problem concerning peatlands acting as a sink for heavy metals. Peat bogs may contain up to 3 ppm of mercury. The contamination of water with heavy metals is a great concern in a fishery. These substances, even in minute quantities, can accumulate in fish.

The differences in the composition of bog water from Red Lake water suggest a high potential for adverse impact on the fish if large amounts of bog water are drained into the Lake. The localized impacts of moderate amounts of water discharge near drainage outlets to the Lake should not be underestimated, particularly if these outlets are near spawning areas.

RESERVATION ENTERPRISE: RED LAKE FISHERIES

THE RED LAKERS HAVE BEEN COMMERCIAL FISHERMEN FOR OVER 60 YEARS.

THE RESERVATION FISHERY PROCESSES EIGHT DIFFERENT SPECIES OF FISH FOR VARIED MARKETS.

THE FISHERY IS THE MAJOR SOURCE OF EMPLOYMENT ON THE RESERVATION AND IS THE SINGLE MOST IMPORTANT COMPONENT OF THE RESERVATION ECONOMY.

Fishing has long been a way of life for the Red Lake Indians. In 1917 the pressures of a war economy resulted in high meat prices and a necessity for conserving food supplies. Development of a commercial fishing enterprise was started by the State of Minnesota to alleviate this problem. The Minnesota State Fisheries of Red Lake operated the industry from 1920 through 1928. They acted as a distributor and wholesaler for the fish produced in that period. During this period, the Red Lake Indians sold their catch to the State for processing.(Van Oosten and Deason, 1957)

In 1922, the Indians objected to the competition by State fishing crews and the wholesaling operations conducted by the State. At this time the Indians also claimed they were being underpaid for their catches and that the weighing of the fish was inaccurate. In 1929, following a complaint and summons instigated by a Winona fish wholesaler, the State Supreme Court issued an order restraining the State from competing with private industry. On March 27, 1929 the Red Lake Fisheries Association was organized by the Red Lake Tribe in order to utilize the fish resources of Red Lake.

The eight species processed in the fishery include walleye, perch, freshwater drum (sheepshead), whitefish, bullhead, northern, sucker and goldeye.(Eisenrich, 1977) The walleye and perch catches provided nearly fifty percent (50%) of the total catch and are thus the most important economically to the area.

The Red Lake Fishery is the major source of employment and income to the Tribe. Nearly two-thirds of the non-public employment is generated by this resource. In 1977 the Fishery produced over a million and a half pounds of fish. This excludes a substantial amount of fish caught for personal consumption by the Indians. Table 9 shows the annual catch, by species for the past three years.

Table 9

RED LAKE FISHERIES
1975, 1976 AND 1977 ANNUAL CATCH
(IN POUNDS)

Year	Species	Annual Catch (pounds)
1975	Walleyed Pike	159,000
	Perch	119,000
	Whitefish	176,000
	Sheepshead	149,000
Total 1975 Catch		603,000
1976	Walleyed Pike	230,000
	Perch	403,000
	Whitefish	86,000
	Sheepshead	363,000
Total 1976 Catch		1,082,000
1977	Walleyed Pike	661,000
	Perch	600,000
	Whitefish	78,000
	Sheepshead	320,000
Total 1977 Catch		1,659,000

There are over 200 fishermen in the Fishermans Co-op. Over $700,000.00 was paid to fishermen last year. Nearly $100,000.00 was paid in direct wages to employees of the fishery. As many as thirty people are employed directly in the processing plant. The total operating budget of the facility is $1,055,000.00. In 1977 the Fishery paid over $52,000.00 to the Red Lake Tribal Council. Clearly, the Fishery is the single most important component of the Reservation economy. Any reduction in the amount of fish available to the fishery caused by peat utilization would have a severe impact on the Reservation economy.

IMPACTED RESOURCE: FORESTRY

All three impact mediums, Air, Land and Water will affect the Red Lake forests. A general description of the Red Lake forests will provide the background for the review of potential impacts.

GENERAL DESCRIPTION: FORESTRY

THE RED LAKE FORESTS ARE MANAGED PRIMARILY TO SUPPLY THE RED LAKE INDIAN SAWMILLS.

THE TIMBER SUPPLY AVAILABLE TO THE SAWMILL IS 26% CONIFER AND 74% HARDWOOD.

NINETEEN DIFFERENT SPECIES EXIST IN SIGNIFICANT NUMBERS ON THE RESERVATION.

ONLY 19% OF THE DESIRED CUT IS CURRENTLY BEING HARVESTED ON THE RESERVATION. AS A RESULT, MUCH OF THE TIMBER IS OVER-MATURE.

EXPANDED CUTS ARE URGENTLY NEEDED IN ASPEN AND MOST OF THE SWAMP SPECIES.

THE SWAMP SPECIES ARE THOSE PREDOMINATELY ASSOCIATED WITH PEAT LAND.

Both the Diminished Reservation and Ceded Lands of the Red Lake Reservation are rich in forest resources. Most of the virgin pine forests were logged near the turn of the century. A wide variety of species have reforested the area. The Red Lake Indian forest was established by law on May 18, 1916. The Red Lake Indian forest comes under the general jurisdiction of the Minnesota Agency of the Bureau of Indian Affairs. Several Agency foresters are stationed at Red Lake to manage the forests of the Reservation. There are 198,743 acres of Commercial forest land on the Reservation. The Ceded Lands contain 85,162 acres of commercial forest land. The majority of commercial forests on the Ceded Lands are in the Northwest Angle (52,841 acres). The forest management area concentrates on the Diminished Reservation. The Red Lake forests are managed primarily to provide raw material for the Red Lake Indian Mills. Sale of timber to non-Reservation residents occurs but is not frequent.

Significant amounts of timber exist in a wide variety of species. These species are divided into two principle timber types: hardwood and conifer (softwood). The 1971-1980 Forest Management Plan for the Red Lake Diminished Reservation indicates the timber supply available to the Red Lake Sawmill is 26% Conifer and 74% Hardwood. If White Cedar is not used in the sawmill, the Conifer supply is only 17% of the total volume. The revised forest management plan for the Diminished Red Lake Reservation shows a total timber volume of almost 235 million boardfeet of sawtimber and over 2 million cords of cordwood. The largest volume is Aspen which makes up 36% of the sawtimber and 37% of the cordwood. The pines, red, white, and jack, comprise 34% of the sawtimber and 3-1/2% of the cordwood.

Over one-third of the commercial forests of the Reservation are the swamp species associated with peatlands. The swamp species of Black Spruce, Tamarack, and Northern White Cedar have a total cordwood and sawtimber volume of 515,900 cords or 25-1/2% of the total cordwood. Approximately 46% of this volume is Cedar and 39% is Tamarack. A breakdown of raw material (available annually) as to species, board foot volume, cordwood volume, and timber size in shown in Tables 10 and 11.

Table 10

CONIFER RAW MATERIAL
(Based on Annual Desirable Cut - 1970 C.F.I.)

Species	MBF	Cords	Tree Dia (DBH) Inches MBF	Cords	Av. Merch Tree Length (Ft)	Tree Length Logs Per MBF	Cords
White Pine	935	472	10-30 (18)	6-10(7)	65	3	-
Red Pine	373	455	10-22 (14)	6-10(7)	55	6	4*
Jack Pine	1,082	1,870	10-16 (13)	6-10(8)	55	8	6*
Balsam Fir	-	5,354	--	6-16(9)	50	-	7
White Spruce	300	450	10-16 (12)	6-10(8)	60	8	-
Black Spruce	-	5,227	--	6-14(9)	45	-	8
White Cedar	1,800	11,000	10-18 (11)	6-10(7)	35	14	-
Tamarack	-	12,560	--	6-16(9)	45	-	9
Total Conifer	4,490	37,388					
Conifer	26%	27%					

MBF - Thousand Boardfeet Sawtimber (18) Median Diameter *If total volume is measured in cords Cords = pulpwood and posts
DBH - Diameter Breast High

Some adjustments to Management Plan figures were made by the Project Team based on project research. The White Cedar and White Spruce was not estimated for the forest inventory in board foot volume for saw timber size material. The figures shown are Project Team estimates of sawtimber made available from the Reservation inventory data.

Table 11

HARDWOOD RAW MATERIAL
(Based on Annual Desirable Cut - 1970 C.F.I.)

Species	MBF	Cords	Tree Dia (DBH) Inches MBF	Cords	Av. Merch Tree Length (Ft)	Tree Length Log Per MBF	Cords
Hard Maple	160	1,373	10-16 (12)	-	24	18	-
Soft Maple	182	725	10-22 (12)	-	25	25	-
Paper Birch	1,563	12,412	10-18 (13)	6-10(8)	40	9	6
Basswood	642	1,753	10-16 (13)	-	40	9	-
Aspen	8,066	61,949	10-18 (12)	6-10(8)	55	10	5
Balsam Poplar	-	12,997	-	6-20(11)	-	-	-
No. Red Oak	190	1,099	10-14 (13)	-	-	-	-
Scrub Oak	-	585	10-14	6-10(8)	25	15	-
Burr Oak	855	908	10-18 (13)	6-10(8)	-	-	-
Elm	815	2,647	10-22 (15)	-	32	7	-
Ash	269	2,802	10-16 (12)	-	40	11	-
Misc.	-	54	-	-	-	-	-
Total Hardwood	12,742 74%	99,304 73%					
Grand Total	17,232	136,692					

These tables give an indication of the potential of the forestry resource. Nineteen different species of trees are available in large quantities for the Sawmill. Few other commercial forest lands in Minnesota have this variety in these quantities. Also, the Red Lake trees tend to be larger than in other Minnesota commercial forests. The relatively large stands of conifers, such as pine, spruce and cedar, represent a vital resource for the Reservation. The hardwoods, such as birch, basswood, oak, elm and aspen, are also an important Reservation resource.

The total amount of timber available annually to the Sawmill is only one indication of the value of this resource. The amount of forest land on the Reservation is substantial. The total timber, by cover type, on the Dimished Reservation is shown in Table 12. The total timber on the Ceded Lands is shown in Table 13.

Table 12

RED LAKE DIMINISHED RESERVATION
COVER TYPE, AREA, VOLUME AND AVERAGE VOLUME/ACRE 1/

Cover Type	Area Acres	Total Volume Sawtimber MBF	Total Volume Cordwood Cords 2/	Average Volume/Acre Sawtimber BF	Average Volume/Acre Cordwood Cords 2/
			COMMERCIAL FOREST LAND		
White Pine	2,981	22,256	26,175	7,466	8.780
Red Pine	6,459	31,477	47,062	4,873	7.286
Jack Pine	6,459	14,853	44,668	2,300	6.916
Spruce-Fir	5,456	2,054	49,101	376	8.984
Black Spruce	5,962	786	38,786	132	6.506

Table 12 (Continued)

RED LAKE DIMINISHED RESERVATION
COVER TYPE, AREA, VOLUME AND AVERAGE VOLUME/ACRE 1/

Cover Type	Area Acres	Total Volume Sawtimber MBF	Total Volume Cordwood Cords 2/	Average Volume/Acre Sawtimber BF	Average Volume/Acre Cordwood Cords 2/
White Cedar	25,340	2,621	326,734	103	12.894
Tamarack	20,371	241	155,423	12	7.630
Northern Hardwoods	8,943	34,974	93,610	3,911	10.467
B. Hardwoods	15,403	23,301	176,018	1,513	11.428
White Birch	7,453	10,394	82,565	1,395	11.078
Aspen	64,591	82,732	812,337	1,281	12.577
Balsam Poplar	7,453	2,973	97,018	374	13.018
Oak	2,981	4,922	26,704	1,651	8.958
Timber Type TOTAL	179,861	233,584	1,976,201	1,295	10.988
Grass	497	-	-	-	-
Upland Brush	2,982	896	4,759	360	1.597
Lowland Brush	15,403	233	32,699	15	2.123
Commercial Forest Land TOTAL	198,743	234,713	2,013,659	1,181	10.132
			NON-COMMERCIAL FOREST LAND		
Non-productive	9,440	-	3,463	-	.367
			NON-FOREST LAND		
Wild Non-Forest	22,359	209	289	9	.013
Farm Land	497	-	-	-	-
Other	1,987	-	5,187	-	1.750
TOTAL	233,026	234,922	2,022,598	1,008	8.680

1/ Board foot volumes include material of all sizes and qualities suitable for sawlogs and bolts, veneer logs and bolts. Cordwood volumes include material of all sizes but suitable only for cordwood products.

2/ Aspen cordwood includes material in tops of sawlog trees.

Table 13

CEDED LANDS
COVER TYPE AND VOLUME

Cover Type	Acres	Volume (All Species) MBF	Cords
Red Pine	1,947	-	861
Jack Pine	6,326	7,485	54,142
Spruce-Fir	5,353	1,184	52,160
Black Spruce	26,765	1,718	210,744
Cedar	6,326	1,413	90,423
Tamarck	9,246	59	67,054
Bottom Land Hardwoods	4,380	1,607	42,259
Birch	4,867	2,101	48,293
Aspen	6,326	7,271	60,978
Commercial Timber Area Subtotal	77,536	22,838	626,914
Upland Brush Subtotal	1,460	436	3,400
Lowland Brush Subtotal	12,166	297	22,493
Nonproductive Subtotal	66,670	46	20,143
Non-Forest	4,863	-	170
Grand Total	156,694	23,617	673,128

Source: Forest Management Plan: Ceded Lands Adjusted: 1961-1962 Cruise

The concept of a desirable cut is referred to throughout this section. In forestry this term refers to the timber cutting at a volume where the resource is being optimally utilized. This infers that species are not being undercut allowing trees to become over-mature and rot in the field. Also, the species is not being cut at a rate that exceeds reforestration, allowing the species to be depleted. Table 14 shows Annual Desirable Cut by Species and Project Class.

Table 14

RED LAKE DIMINISHED RESERVATION TOTAL VOLUME AND ANNUAL DESIRABLE CUT BY SPECIES AND PRODUCT CLASS

	Total Volume		Annual Desirable Cut	
Species	MBF	Cords	MBF	Cords
White Pine	30,548	14,330	935	472
Red Pine	37,410	32,943	373	455
Jack Pine	12,183	23,631	1,082	1,870
Balsam Fir	-	* 68,575	-	* 5,354
White Spruce	-	* 17,236	-	* 1,350
Black Spruce	-	* 77,216	-	* 5,227
Cedar	-	* 236,873	-	*16,573
Tamarack	-	* 201,789	-	*12,560
Maple	3,835	33,867	342	2,098
Paper Birch	17,982	157,080	1,563	12,412
Basswood	13,601	44,592	642	1,753
Aspen	84,832	742,666	8,066	61,949

Table 14 (Continued)

RED LAKE DIMINISHED RESERVATION TOTAL VOLUME AND ANNUAL DESIRABLE CUT BY SPECIES AND PRODUCT CLASS

Species	Total Volume MBF	Total Volume Cords	Annual Desirable Cut MBF	Annual Desirable Cut Cords
Balsam Poplar	-	* 166,389	-	*12,997
Oaks	14,291	56,302	1,045	2,592
N. Red	(2,225)	(18,997)	(190)	(1,099)
Scrub	-	(8,917)	-	(585)
Burr	(12,066)	(28,388)	(855)	(908)
Elm	13,853	54,091	815	2,647
Ash	6,383	89,590	269	2,802
Misc.	-	5,428	-	54
TOTALS	234,918	2,022,598	15,132	143,165

*Includes sawtimber and boltwood material.

Table 15 shows the Percentage of Actual Cut compared to Desirable Cut for key Reservation species.

Table 15

Species	Actual Cut Compared to the Desirable Cut
Jack Pine	95%
Black Spruce	75%
Aspen	8%
Balsam Fir	14%
Paper Birch	11% (Sawtimber only removed)

As Table 15 indicates, the Reservation is only utilizing 8% of the optimal cut of Aspen, 14% of Balsam Fir and 11% of Paper Birch.

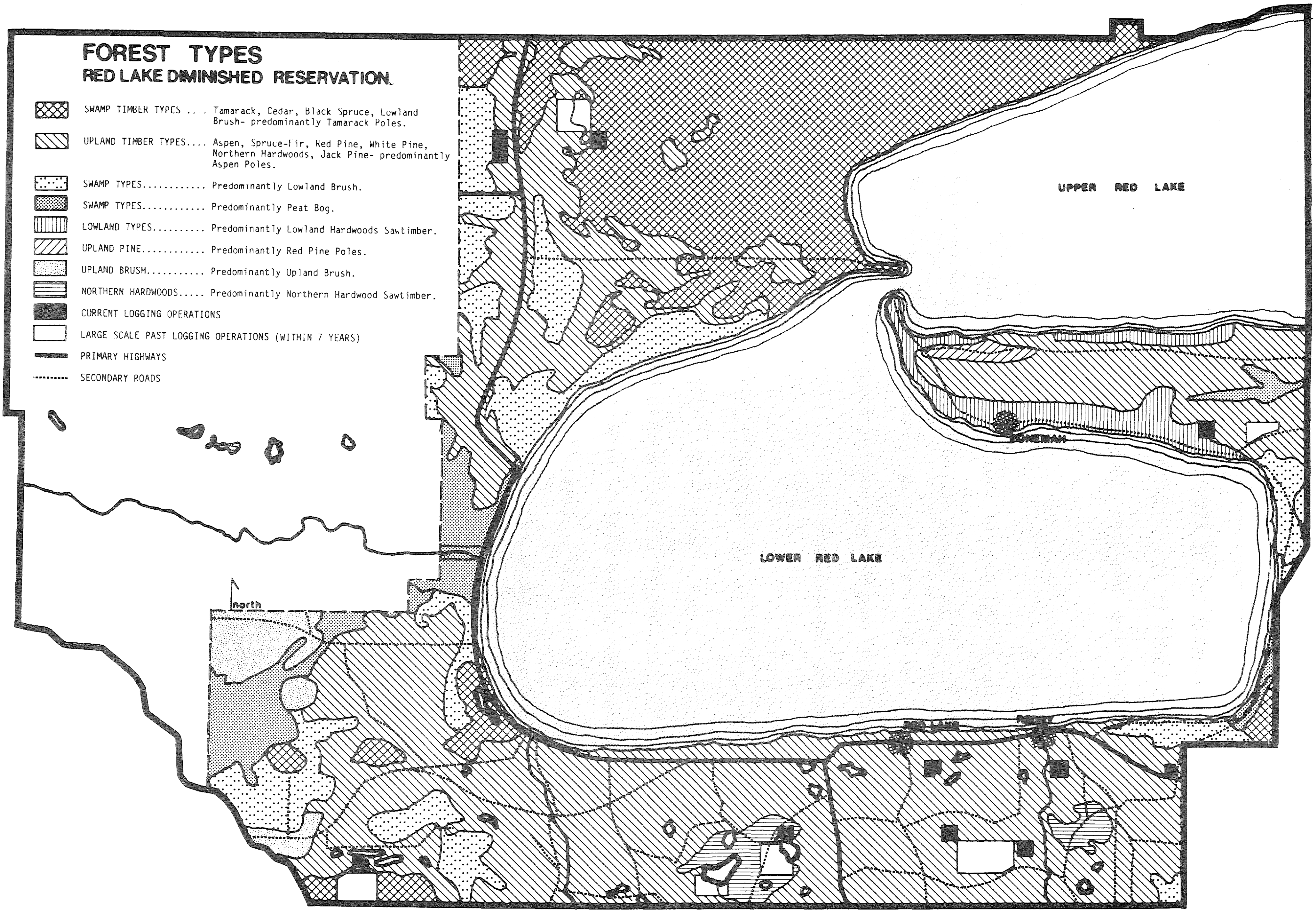

FOREST TYPES
RED LAKE DIMINISHED RESERVATION
SWAMP TIMBER TYPES .... Tamarack, Cedar, Black Spruce, Lowland Brush- predominantly Tamarack Poles.
UPLAND TIMBER TYPES.... Aspen, Spruce-Fir, Red Pine, White Pine, Northern Hardwoods, Jack Pine- predominantly Aspen Poles.
SWAMP TYPES............ Predominantly Lowland Brush.
SWAMP TYPES............ Predominantly Peat Bog.
LOWLAND TYPES.......... Predominantly Lowland Hardwoods Sawtimber.
UPLAND PINE............ Predominantly Red Pine Poles.
UPLAND BRUSH........... Predominantly Upland Brush.
NORTHERN HARDWOODS..... Predominantly Northern Hardwood Sawtimber.
CURRENT LOGGING OPERATIONS
LARGE SCALE PAST LOGGING OPERATIONS (WITHIN 7 YEARS)
PRIMARY HIGHWAYS
SECONDARY ROADS
north
UPPER RED LAKE
LOWER RED LAKE

FIGURE 11

The annual allowable cut of timber on the Diminished Red Lake Reservation and the Ceded Lands is 76.5 million boardfeet. The actual cut in the last five years has averaged 14.8 million boardfeet or 19% of the allowable cut.

A review of the actual cut for the current period indicate that the cut for red, white and jack pine, and basswood approach the desired annual cut. To prevent over-maturity and wasted resources, expanded cuts are urgently needed in aspen, paper birch, tamarack, balsam fir types, and to a lesser extent, Black Spruce.

Harvesting of timber on the Indian lands has not been sufficient to create a good age class distribution. With the actual cut only 19% of the allowable cut, the forest is becoming mature and overmature. Only a very small percent of the area is in young stands. Less than 11% of the swamp types of black spruce, tamarack and cedar are in the reproduction and sapling stage. The largest imbalance in age classes is in the tamarack and cedar types. In these and other species, mortality exceeds the new growth.

The main deterrent to good forest growth is the lack of cutting in overmature and mature stands necessary to regenerate young vigorous timber stands. Regeneration cuts, in most cases, will be clear cuts. Clear cutting is necessary for the establishment of new stands. Conversion of some of the aspen and other hardwood stands to pine is desirable, but not practical with the present ban on the use of herbicides. Some aspen, birch and northern hardwood stands are on areas of good red pine sites. Red pine is capable of out-producing these species in wood volume by about 50 percent and, it yields a more valuable timber product.

Figure 11 shows the location of the forest types on the Diminished Reservation. The western portion of the Reservation is not in the forest management area. This region is mostly swamp land with few commercial stands of timber. Specifically, this includes the western townships of T.154N., R37W.; T.154N, R38W.; T.153N, R38W.; T.152N, R37W.; and T.152N, R38W. The map identifies five areas of broad timber types and three areas of general ground cover. Two general classifications are the Swamp Timber types and the Upland Timber types. The Swamp types include the Tamarack, Cedar and Black Spruce. The Upland Timber types include Aspen, Spruce-Fir, Red Pine, White Pine, Northern Hardwoods and Jack Pine. The location and growth of particular species of trees is primarily determined by climate, soil type and the water table. Both the soil type and water table can be drastically altered by peat utilization.

AIR IMPACTS: FORESTRY

ALTERATION IN AIR QUALITY OF THE TYPE EXPECTED FROM PEAT UTILIZATION SHOULD NOT HAVE WIDE SPREAD DETRIMENTAL EFFECTS ON SURROUNDING TIMBER STANDS.

The trees of the area have not been adversely affected by the gasses and particulate matter released into the air by bog and forest fires. The forests of the area appear to have a high tolerance for the substances and particles released into the air by peat utilization.

Peat utilization may change the evapotranspiration rates in a project area. The effects of altered evapotranspiration on existing vegetation are not clearly defined and should be further studied.

LAND IMPACTS: FORESTRY

PEAT UTILIZATION REQUIRES THE REMOVAL OF ANY TIMBER ON THE SITE.

OVER 90,000 ACRES OF RED LAKE COMMERCIAL FORESTS ARE ON PEAT SOILS.

THE MAJORITY OF COMMERCIAL FORESTS ON PEAT SOILS ARE THE SWAMP TYPES. THESE SPECIES ARE OVER-MATURE AND WOULD BENEFIT FROM HARVESTING.

RAISED BOG PEATS SUPPORT POOR TREE GROWTH. REMOVAL OF THESE SOILS WITH PROPER RECLAMATION WOULD INCREASE THE AMOUNT OF COMMERCIAL FOREST LAND.

The impact medium of land will affect the forest resource through alterations in the land use, changes in the composition of the soil, fires and visual impacts. Most forms of peat utilization require clearing of vegetation from the land. Over 90,000 acres of the Red Lake commercial forests are on peat soils.

Commercial forest land associated with peat lands under management on the Diminished Reservation include 51,673 acres of the Tamarack, Black Spruce and Northern White Cedar. Lowland brush covers another 15,403 acres.

Peat lands in the eastern part of the Diminished Reservation in many cases support well stocked productive commercial timber stands of Tamarack, Black Spruce and Northern White Cedar. The Ceded Lands contain another 40,000 acres of timber on peat soils.

The present tree growth or lack of tree growth in the fibric peats of raised bogs is similar to what has existed for hundreds of years. The tree species most prevalent on the fibric peat of raised bogs of the Red Lake area is Black Spruce. Tree growth is very slow and for the most part is less than that required for commercial forest land. The major factor related to tree growth is the depth of undecomposed peat. This material is very low in nutrients, generally resulting in stunted grwoth.

Fires have occured in this area destroying the timber cover, but stands of similar composition and character have regenerated. Fire usually causes a deterioration of site quality, but on peat soils found in this area the reverse is more likely to occur.

On the highlands, the trees that most commonly reforest an area following fire are: Aspen , Paper Birch and Jackpine. In the lowlands, which would be mostly the hemic to sapric peats in a depression filled bog, a number of areas formerly supporting commercial timber stands have reverted to brush types. Brush species took over the area because fires and logging failed to leave a seed source of conifer trees.

If the timber stands are on peatland, these trees must be removed for peat utilization. The impact of this depends upon the maturity of the trees to be removed. If the timber is not of commercial size, harvesting would be premature. If the timber is mature or over-mature, the forest would benefit from harvesting.

Utilizing the Red Lake bog area for timber production after peat extraction and reclamation would be possible. Removal of the undecomposed and slightly decomposed peat would increase the site quality for growing trees. Water movement and the introduction of groundwater associated with mineral soils would increase a sites' potential for growing trees.

WATER IMPACTS: FORESTRY

TREES, PARTICULARLY SWAMP TYPES, HAVE A NARROW RANGE OF TOLERANCE FOR CHANGES IN AVAILABLE WATER.

A MODEST LOWERING OF THE WATER LEVEL WILL BENEFIT SWAMP TYPE TIMBER.

A RAISED WATER LEVEL WILL HINDER TREE GROWTH. FLOODING, EVEN FOR A SHORT TIME, WILL KILL TREES.

WITHIN THE LIMITS EXPECTED FROM PEAT USE, CHANGES IN WATER ACIDITY IS NOT AS CRITICAL TO TREE GROWTH AS CHANGES IN THE QUANTITY OF AVAILABLE WATER.

Peat utilization will have a direct effect on ground and surface water of the Red Lake area. Any changes in water flows and water quality will directly impact the forest resources. Surface water and the water of the shallow aquifer are the most critical to tree growth. Deep aquifer water will affect tree growth only to the extent that surface and shallow aquifer water is affected by the deep aquifer water. Depending on the type and scale of peat utilization, the water impacts are likely to be directly transferred into forest impacts.

Peat utilization requires the removal of water from the area of actual peat use. This removed water must be transferred to another location and stored. That storage area may be another bog adjacent to the use site, or it may be a lake basin some distance from the utilization site. In any case, the water level in one area, the peat use site, will be lowered and the water level in another area, the storage area, will rise.

The impact on trees depends on the species of tree and the present water conditions. The species most likely to be impacted by major peat utilization are the swamp types. These species are directly affected by any changes in the surrounding surface water. These are also the species that are prevalent in the immediate area of peat bogs in the Red lake area

Trees have a narrow range of tolerance for changes in the water table. The water table can be lowered by drainage in the peat harvesting area and raised in the area to which the water is drained. The lowering of the water table on swamp lands bordering a peat utilization site will benefit timber growth. Surrounding timber stands on uplands will not suffer any adverse effects from the lower water table in the area of peat utilization.

The storage of water drained from the peat utilization area is a major impact on forest resources of the Red lake Reservation and adjacent areas. The main impact would be the raising of the water level in swamp areas surrounding the area into which the water is discharged. A temporary rise of the water level in swamps to cause flooding for just a few months is enough to kill the tree growth. Modest long term rises in the water level will retard the growth of the trees.

The construction of roads in a peat bog effects the growth of trees. Up hill from the road, the water table will rise, flooding of roots may occur as a result of the damming effect of the road. Trees in this area would be killed on stunted. Downhill from the road, the water table would be lowered and tree growth would accelerate. Effective culvert systems must be provided to diminish the impact of roadway construction on adjacent forests.

A major change in water quality would result from peat utilization through changes in water, pH and nutrient content. Forest growth on peatlands is dependent mainly on the availability of nutrients to the trees and the water table. Soil composed of several feet of undecomposed peat is very low in nutrients. Groundwater near the surface is supplied by rainfall is also very low in nutrients and has a low pH. These low nutrient conditions are found in the raised bogs of the Red Lake area where tree growth is lacking or stunted. Peatlands on depression filled bogs, having decomposed peat and humus near the surface, are higher in nutrients and pH, and can support commercial forest growth. Groundwater in contact with mineral soil has good nutrient composition.

Drained water from a raised bog, such as much of the Red Lake bog, is expected to have a relatively low pH (acid). The chemical composition of this water table should not have a detrimental effect on the timber stands, as the trees have a wide range of tolerance for degrees of acidity.

Tree growth has been increased considerably on peatlands in Europe by draining to lower the water level. In Finland, 8-1/2 million acres had been drained for forestry by 1970. Presently 750,000 acres are drained annually. By water level control through drainage, treeless bogs have been transferred into productive forests comparable to those on mineral soil (Kapustinskaite).

Under existing conditions, much of the Red Lake Bog is not capable of producing commercial forests. As time progresses the Bog becomes less capable of supporting commercial tree growth due to the accumulation of undecomposed sphagnum peats. Profiles of similar bogs show that much better tree growth was present 3000 years ago (Boelter and Verry). Drainage ditches which were put in the Red Lake area approximately sixty years ago, a mile or two apart, have not altered the tree growth to any significant extent. A study made in the area to determine the effect on tree growth 15 years after the ditching showed that on an average no increase in growth occurred beyond 331 feet from the ditch (Averell and McGrew).

Results of current research on bog drainage to increase timber growth in areas similar to the Red Lake Bog, has been poor to altogether ineffective. Drainage alone does not seem to be the answer to obtain productive forest growth on the Red Lake Bog. Even good swampland, where drainage structures are unnecessary is marginal for growing timber based on present economics.

RESERVATION ENTERPRISE: THE RED LAKE INDIAN SAWMILLS

THE RED LAKE INDIAN SAWMILLS HAVE BEEN A SOURCE OF RESERVATION EMPLOYMENT AND INCOME FOR OVER HALF A CENTURY. THE SAWMILL PROVIDES NEARLY ONE-THIRD OF THE NON-PUBLIC EMPLOYMENT ON THE RESERVATION.

DECLINES IN THE AVAILABILITY OF PINE HAVE MADE MAINTAINING SAWMILL PROFITABILITY DIFFICULT. THE TRIBE HAS BEGUN A COMPREHENSIVE PROGRAM OF EXPANDED UTILIZATION OF ASPEN AND THE SWAMP TIMBER SPECIES. THE SWAMP TYPES CAN BE DIRECTLY AFFECTED BY PEAT UTILIZATION.

Although logging has taken place on the Reservation since before the turn of the century, the first sawmill was constructed at Redby around 1924. This mill was steam operated and primarily produced White and Norway Pine lumber. This mill generally prospered, primarily due to the profitability of producing pine. In 1961, the mill was rebuilt and completely modernized. This new mill was designed to produce both soft and hardwood efficiently. In the late 1950's, the supply of pine began to be limited to the mill. This began to adversely affect the profitability of the mill. As a general rule, hardwoods result in higher production costs and lower prices. The new mill had a design capacity of approximately 5,000,000 feet of lumber each year. In 1965, the mill burned and was rebuilt in 1966 at roughly the same capacity. A planing mill and general improvements were added in 1969.

The Sawmill currently employs over 50 Reservation residents. Also, as many as 25 loggers supply timber to the Mill. This represents over one-third of the non-public employment on the Reservation.

In the 10 years, from July 1, 1966 through June 30, 1976, the Mill had the desired level of production in only one year (F.Y. 1969). Table 16 illustrates how the lack of volume creates higher manufacturing costs and can result in an operating loss to the mill:

Table 16

SAWMILL PRODUCTION AND PROFITS

Fiscal Year	Sawmill Production M	Sawmill Manufacturing Cost M	Net Profit or Loss Average M
7/1/66 - 6/30/67	2,036,128	$52.66	$(57.79)
7/1/67 - 6/30/68	4,427,945	$40.94	$(19.40)
7/1/68 - 6/30/69	5,739,301	$33.64	$ 2.52
7/1/69 - 6/30/70	4,472,877	$38.47	$ 3.07
7/1/70 - 6/30/71	4,656,919	$36.71	$ 4.75
7/1/71 - 6/30/72	4,746,425	$37.22	$ 12.25
7/1/72 - 6/30/73	3,011,990	$55.13	$ 30.28*
7/1/73 - 6/30/74	3,632,572	$65.26	$ 48.58*
7/1/74 - 6/30/75	3,228,664	$76.38	$(44.37)
7/1/75 - 6/30/76	3,954,302	$70.69	$(1.49)

*These were years of highly inflated lumber prices

Source: McFarland Report, 1977

From the above, it can be clearly seen how the lack of production volume affects the manufacturing cost of lumber which, in turn, affects the mill's profit (this latter item usually follows poor production years by from 1 to 3 years dependent upon the size of the rough lumber inventory carried over from year to year).

The problems with profitability in the mill are the result of basic changes in the raw material available to the Sawmill. These will be commented on only to the extent that they may be worsened or improved by peat use.

The type of log going into the mill can greatly affect production. Figure 12 indicates how heavy pine production greatly increases the mill productivity.

The high pine production years are past. As a result, the Sawmill has been facing extreme difficulty keeping production up to profitable levels. In recent years, the Tribal Council has undertaken an active program to overcome the Sawmill's difficulty maintaining profitability. The Tribe has recently recruited new Mill management. Several recently completed and on-going studies were commissioned. It is the consensus of the new management and the specialists involved in the studies that the Sawmill must expand its production emphasis to other species.

The sawmill must expand its utilization of the more predominant timber such as aspen and swamp types. Many of these species are only marginally profitable as lumber, particularly if produced by present sawmill methods. To be competative in these species, the Sawmill must convert from its present sawlog system to a tree length utilization system. To handle tree length material, machinery must be added to the Sawmill. This will represent a million dollar investment.

Further Sawmill expansion is planned. The foundation of this Sawmill improvement strategy is the utilization of aspen and the swamp types. For example, expanded use of cedar is currently under consideration by specialists studying the Red Lake Sawmill problems.

The Sawmill is a vital component of the Reservation. One of the solutions of current operating difficulties is utilizing species that have a high probability of being impacted by peat use.

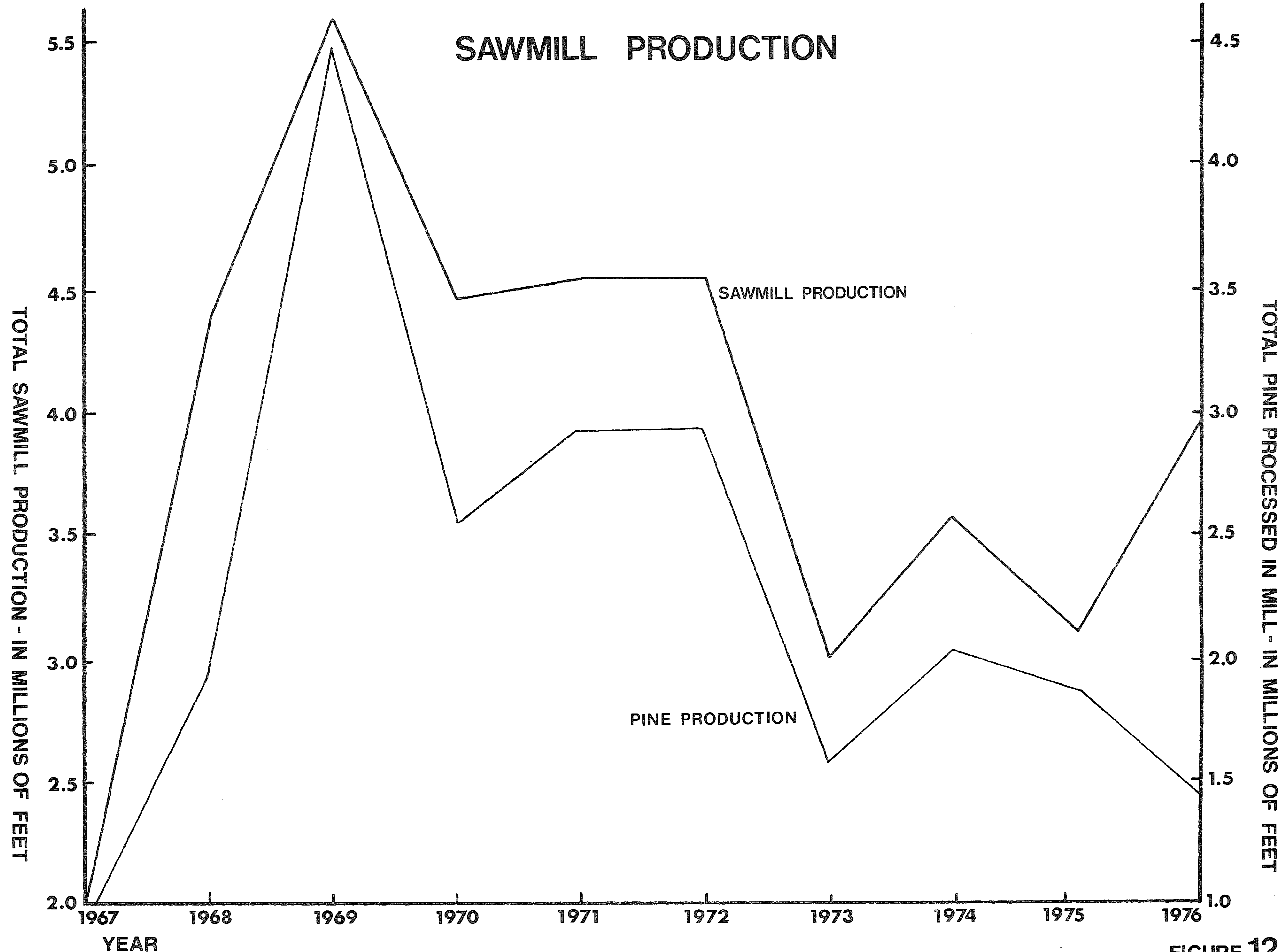

SAWMILL PRODUCTION
SAWMILL PRODUCTION
PINE PRODUCTION
TOTAL SAWMILL PRODUCTION - IN MILLIONS OF FEET
TOTAL PINE PROCESSED IN MILL - IN MILLIONS OF FEET
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
YEAR

FIGURE 12

IMPACTED RESOURCE: WILDLIFE

Each impact medium; air, land, and water, affects wildlife in the Red Lake area. The following description of the wildlife of the area provides the background for review of the potential impact of peat utilization on Reservation wildlife.

GENERAL DESCRIPTION: WILDLIFE

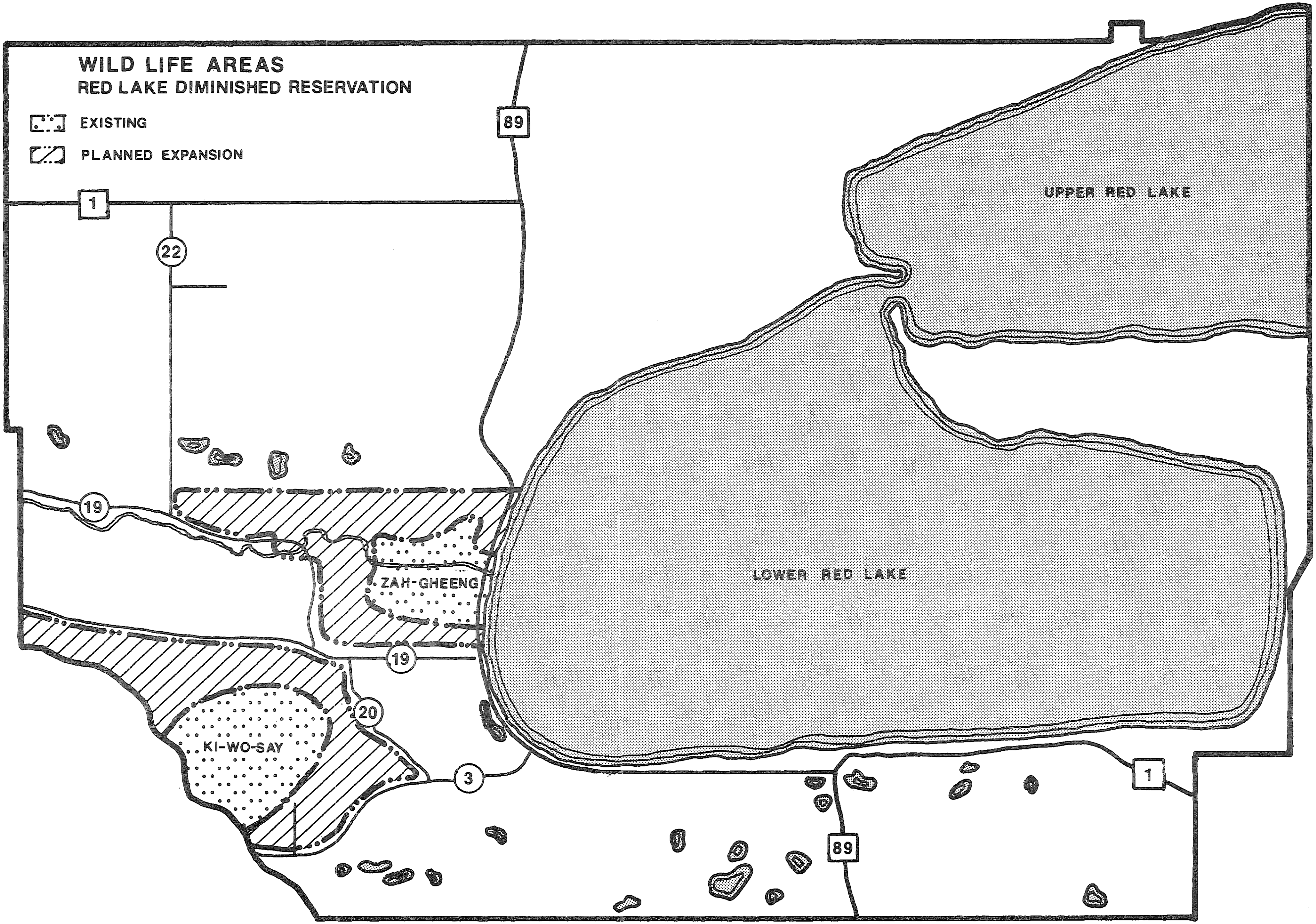
THE RED LAKE FORESTS, LAKES, AND SWAMPS PROVIDE HABITAT FOR MANY WILDLIFE SPECIES INCLUDING MOOSE, DEER, FOX, DUCKS, GEESE AND MUSKRATS.

OVER 60 DIFFERENT MAMMALS, NEARLY 200 SPECIES OF BIRDS AND OVER THIRTY AQUATIC INVERTEBRATES INHABIT MINNESOTA PEAT LANDS

ENDANGERED SPECIES SUCH AS THE ARTIC PEREGRINE FALCON AND THE EASTERN TIMBER WOLF ARE FOUND IN THE AREA.

THE WILDLIFE MANAGEMENT SYSTEM OF THE RED LAKE INDIAN RESERVATION CREATES A GAME MANAGEMENT SYSTEM WHICH IS UNIQUE TO THAT AREA OF THE STATE.

The Red Lake Indian Reservation is a wildlife rich area which includes the Ki-Wo-Say and Zah Gheeng wildlife areas. Both these areas are west of Lower Red Lake (see Figure 13). The area north of Upper Red Lake is a designated Wildlife Management area. Many additional areas throughout the Reservation act as undesignated wildlife refuges. Table 17 shows many of the species of animals which were known to be on the Reservation in 1971.



WILD LIFE AREAS
RED LAKE DIMINISHED RESERVATION
EXISTING
PLANNED EXPANSION
89
1
22
UPPER RED LAKE
LOWER RED LAKE
19
ZAH-GHEENG
19
20
KI-WO-SAY
3
1
89

FIGURE 13

Table 17

ANIMALS PRESENTLY KNOWN TO BE ON THE RED LAKE INDIAN RESERVATION

	Resident 1971	Seasonal 1971	Removed 1971
Bear	100	10	15
Elk	--	10	3
Deer	6,000	--	--
Moose	60	--	--
Ducks (unnamed)	5,000	350,000	5,000
Geese (unnamed)	3	5,000	200
Pheasant	--	15	--
Grouse	600	--	100
Partridge	10,000	--	3,000
Dove	650	--	--
Beaver	550	--	--
Muskrat	20,000	--	4,000
Mink	300	--	50
Otter	80	--	6
Raccoon	1,000	--	35
Weasel	600	--	50
Skunk	1,000	--	35
Fox	400	--	75
Timber Wolf	30	--	6
Coyote	100	--	20

Source: Jorgenson, 1971

The inventory of bog inhabitants north of Upper Red Lake is incomplete at this time. Dr. William H. Marshall, Dr. Elmer C. Birney and Dr. Dwain Warner of the University of Minnesota are each presently conducting studies of the area's wildlife which will be completed by June 30, 1979.

The wildlife population of the Diminished Reservation has been investigated to a limited degree, but the bog areas on the Ceded Reservation have had no substantial wildlife inventory. Tables 18 and 19 give a partial list of wildlife species in and around Minnesota peatland bog areas as compiled by MRI (1976), but is not site specific to the Red Lake area. The length of these tables indicate that the bogs of Minnesota are rich in wildlife.

Table 18

ANIMAL SPECIES OF MINNESOTA'S PEATLANDS AND ADJACENT AREAS:
A PRELIMINARY LIST
(Gunderson and Beer, 1953; Elwell, et al., 1973, Knapp, 1960)

Habitat Key
x Spruce bogs; o Fen
* Streams and banks
+ Lakes
No Symbol-Wooded Uplands & Grasslands

Endangered Status
E-Endangered Species -p -Protected
T-Threatened -u -Unprotected
C-Changing/Uncertain Status
S-Special Interest

	Common Name	Scientific Name
	Mammals	
ox	Star-Nosed Mole	Condylura cristata
	Cinereous Shrew	Sorex cinereus
x	Saddle-Backed Shrew	Sorex arcticus
*	Water Shrew	Sorex palustris
	Pigmy Shrew	Microsorex hoyi
x	Short-Tailed Shrew	Blarina Brevicauda
	Little Brown Bat	Myotis lucifugus
	Keen's Little Brown Bat	Myotis keenii
	White-Tailed Jack Rabbit	Lepus townsendii
x	Snowshoe Hare	Lepus americanus
	Cottontail Rabbit	Sulvilagus floridanus
*	Woodchuck	Marmota monax
	Richardson's Ground Squirrel	Citellus rechardsonii
	Striped Ground Squirrel	Citellus tridecemlineatus
	Franklin's Ground Squirrel	Citellus franklinii
x	Least Chipmunk	Eutamias minimus
	Eastern Chipmunk	Tamias striatus
x	Red Squirrel	Tamiasciurus hudsonicus
	Gray Squirrel	Sciurus corolinensis
*	Fox Squirrel	Sciurus niger
	Little Flying Squirrel	Glaucomys volans
	Northern Flying Squirrel	Glaucomys sabrinus
*	Beaver	Castor canadensis
	Canadian White-Footed (Woodland Deer) Mouse	Peromyscus maniculatus gracilis

Table 18 (Continued)

	Common Name	Scientific Name
Mammals		
	Northern White-Footed Mouse	Peromyscus leucopus noveboracensis
o	Bog Lemming	Synaptomys cooperi
x	Northern Bog Lemming	Synaptomys borealis
x	Red-Backed Mouse (Vole)	Clethrionomys gapperi
	Common Meadow Mouse (Vole)	Microtus pennsylvanicus
	Rock Vole (c-u)	Microtus chrotorrhinus
*	Muskrat	Ondatra zibethica
	Norway Rat	Rattus norvegicus
	House Mouse	Mus musculus
	Meadow Jumping Mouse	Zapus hudsonius
*	Woodland Jumping Mouse	Napaeozapus insignis
	Porcupine	Erethizon dorsatus
	Black Bear	Ursus americanus
*	Raccoon	Procyon lotor
*	Fisher (C-p)	Martes pennanti
	Short-Tailed Weasel	Mustela erminea
*	Long Tailed Weasel	Mustela frenata
x	Least Weasel	Mustela rixoso
*	Mink	Mustela vision
*	Otter	Lutra canadensis
*	Striped Skunk	Mephitis mepitis
	Badger	Taxidea taxus
	Red Fox	Vulpes Fulva
	Gray Fox	Urocyon cinereoargenteus
x	Coyote	Canis latrans
x	Timber Wolf (E-p)	Canis lupus
x	Canada Lynx (C-U)	Lynx canadensis
	Bobcat (S-U)	Lynx refus
	American Elk	Cervus canadensis
ox	Wite-Tailed Deer	Odocoileus virginianus
	Mule Deer	Odocoileus hemionus
o*	Moose	Alces alces
INVERTEBRATES (Aquatic)		
+	Water fleas	Cladocera
+	Fingernail clam	Pisidium sp
+	Fingernail clam	Sphaerium sp
+	Snail	Amnicola sp
+	Snail	Lymnea stagnalis
+	Snail	Physa sp
+	Snail	Valvata tricarinata
+	Snail	Promenetus exacuatus
+	Leech	Helobdella stagnalis
+	Leech	Dina parva

Table 18 (Continued)

Common Name	Scientific Name
INVERTEBRATES (Aquatic) (Continued)	
+ Flatworm	Turbellaria
+ Flatworm	Planariidae
+ Aquatic annelids	Oligochaeta
+ Burrowing mayfly	*Ephemera* sp
+ Burrowing mayfly	*Hexagenis* sp
+ Bottom sprawler mayfly	*Caenis* sp
+ Net-spinning caddisfly	Hudropsychidae
+ Caddisfly	Molannidae
+ Silken tube-spinners, Finger net caddisfly	Philopotamidae
+ Tube-making, trumpet net caddisfly	Psychomyiidae
+ Midge	Chiromomidae
+ Midge	Chiromomidae
+ Biting midge	Ceratopogonidae
+ Riffle beetles	Elmidae
+ Scud	Gammaridae
+ Scud	*Hyalella azteca*
+ Seed Shrimp	Ostracoda
+ Clam shrimp	Eubranchiopoda

Table 19

BREEDING BIRDS IN MINNESOTA'S PEATLANDS AND ADJACENT AREAS:
A PRELIMINARY LIST
(Eckert, 1974; Green and Janssen, 1975).

Habitat Key
+ = Coniferous Forests
x = Spruce Bogs
o = Fens

No symbol = Wooded uplands and Grasslands

Endangered Species
E = Endangered Species
T = Threatened
C = Changing/Uncertain Status in Minnesota
S = Special Interest in
-p= Protected
-u= Unprotected

Common Loon	Ruby-throated Hummingbird
Horned Grege	Belted Kingfisher
Double-crested Cormorant (C-u)	Common Flicker
Great Blue Heron (S-p)	Pileated Woodpecker
American Bittern	Red-headed Woodpecker
Canada Goose	Yellow-bellied Sapsucker
Mallard	Hairy Woodpecker

Table 19 (Continued)

Habitat Key	Endangered Species
+ = Coniferous Forests	E = Endangered Species
x = Spruce Bogs	T = Threatened
o = Fens	C = Changing/Uncertain Status in Minnesota
No symbol = Wooded uplands and Grasslands	S = Special Interest in
	-p= Protected
	-u= Unprotected

+	Black Duck
	Green-winged Teal
	Blue-winged Teal
+	American Widgeon
	Wood Duck
+	Ring-Necked Duck
+	Common Goldeneye
+	Hooded Merganser
+	Common Merganser
+	Red-breasted Merganser
	Turkey Vulture
x	Goshawk
	Cooper's Hawk (C-p)
	Red-tailed Hawk
	Broad-winged Hawk
+	Bald Eagle (C-p)
+	Marsh Hawk (C-p)
+	Osprey
+	Merlin
	American Kestrel
x	Spruce Grouse
	Ruffed Grouse
o	Sharp-tailed Grouse
x	Sandhill Crane (T-p)
o	Yellow Rail
	Sora Rail
	Killdeer
o	American Woodcock
o	Common Snipe
	Spotted Sandpiper
+	Solitary Sandpiper
+	Herring Gull
+	Common Tern (C-p)
	Black-billed Cuckcoo
+	Great Horned Owl
+	Hawk Owl
+	Barred Owl
+	Great Gray Owl
	Downy Woodpecker
x	Black-backed Three-toed Woodpecker
x	Northern Three-toed Woodpecker
	Eastern Kingbird
	Great Crested Flycatcher
	Eastern Phoebe
x	Yellow-bellied Flycatcher
o	Alder Flycatcher
	Least Flycatcher
x	Olive-sided Flycatcher
	Eastern Wood Pewee
	Tree Swallow
	Bank Swallow
	Rough-winged Swallow
	Barn Swallow
	Cliff Swallow
	Purple Martin
	Blue Jay
+	Gray Jay
+	Common Raven
	Common Crow
	Black-capped Chickadee
x	Boreal Chickadee
+	Red-breasted Nuthatch
	Brown Creeper
	House Wren
x	Winter Wren
o	Short-billed Marsh Wren
	Gray Catbird
	Brown Thrasher
	Wood Thrush
x	Hermit Thrush
x	Swainson's Thrush
	American Robin
	Veery
	Eastern Bluebird

Table 19 (Continued)

Habitat Key	Endangered Species
+ = Coniferous Forests	E = Endangered Species
x = Spruce Bogs	T = Threatened
o = Fens	C = Changing/Uncertain Status in Minnesota
No symbol = Wooded uplands and Grasslands	S = Special Interest in
	-p= Protected
	-u= Unprotected

o	Short-eared Owl	x	Golden Crowned Kinglet
	Long-eared Owl	+	Ruby-crowned Kinglet
x	Saw-whet Owl		Cedar Waxwing
	Whip-poor-will		Starling
	Common Nighthawk	x	Solitary Vireo
	Chimney Swift		Red-eyed Vireo
+	Philadelphis Vireo		Black & White Warbler
x	Gold-winged Warbler	x	Tennesee Warbler
x	Oragne-crowned Warbler	x	Nashville Warbler
x	Northern Parula		Yellow Warbler
x	Magnolia Warbler	x	Cape May Warbler
x	Black-throated Blue Warbler	x	Yellow-rumped Warbler
x	Black-throated Green Warbler	x	Blackburnian Warbler
	Chestnut-sided Warbler	x	Bay-breasted Warbler
x	Pine Warbler	x	Palm Warbler
	Ovenbird	+	Northern Waterthrush
+	Connecticut Warbler	+	Mourning Warbler
+	Common Yellowthroat	+	Wilson's Warbler
+	Canada Warbler		American Redstart
	House Sparrow		Eastern Meadowlark
	Bobolink		Red-winged Blackbird
	Northern Oriole	+	Rusty Blackbird
	Common Grackle		Brown-headed Cowbird
	Scarlet Tanager		Rose-breasted Grosbeak
	Indigo Bunting	+	Evening Grosbeak
+	Purple Finch	+	Pine Siskin
	American Goldfinch	+	Red Crossbill
+	White-winged Crossbill		Rufous-sided Towhee
	Savannah Sparro	o	LeConte's Sparrow
o	Sharp-tailed Sparrow	+	Dark-eyed Junco
	Chipping Sparrow		Clay-colored Sparrow
x	White-throated Sparrow	x	Lincoln's Sparrow
	Swamp Sparrow		Song Sparrow

It has been reported that an endangered species, the Artic Peregrine Falcon, frequents the bog areas to the west of Lower Red Lake during its migrations (Army, 1977). Jorgensen (1977a) has stated that the Peregrine Falcon is found throughout the area during migration and the peatlands north of Upper Red Lake are no exception.

The Eastern Timberwolf, another endangered species, lives in and around these northern bog areas. Minnesota does not consider the timberwolf endangered but does feel special consideration and management are necessary. Minnesota describes the timberwolf as a "species of changing or uncertain status" (Minnesota, 1975). The U.S. Fish and Wildlife Service has proposed to reclassify the Eastern Timberwolf and designated portions of northern Minnesota a "critical habitat" for the wolf. The entire area north of Upper Red Lake would be affected by this Habitat area. This includes the area known as the Red Lake Bog and the entire area of the Minnegasco lease request.

Besides the endangered species mentioned above, the bog lemming, spruce grouse and red squirrel occupy the peatland areas as their prime habitat (MRI, 1975). The snowshoe hare and lynx live in the bogs as their major habitat and sparrows, warblers, thrushes, flycatchers and woodpeckers are common in spruce and tamarack bogs. A complete census of wildlife in the peatland areas is necessary in this unique environment.

The management of wildlife in the Red Lake Indian Reservation poses unusual problems due to the open season hunting practiced by the Tribe. Tribal members are not governed by Minnesota game laws.

AIR IMPACTS: WILDLIFE

THE NOISE GENERATED BY PEAT HARVESTING MACHINERY COULD DRIVE WILDLIFE OUT OF THE IMMEDIATE AREA OF PEAT USE.

THE POSSIBILITY OF PEAT USE RELEASING TOXIC POLLUTANTS, SUCH AS HEAVY METALS, MAY ADVERSLY IMPACT AREA WILDLIFE.

CHANGES IN THE MOISTURE CONTENT OF THE AIR AS A RESULT OF PEAT USE MAY IMPACT WILDLIFE AND WILDLIFE HABITAT.

THE WILDLIFE OF THE RED LAKE AREA MAY CHANGE THEIR MIGRATORY PATTERNS AND FEEDING HABITS IF THE AMBIENT AIR QUALITY IS CHANGED BY PEAT USE.

Peat utilization processes include vegetation removal which could effect evapotranspiration and moisture content of the air which may alter the activities of the wildlife, land fowl and water fowl of the area.

Aspects of peat utilization that affect air quality include the use of vehicles and equipment for harvesting, transporting and the processing of peat products. The introduction of this motorized equipment into this previously undisturbed wildlife habitat could greatly increase the amount of noise and suspended particulates in the air.

Attention should be devoted to the types of heavy metals and other toxic substances which may be transported in the air. The effect of even small amounts of these pollutants on peatland animals should be scrutinized. The effects of noise on wildlife population is a point of concern and must be carefully inspected before allowing peat development.

LAND IMPACTS: WILDLIFE

THE DEVELOPMENT OF LAND FOR COMMERCIAL, INDUSTRIAL OR RESIDENTIAL PURPOSES WILL CHANGE WILDLIFE HABITAT.

THE DEVELOPMENT OF LAND FOR AGRICULTURAL PURPOSES WILL ALTER THE QUANTITY OF NATURALLY EXISTING WILDLIFE FOOD SOURCES.

Both extraction and on-site uses of peat require removal of the vegetative cover. Much of the existing peatland wildlife is dependent upon existing vegetation as a source of food. For example, the moose population consumes amur maples which grow on the peatlands. Removal of existing vegetation would force the dependent wildlife population to find another peatland habitat.

The extraction of high energy, lower level peat depostis will very likely result in the formation of a series of ponds. Undoubtedly, more water dependent wildlife would frequent ponds which resulted from peat extraction.

The change of land use from wildlife rich habitat to ditches, roads, ponds or commercial and residential developments will impact many forms of area wildlife.

WATER IMPACTS: WILDLIFE

CHANGES IN THE AMOUNT OF SURFACE WATER AVAILABLE FOR WILDLIFE HABITAT AND ALTERATION OF WATER QUALITY WILL CHANGE THE WILDLIFE MIX IN THE AREA.

THE CONSTRUCTION OF DRAINAGE FACILITIES FOR PEAT USE MAY ALTER THE MIGRATION AND FEEDING PATTERNS OF AREA WILDLIFE.

The extraction of peat would result in the formation of ponds in the area. These shallow ponds could conceivably support more waterfowl and more water dependent mammals than the present bogs. The increase in waterfowl would be at the expense of more land dependant wildlife. During extraction, draining of the area would be necessary. The area wildlife would most likely leave the area during this dry period as the did in 1955 when the Army Corps of Engineers accidentally drained the Zah Gheeng marsh area (Army, 1975).

The construction of drainage ditches for removal of water from a peat use site may disrupt present wildlife migration trails and feeding areas. The drainage of peat lands may alter the quality of existing water, making it unfit for use by wildlife.

Utilization of peat, especially extractive uses, would undoubtedly change the existing wildlife in the area. This could affect hunting in the area.

RESERVATION ACTIVITY: HUNTING

HUNTING IS A PART OF THE CULTURAL HERITAGE OF THE CHIPPEWA INDIANS OF THE RED LAKE AREA.

GAME TAKEN FROM THE LAND IS A MAJOR YEAR-ROUND FOOD SOURCE FOR RESERVATION RESIDENTS. OVER HALF OF THE FOOD CONSUMED BY THE RED LAKERS IS SUPPLIED HUNTING AND FISHING.

A CHANGE IN THE WILDLIFE POPULATIONS OF THE AREA WILL EFFECT THE LIFESTYLE OF THE AREA RESIDENTS.

For hundreds of years the Indians of the Red Lake have hunted, fished and foraged for all their food needs. Today fish, venison, moose, partridge, rough grouse and ducks still comprise a large portion of the diet of Red Lake Reservation residents. It has been estimated that over 50% of the Indians' food supplies are derived directly from wildlife and fish. (Jorgenson 1977a). Clearly, hunting is much more than sport to the Red Lake Indians.

The advent of the high powered rifle and the all-terrain vehicle have enabled hunters to be more effective and cover more ground that was previously possible. This effectiveness, in combination with open season hunting, and a lack of monitoring animals taken, creates difficulties in management of area wildlife.

In 1971 there was a resident muskrat population of 20,000, of which 4,000 were trapped during that season. The Indian trapping of muskrats fluctuates considerably but represents a potential source of income to some Indian families. In 1971, 5,000 ducks and 3,000 partridge were hunted.

The reliance of the Reservation residents on specific wildlife species could be severely impacted by peat utilization. The utilization of peats could drive some types of wildlife from the area. If these species were either moose or venison, which are staples of the Reservation residents' diet, social and economic impacts could be severe. The cost of acquiring alternative foods would further limit the purchasing power of the Reservation residents.

IMPACTED RESOURCE: WILD RICE

Each impact medium, Water, Land and Air, may influence the development of wild rice cultivation in the Red Lake area. Wild rice is a naturally existing food source native to the area. A large market for wild rice exists and has fostered commercial development. Wild rice is a potential use of the peat resources of the Red Lake area. Extractive peat utilization may impact existing and planned wild rice areas.

GENERAL DESCRIPTION: WILD RICE

THE FLAT TOPOGRAPHY, ABUNDANCE OF MOISTURE AND COOL TEMPERATURES OF THE RED LAKE AREA SUPPORT LARGE NATURAL STANDS OF WILD RICE.

WILD RICE OCCURS NATURALLY IN SEVERAL LOCATIONS ON THE RESERVATION. THE RED LAKERS HARVEST THE RESOURCE FOR PERSONAL CONSUMPTION AND SALE.

THE TRIBE HAS BEEN ACTIVELY SEEKING TO EXPAND THEIR COMMERCIAL WILD RICE OPERATIONS FOR SEVERAL YEARS. NEARLY 50,000 ACRES OF RESERVATION LAND IS SUITABLE FOR WILD RICE DEVELOPMENT.

Wild rice, an aquatic annual plant, grows naturally in marshes, shallow lakes, and on the borders of slow-moving streams. The grains, which average 1/2 inch long x 1/16 inch wide, are encased in a hull similar to oats.

The plants reseed themselves by grains, or seeds, which fall into the water and become attached to the bottom by a terminal awn "beard." There they lie throughout the winter, germinating in spring. The seed will only germinate after being wintered in water at termperatures of 33-35 degrees which is required to break dormancy.

Wild rice is harvested in many ways. Commercial wild rice harvesting involves draining of the flooded paddie and the combing of the rice with motorized equipment. The hull is removed by a process known as "parching." The grain is fed into a tumbling chamber which rests over a fire. Parching removes the hull and drives out the moisture.

The Red Lake Indians have harvested naturally growing wild rice in the area for many years. The Red Lakers used much of the wild rice they harvested for food. Traditional harvesting is done in a narrow flat bottomed boat which is poled through the rice stands. The stands are bent over the side of the boat and beat with a long stick to release the grains into the boat.

The Red Lake Indians now harvest naturally existing wild rice in various locations throughout the Reservation. The Butcher Knife Creek area, with its six small lakes, produces the greatest amount of rice. This area is adjacent to the Tribally owned commercial rice paddies. Manomin Creek, which runs into the western end of Upper Red Lake, also supports an abundance of natural rice stands. This area is harvested only when an especially good crop has grown, because it is accessable only by boat.

There is also a thin line of rice which grows along the shores of the Battle and Blackduck Rivers, which flow into the eastern end of Lower Red Lake. Because it is near shore, it is often heavily infested by the Wild Rice Stem Borer. This area does not usually yield enough rice to make harvesting practical. The Reservation Comprehensive Development Plan specifies three planned wild rice development areas (see Figure 14).

The Reservation also contains numerous other areas which produce natural stands of wild rice but which are small in acerage. This, however, does not represent the total acreage with potential for wild rice development. The area between the Clearwater and Red Lake Rivers offers close to 50,000 acres of land conducive to wild rice growth. Wild rice developments planned by the Tribe include a 300 acre plot adjacent to Highway 72, approximately 5 miles north of Waskish.

A recent Department of Natural Resources study shows a total of 54,000 acres of land with potential for wild rice production. Department of Natural Resources permits for development of more than 11,000 acres of wild rice paddies in the area surrounding the Reservation have been issued already, permits are pending on another 7,000 acres. The water used to flood rice producing paddies in this area would be drawn from the nearby river.

The area immediately north and south of Upper Red Lake has also supported private wild rice ventures. By 1977, 3,000-4,000 acres in this area were under cultivation. Rice paddies scattered from 3 miles north of Upper Red Lake to 10 miles east of Highway 72. In this area, the source of water to flood paddies is the water drained from the peatlands.

AIR AND LAND IMPACTS: WILDRICE

LAND FROM WHICH PEAT HAS BEEN EXTRACTED MAY BE RECLAIMED AS LARGE SCALE WILD RICE PRODUCING AREAS.

PARTICULATE MATTER, POLLUTION AND HEAVY METALS IN THE AIR MAY EFFECT WILD RICE GROWTH.

Peat utilization necessitates changing the land. Typical land changes include drainage of surface and groundwater, removal of surficial layers of fibric materials and cultivation or extraction of the remaining peat layers.

Changes in the land for peat development may affect existing wild rice production areas if the development is close to the flooded fields. If the drainage of the area peatlands results in lowering of the water table to expose surfaces once covered by water, the wild rice re-seeding cycle will terminate.

The extraction of peats could result in the actual destruction of areas that presently support growths of wild rice. Peat extraction may, however, benefit the future production of wild rice if a planned reclamation occurs. The removal of peat offers an opportunity to develop a reclaimed area into a large scale, high production wild rice site.

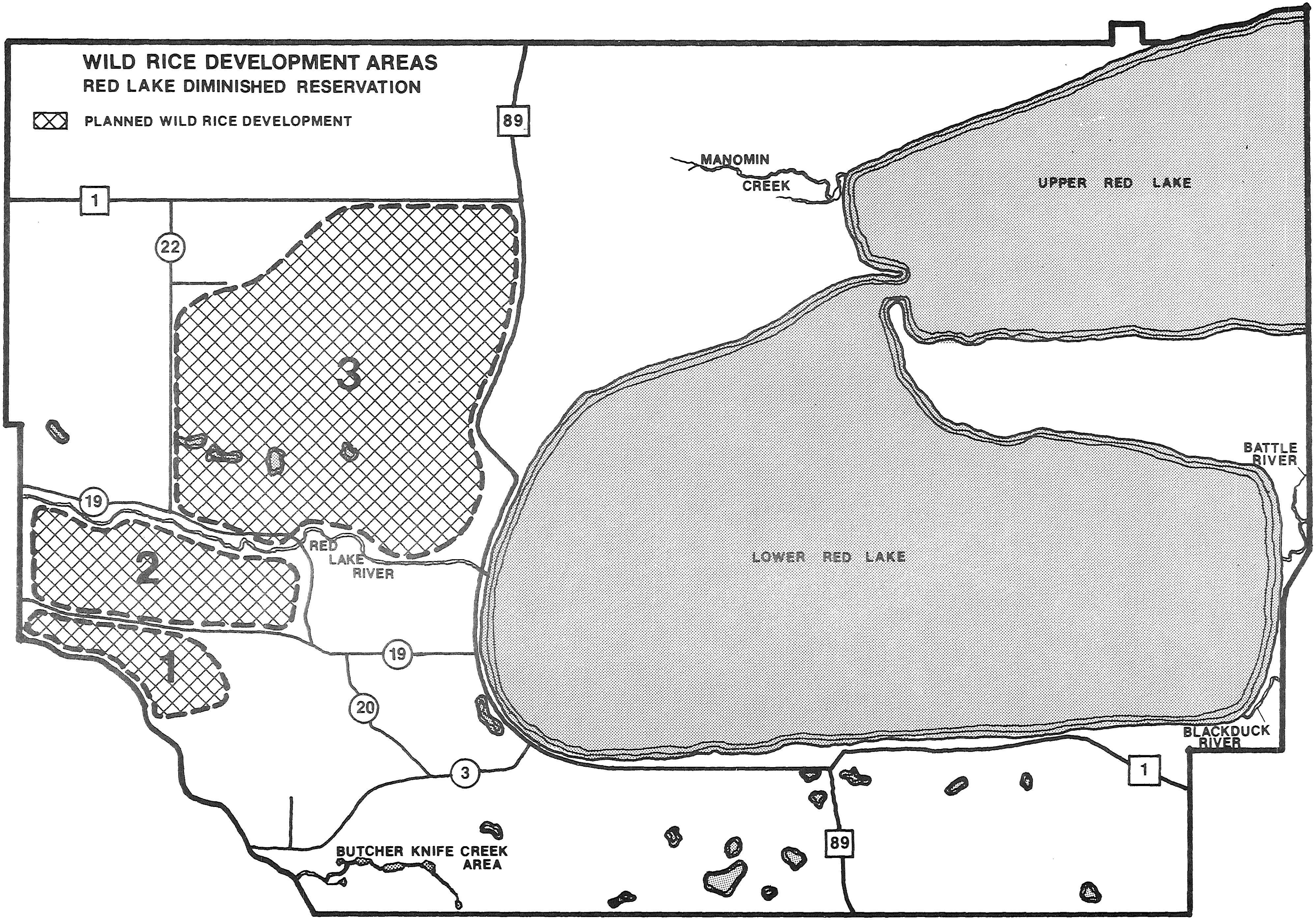

WILD RICE DEVELOPMENT AREAS
RED LAKE DIMINISHED RESERVATION
PLANNED WILD RICE DEVELOPMENT
89
1
22
3
2
1
19
RED LAKE RIVER
20
MANOMIN CREEK
UPPER RED LAKE
LOWER RED LAKE
BATTLE RIVER
BLACKDUCK RIVER
BUTCHER KNIFE CREEK AREA

FIGURE 14

When access roads and drainage ditches are constructed, paddy water control measures, such as dams, outlets and erosion control are essential. A thin organic cover of peat must remain or be deposited over the mineral soil. This leaves an easily workable, fertile organic soil which facilitates wild rice production.

Peat utilization could also result in the release of particulate matter into the air by several different processes. Dust may enter the air from the movement of equipment across drained bogs or from the movement of vehicles on roads leading to the peat development areas.

Pollutants and heavy metals, such as lead, may be released into the air by the harvesting and refining of peat. These substances could retard wild rice growth and be passed through the food chain if absorbed by the plants.

Peat removal could reveal a very irregular mineral soil topography. If the slope of the resulting topography exceeds 10%, the site cannot be used for wild rice. A grade of one or two percent is ideal for wild rice growth.

WATER IMPACTS: WILD RICE

WILD RICE GROWTH REQUIRES THE PRESENCE OF A LARGE QUANTITY OF WATER.

WILD RICE PRODUCING AREAS MAY BE DAMAGED IF THE WATER TABLE IS LOWERED FOR PEAT UTILIZATION.

THE RATE OF FLOW AND TEMPERATURE OF WATER EFFECT WILD RICE PRODUCTION.

CHANGES IN WATER ACIDITY MAY HAVE LIMITED IMPACT ON THE GROWTH OF WILD RICE.

Wild rice grows well in many parts of the area which are covered by water of a proper depth. If this water level is altered by utilization of peat, some wild rice producing areas may be destroyed. The lowering of the areas' water table may, however, encourage wild rice development in some areas.

Ideally, wild rice production areas should have a water table with a seasonal high 4-5 feet below the surface of the paddy. Wild rice paddies should, ideally, be located adjacent to a source of large quantities of water such as a river or a lake. The lake or river is used as a water source when the paddies are flooded after planting, and is used as a discharge area when water is removed from the paddies.

Wild rice cannot grow in areas of rapidly moving water. If the release of water from peat utilization causes an increase in the rate of flow of streams which now support wild rice stands, some of the stands may be destroyed.

The ideal level of acidity of water in a rice paddy should be within a range of 6.8 to 8.8 pH. The present runoff from bogs is near the ideal pH level for use in wild rice paddies. Mineral rich, high pH water will be released into the surface water system as a result of drainage of lower layers of peat. The release of low pH (acidic) water from raised bogs may adversely effect the growth of wild rice in the area of water discharge.

Peat utilization may increase the turbidity and quantity of suspended solids in the water. The effect of the addition of suspended or dissolved solids on wild rice production should be carefully evaluated.

RESERVATION ENTERPRISE: AGRICULTURE

ORDINARY DRY LAND FARMING PRACTICES ARE RARELY SUCCESSFUL ON THE RED LAKE PEATLANDS.

WILD RICE IS THE AGRICULTURAL PRODUCT WITH THE GREATEST POTENTIAL FOR DEVELOPMENT IN THE AREA.

In the early 1900's the Federal programs encouraged the migration of people to the Red Lake area. Attempts were made to develop settlements and to farm the land in the bogs.

Extensive drainage systems were laid out in the Lake of the Woods Watershed and in the Red Lake Watershed in an attempt to prepare bog lands for cultivation. The ditches were usually located on section lines in a pattern ignoring existing topographic conditions. Conventional farming techniques had little or no positive effect on the land and were unprofitable. Over 300 families were relocated by 1936 with the aid of the Agricultural Adjustment Administration. Those ditches constructed prior to termination of the program in the late 1920's are now overgrown and blanketed with organic matter and silts.(Farnham, 1965) Today, few farms exist in the bogs of the Red Lake area.

The Red Lake Tribe considers wild rice a most important agricultural product with potential for further development. Long before the arrival of the white man in the Red Lake area, the Indians were harvesting wild rice for food and as a medium for trade.

The Tribe feels commercial wild rice production would generate new revenue and additional employment on the Reservation, and most importantly, retain an important part of their heritage. Obstacles to commercial development of wild rice stem from the make-up of the plant itself. Natural wild rice grains grow within a head which ripens at the top first and progressively downward. As the grains ripen, they fall from the head into the water. This "shattering," which is characteristic of many wild grasses, makes harvesting by machine difficult.

Investigation into development of a non-shattering strain, exhibiting qualities much like wheat, oats, and other cultivated grains, began in the late 1960's in Minnesota. By 1969, selection of seeds from naturally occuring non-shattering heads had begun and development and purification for seed stock followed.

The problems of commercial development which have plagued the industry at large, have not been escaped by the Indians. In the last few years, though the amount of harvesting equipment in the area has increased. A problem for the Indians has been the inability to obtain rented harvesting equipment early enough in the season. Often much of the grain has shattered off the plant by the time the equipment arrives at the Reservation. The needed equipment includes wild rice combines, two 4-wheel drive tractors, a dragline and a dozer.

To acquire harvesting and processing equipment the Tribe, in 1969, obtained limited assistance from the Economic Development Administration (EDA), United States Department of Commerce, for wild rice development. The funds were inadequate to equip the operation. In December of 1971, a request for additional funds of $350,000 was submitted to the Upper Great Lakes Regional Commission (UGLRC). The request was not funded due to lack of funds at UGLRC. In 1973 the Tribe again requested a grant of $291,383 from EDA. This request was also denied. The Tribe is continuing to search for funds to expand and improve the program.

The Tribe's long range plans are to develop 50,000 acres in the area from 1-1/2 miles north of the Red Lake River, south to the Clearwater River. The first phase is the development of 700 acres along the Clearwater River, adjacent to the Ki-Wo-Say wildlife area. In 1972, 90 acres were seeded, which yielded 4,100 pounds of finished rice, about 45 pounds per acre. Two-thirds of the total harvest was lost because of equipment timing problems. 1977 saw the operation expanded to 140 acres, yielding an average 400-500 pounds per acre with some plots as high as 1,000 pounds per acre.

The areas with potential for wild rice cultivation in the peatlands north of Upper Red Lake have been ignored during the rapid expansion along the Clearwater River and other areas south of the Reservation. The northern areas' potential stems from the organic soil, abundance of water, and flat terrain inherent to the site.

ECONOMICS

THE ECONOMIC STATISTICS FOR INDIANS NATIONWIDE ARE DISMAL. ONLY BLACKS LIVING IN RURAL AREAS SUFFER WORSE ECONOMIC CONDITIONS THAN THE INDIANS. NATIONWIDE, INDIAN UNEMPLOYMENT AVERAGES 37% WITH ABOUT HALF OF ALL RURAL NON-FARM INDIANS EARNING LESS THAN $5,000.00. INDIAN PER CAPITA INCOME WAS BELOW $1,600.00 PER YEAR IN 1969, WHICH WAS THE LOWEST OF ANY ETHNIC GROUP.

UNEMPLOYMENT ON THE RED LAKE RESERVATION AVERAGES 45%. PER CAPITA INCOME WAS ONLY $794.00 IN 1976. OVER 40% OF THE RED LAKE WORKERS EARN LESS THAN $5,000.00.

VIRTUALLY ALL OF THE NON-GOVERNMENT EMPLOYMENT ON THE RESERVATION IS GENERATED BY THE NATURAL RESOURCES BASED TRIBAL ENTERPRISES. THESE ENTERPRISES CAN BE DIRECTLY IMPACTED BY PEAT UTILIZATION.

SMALL AND MEDIUM SIZED TRIBALLY SPONSORED PEAT DEVELOPMENT PROJECTS HAVE A GOOD POTENTIAL FOR BALANCING THE COSTS AND BENEFITS OF PEAT UTILIZATION.

THE MINNEGASCO PROPOSAL WILL USE 40 ACRES OF PEATLAND EACH YEAR FOR EACH DIRECT JOB PRODUCED LOCALLY. ONLY A MODEST NUMBER OF THESE JOBS ARE LIKELY TO BE AVAILABLE TO THE RED LAKE INDIANS. THE UNIQUE LEGAL AND ECONOMIC STATUS OF THE RESERVATION WILL PRECLUDE THE RED LAKERS FROM REALIZING ANY OF THE SUBSTANTIAL ECONOMIC SPIN-OFFS OF THE MINNEGASCO PROJECT.

This section will consider the Peat Utilization programs impact on the Reservation's economy. Peat utilization will affect the Reservation economy by two basic mechanisms: the impact on Reservation enterprises and economic development from peat use. To assess these impacts, the existing conditions on the Reservation should be described. To put the Red Lake Reservation economy in perspective, it would be appropriate to discuss the economic conditions of the Indians as a whole.

The Indian population is relatively younger than other populations. The median age of Indians on, or adjacent to, Reservations is only 17 years. The median age for the U.S. population as a whole is 29 years.

The Indian population is also growing at a rate twice the National Average. This is in spite of an infant mortality rate that is 22% above the National Average. The life span of Indians is also much shorter than either White or Black populations. The average life span for an Indian is six years shorter than for the average American. However, the Indians have an unusually high birth rate which is expected to continue this trend of rapid population growth. This trend will be reinforced if current health care programs are continued. The reduction of mortality rates will alter the characteristics of the population. The median age will rise over the years and the total growth rate of the population will increase even further.

Any long-run planning for Manpower Programs for Indians must consider these population trends. For example, to maintain a constant level of employment, twice as many jobs must be created for Indians as for the general population. Also, the lower age would indicate the need for Manpower Programs to emphasize youth training programs. These factors contribute to the difficulty of maintaining acceptable employment levels on the Reservation.

The median family income among Indians living on the Reservaton was only $4,088. Therefore, over half of all rural Indians earned less than $5,000 in 1969. This compares with only one-fifth of White families that earned below $5,000. The Indians tend to have larger families which makes the impact of these low income levels more severe. The Indian per capital income is below $1,600 per year which is the lowest of any ethnic group. The following table summarizes these comparisons.

Table 20

MEDIAN PER CAPITA FAMILY IMCOME OF MINORITIES BY RESIDENCE
1969

	Total		Urban		Rural Nonfarm		Rural Farm	
	Family	Per Capita	Family	Per Capita	Family	Per Capita	Family	Per Capita
Indian	$5,832	$1,573	$ 7,323	$2,108	$4,691	$1,147	$4,319	$1,104
Black	6,067	1,818	6,581	1,989	4,035	1,094	3,445	964
Chicano	6,962	1,716	7,256	1,797	5,329	1,236	5,020	1,267
White	9,961	3,314	10,629	3,567	8,542	2,673	7,534	2,560

Only Blacks living in rural areas suffer worse economic conditions than the Indians.

The severity of Indian unemployment is shown by a variety of statistics. One of the most striking figures is that only 47% of rural Indian men aged 16 or over are employed. This compares with 73% for rural Whites. On the average, only 18 out of 100 Indians support themselves and their dependents. Throughout the United States the figure is 38 out of 100. This is because far fewer adults have jobs and much more of the Indian population is under 16 years old.

Unemployment is so high on the Reservation that the usual unemployment measures are difficult to apply to the Reservation. The Bureau of Census collects National statistics in the following manner. A survey is taken of a selected group of respondents. They are first asked if they have been actively seeking employment. If they have not, they are considered out of the labor force. Unemployment is determined by the number of persons in the labor force not working. Therefore, there is a substantial number of people who are capable of working, and are not employed, yet are not counted as unemployed.

This introduces the concept of the Discouraged Worker Effect. This is based on the theory that after a long period of job search, the worker becomes discouraged and gives up trying to find a job. Consequently, the worker would not be considered unemployed, only out of the labor force. In periods of high unemployment this Discouraged Worker Effect becomes significant. Therefore, the unemployment figures often understate the severity of a depressed economy.

In a situation like an Indian Reservation, where there are prolonged and extremely high levels of unemployment, the Discouraged Worker Effect so distorts unemployment figures collected in the usual manner, that they are nearly meaningless. To secure more realistic estimates, the Bureau of Indian Affairs began to compile its own statistics in 1963.

The BIA estimates are based on all those who are able to work, but are not working. This excludes those who are in school, have health problems, or have child-care responsibilities. Using this definition of unemployment, 37% of Indians are unemployed on the average. Using the Bureau of Census method, which excludes all discouraged job hunters, the male Indian unemployment rate is estimated to average 19%, nearly three times the National Average.

Average unemployment rates do not give an indication of the high levels of underemployment and seasonal employment on the Reservation. It is estimated that on the average, peak unemployment is 70% higher in the winter months than during the summer months (Sorkin). Another study found the proportion of Indians aged 16 and over who worked for more than 10 months during the year, ranged from 12% to 36%, depending on the Reservation surveyed.(Taylor and O'Connor)

Those Indians who are employed typically have jobs lower in the management echelon. Only about 9% of all Indian males were professional, technical, and kindred workers, compared with a National Average of 15%. Similarly, few Indians were in entrepreneurial and management positions. Less than 5% of male Indians were non-farm managers, officials, or proprietors. The National Average is about 12%.

Clearly, there are severe employment problems on Indian Reservations. The obvious solution is to create more job opportunities and develop programs to help the Indian take advantage of these opportunities. Certainly, existing jobs must be maintained.

It has been suggested that because of the high level of public service programs and income from non-work sources, that wages and salaries are a less important source of income for the Indians. However, in the United States as a whole, nearly 70% of personal income is derived from wages and salaries. The Indian proportion of income from wages is about the same as the United States average. Therefore, a source of wage and salary income is as important to the Indian as anyone else.

This view of the Indian problem as a whole is valuable in gaining a perspective of the problems on the Red Lake Reservation. The remaining part of this section will examine the labor market and economy on the Red Lake Reservation and consider the impacts of peat use.

The economy and labor market on the Red Lake Reservation reflect the same trends that exist for Indians nationally.

The principle components of the economy of the Reservation are the Public Service Sector and Tribal Enterprises. These Enterprises include the Red Lake Indian Sawmills, Red Lake Fisheries Cooperative, the Chippewa Fence Company, Wild Rice Farming, and the Red Lake Housing Industry. These industries make use of the natural resources of the Reservation. The public service sector consists of the Bureau of Indian Affairs, Indian Health Service, Tribal Municipal Services and various government programs such as the Comprehensive Employment Training Act, Community Action Program and chemical dependency centers.

The Red Lake labor market is much younger than the non-Indian National Average, although it's older than the Indian average. The following table lists the distribution of the working age population.

Table 21

RESIDENT INDIAN POPULATION OF WORKING AGE
(16 Years and Over)

Age In Years	1972	1973	1974	1975	1976	1977
Total 16 & over	1394	1667	n.a.	2279	2353	2364
16 - 24	527	559	n.a.	863	874	870
25 - 34	245	305	n.a.	441	470	476
35 - 44	228	275	n.a	369	390	401
45 - 64	280	326	n.a.	940	454	458
65 & over	114	152	n.a	166	165	159
Total Population	2761	3163	n.a.	4200	4229	4234

Source: Red Lake Agency, Bureau of Indian Affairs

The population on the Red Lake Reservation has been growing much faster than the average population of Indians. This is because the last several years has shown a substantial in-migration of Indians returning from the urban areas, particularily Minneapolis.

Table 22

PROJECTED POPULATION FIGURES
INCLUDING POTENTIAL MIGRATION

Age Group	1980	1990
Under 15	1534	1542
15-19	538	445
20-24	296	269
25-29	343	387
30-34	188	249
35-39	174	303
40-44	127	160
45-49	161	168
50-54	114	161
55-59	113	148
60-64	77	100
Over 65	177	218
Total Population	5082	5478
Indigenous	3862	4148
Migration	1220	1330
Projected Labor Force	1780	1920
Projected Unemployment	710	770

Source: Modified from Red Lake Comprehensive Plan

It will be assumed the labor force participation rate and unemployed rates are about the same in 1990 as they were for 1972 to 1976. The labor force averaged nearly 35% of the total population and unemployment averaged 40% of the labor force.

Therefore, the labor force can be projected to approximately 1,780 in the year 1980 and 1,920 in the year 1990. From this, the amount of unemployment can be projected to approximately 710 in 1980 and 720 in 1990. It is clear that a substantial number of jobs must be created to eliminate the high unemployment on the Reservation.

Tables 23 and 24 describe the types of jobs in which Reservation residents are currently employed.

Table 23

OCCUPATION DISTRIBUTION BY TYPE AND SEX

	Male	Female
Manufacturing	55	3
Non-Manufacturing	520	313
Total	575	316

Table 24

OCCUPATION DISTRIBUTION BY FIRM AND % INDIAN

Firm	Product/ Service	Number Employees	Percent Indians
Red Lake Indian Mills	Lumber Products	58 (a)	95
Red Lake Fisheries	Fish Products	100 (b)	99
Chippewa Fence Co.	Cedar Products	10 (c)	90
Governmental	Governmental Services	525	75

Source: State Department of Economic Development
(a) Includes average of 10 loggers (number of loggers varies)
(b) Includes average of 70 fishermen (number of fishermen varies)
(c) Adjusted to reflect present conditions

It has been suggested that the Red Lake Reservation has been getting "more than its share" of Indian Economic Development Aid and has benefited accordingly. Although the Tribal Leaders and various Agencies have been actively working at Red Lake, the statistics indicate the Red Lake income level is below even the National level for rural nonfarm Indians. The per capita income on the Reservation was $794.00 for 1976, which is approximately 30% below the National Average for similar Indians. Also, as the following table indicates, on the average, nearly 40% of the Red Lake workers earn less than $5,000.

Table 25

ANNUAL EARNINGS

Year	Sex	Greater than $5,000		Less than $5,000	
		Number	Percent	Number	Percent
1975	Male	288	41	130	18
	Female	152	22	134	19
Total		440	63	264	37
1976	Male	294	33	281	32
	Female	152	17	158	18
Total		446	50	439	50
1977	Male	330	42	123	16
	Female	213	27	121	15
Total		543	69	244	31

Source: Red Lake Agency, Bureau of Indian Affairs

The employment statistics indicate Red Lake is roughly equal to the National Averages with an average unemployment level of 40% for the last five years. The following tables summarize the employment statistics for Red Lake.

Table 26

RESERVATION EMPLOYMENT

Year	Sex	Available Labor Force	Indian Residents Employed	Indian Residents Not Employed	Actively Seeking Work
1972	Male	533	299	234	135
	Female	395	200	195	90
Total		928	499	429	225
1973	Male	655	348	307	200
	Female	359	222	137	75
Total		1014	570	444	275
1974	Male	n.a.	n.a.	n.a.	n.a.
	Female	n.a.	n.a.	n.a.	n.a.
Total		1044	600	444	275
1975	Male	963	418	545	240
	Female	496	286	210	90
Total		1459	704	755	330
1976	Male	947	575	372	200
	Female	543	316	227	80
Total		1463	787	676	325
1977	Male	944	953	491	75
	Female	519	334	185	270
Total		1490	891	599	280

Source: Red Lake Agency, Bureau of Indian Affairs

Clearly, the Red Lake Reservation suffers economic conditions that are more severe than the National Average for similar Indians. This would indicate that the concern for economic conditions at Red Lake is justified.

The depressed economic conditions on the Reservation suggest great care should be taken to maintain existing employment and income. Virtually all of the non-governmental employment on the Reservation is directly dependant on the fish and forest resources. The wildlife and wild rice resources provide the equivalent of income by providing over 50% of the Indian diet. It is clear that peat utilization could directly impact the Reservation economy by affects on the resource-based Tribal enterprises. Whether this is a positive or adverse impact depends on particular peat development program.

The economic development that results from peat utilization can range from a small horticultural operation to a major gasification facility. The horticultural operation may be a few individuals collecting fibric peats for sale to nurserys. A large scale extractive operation for gasification would generate hundreds of jobs and have widespread economic consequences. The precise economic development results of a peat utilization program can only be determined when a specific development proposal exists. However, several general conclusions can be reached under a general concept of peat utilization.

Both on-site and extractive uses of peat are mostly seasonal operations. As discussed, widely fluctuating levels of employment on the Reservation due to reliance on seasonal industries is a major problem facing the Indians. Economic development based on another seasonable industry is less desirable than stable year-round employment. The situation occurs on Reservations where, during the summer, there is actually a shortage of skilled manpower on the Reservation for certain jobs. This creates a hardship on the industries relying on this labor. Conversely, in the winter the Reservation is faced with massive unemployment. However, seasonable employment is preferable to unemployment.

The proposed Minnegasco gasification plant would generate approximately 335 jobs in the plant and up to 100 jobs in the harvesting operations (MRI 1977). Of these 435 people, an estimated 40 percent will come from outside the project area economy. Consequently, 261 long-term direct jobs will be created on the project area as a direct result of the gassification plant. This would mean that approximately 40 acres of peatland would be harvested each year for each job created (based on Minnegasco's estimate of 18 million tons of peat required per year for the gassification plant).

The employment multipliers that result from spin-off (indirect) employment will not benefit the Reservation. The Reservation does not have a substantial retailing economy. New area residents will not reside on the Reservation. The only economic benefit likely to be realized by the Reservation is the direct employment of its residents in the plant. It is difficult to estimate the number of Indian jobs that will be created. A significant percentage of these jobs will require skill levels that exceed the skill level of the Red Lake labor force. The Red Lake Indians would be in competition with the surrounding non-Indian labor. The individuals of the non-Indian labor market typically have more work experience. This will make it more difficult for the Indians to compete for these jobs.

Although the subject needs further study, it is unlikely the Reservation will realize a substantial number of jobs. The jobs they do obtain will probably be in the lower skilled, lower paid positions, probably in the harvesting operations. This is based on consideration of the composition of the Red Lake labor force and the nature of harvesting and gasification technology.

However, a gasification plant is not the only economic development possibility for peat. Use of peat lands to expand the existing Reservation enterprises based on wild rice and forestry will generate additional jobs and income. Tribal expansion into producing horticultural products similar to existing operations in Minnesota also have economic development potential.

The Tribe could develop a harvesting and refining operation to produce products such as tars, waxes and similar products. These small to medium sized operations would probably generate as many jobs for the Reservation as a large scale gasification plant.

It is not apparent at this point that the Red Lake Indian Reservation will realize substantial economic gains from peat development. The susceptibility of their existing economic activities to the potential adverse impacts of peat use does not encourage this type of economic development as a whole.

The inherent seasonality of most peat project employment detracts from the desirability of this industry. A carefully designed, intensely monitored peat utilization project could provide economic benefit for the Tribe, particularly Tribally sponsored development. However, it may be impossible to demonstrate that a major peat project will generate benefits to the Tribe that outweigh the environmental and economic risk to the Reservation.

SOCIAL

PEAT UTILIZATION WILL IMPACT IMPORTANT COMPONENTS OF THE RED LAKE RESERVATION SOCIETY AND CULTURE.

THE INDIANS HAVE A DEEP ROOTED APPRECIATION FOR THE LAND AND NATURAL RESOURCES OF THE RESERVATION THEY OWN.

THE TRIBAL COUNCIL CONTROLS THE ECONOMIC DEVELOPMENT ACTIVITIES TO PROTECT THE PEOPLE, LAND AND NATURAL RESOURCES OF THE RESERVATION.

This section describes the social and political aspects of the Reservation that directly relate to peat development. The Indian society and culture are complex and encompass varied aspects of the Reservation life. Any comprehensive description of the sociology of the Red Lake community is well beyond the scope of this report. However, peat utilization will directly impact important components of the Reservation society and culture. The impacted social and cultural components are the peoples' identification with and reverence for the land, their strong sense of community, and their prevailing desire for self-governance.

The Chippewa Indian Tribe moved into Northern Minnesota and the Red Lake area in the late 1700's. Their diets and lives revolved around the availability of natural resources both for food and for trade with other people.

Indian title to land - the right of occupancy - was extinguished rapidly as the United States grew. White man's migration into Minnesota began in the early 1800's.(Dana, et.al)

Through the passage of the Nelson Act of January 14, 1889, the Federal government began to concentrate the Indians in the northern part of Minnesota. The Indians were often given land allotments on Reservations as compensation for moving to that area. The good quality timber and fertile rolling prairie encouraged large scale buying of Indian allotments by white men. This resulted in a Bureau of Indian Affairs investigation which revealed that 90 percent (90%) of the allotments, or 80 percent (80%) of the White Earth Indian Reservation, had been purchased by white men for 10 percent (10%) or less of the full value of the land. By 1920, most of the prosecutions initiated by the Bureau of Indian Affairs were settled out of court in favor of the Indians.

While most Indians experienced dispersion and grave hardship during this period, the Red Lake Indian Tribe maintained the organizational control necessary to protect its interests. The Red Lake Band preferred to keep its Reservation in Tribal ownership and has consistently prohibited individuals from accepting allotments. In this respect, the history of this Reservation is much different from that of other Reservations.

The original Red Lake Reservation, as established by the Treaty of October 2, 1863, encompassed approximately 1/18th of the State in a large rectangular area in the northwestern portion of the State. By 1889, the demand for timber and agricultural land became so great that agreements were reached on July 8th and 29th, 1889, to cede most of the original Reservation to the United States. Again, on February 20, 1904, after lengthy negotiations, the area west of the present Reservation was removed from Indian control. Upon this final cession, the Reservation became known as the "Diminished Red Lake Indian Reservation".

Outside of the main body of the Diminished Reservation, north of Upper Red Lake, extending to the Lake of the Woods, numerous small parcels of Indian land are intermingled with other lands. Most of these tracts were transferred from the public domain to Indian control through the Indian Reorganization Act (Wheeler- Howard Act) of June 18, 1934. Many of these lands are 40 acre or slightly larger parcels.

The main population of the Reservation community lives near a 35 mile stretch of highway that connects the three main communities of the Reservation. Red Lake is at the southern edge of Lower Red Lake, as is Redby. Ponemah, the other city in the Reservation, is on the north shore of Lower Red Lake. Red Lake, the largest community of the Reservation with a population of 1700, is the retail and governmental center for the Reservation. Redby, with a population of 1100 is the industrial community of the Reservation. The Red Lake Fisheries and the Red Lake Indian Mills, which includes the Red Lake Chippewa Cedar Fence Plant, are located in Redby. These industries are the principal employers on the Reservation. The 700 people of Ponemah live in a community that has maintained many of the old Indian cultural ways.

The utilization of peat may impact the population and the life of people of these communities in many ways. Ninety percent of the Reservation population lives in the three cities, the rest live in rural homes scattered throughout the Reservation.

The Red Lake Reservation has a unique legal status as a "Closed Reservation". An act of Congress transferred, to the State of Minnesota, civil and criminal jurisdiction over Indians in all parts of the State except the Red Lake Reservation. Civil and criminal regulation is now the responsibility of the Tribal Council, the governing body of the Reservation.

The Tribal Council is the legislative body of the Reservation and operates under a constitution and by-laws approved by the Secretary of the Interior. The Council consists of eleven members who are elected for a term of four years. There is also a seven member Advisory Council consisting of Hereditary Chiefs.

The Tribal Council has legislated fishing and hunting regulations for the benefit of area residents. They have also regulated the operation of vehicles on Reservation lands and regulate the use of Reservation forests and wildlife habitats. The Tribal Council evaluates and acts on proposals to utilize the natural resources of the area. Any utilization of the peat resource on the Reservation would require the approval of the Tribal Council.

Part of the Indian cultural heritage is their deep rooted appreciation for the value of the land and natural resources of the Reservation. In addition to its legislative duties, the Council has led a determined drive toward economic development on the Reservation. The Tribal Council, together with many Government Agencies, has made progress toward improving the quality of life on the Reservation. Economic development activities have involved the carefully controlled utilization of the natural resources to protect the cultural heritage of the Reservation residents. The principal Reservation enterprises utilize natural resources that would be impacted by peat utilization.

The elimination of the poverty that has plagued the Reservation is a problem that has confronted Tribal and government leaders for over 100 years. Early Governmental programs concentrated on various forms of cash and product transfers that usually provided for little Indian self-determination. When economic development programs were instituted, they either disregarded the Indian culture or capitalized on this background to the point of degrading the Indian heritage.

The needs, desires, and capabilities of the Reservation residents now determine the type of the project developed. However, low incomes, underemployment, and high unemployment still haunt the Reservation. On the Reservation as elsewhere, these economic conditions contribute to a number of social ills. Such problems as alcoholism, crime, and juvenile delinquency are directly related to chronic unemployment.

OPINIONS

THE MAJORITY OF KEY RESOURCE PEOPLE, OPINION LEADERS AND POLICY MAKERS OF THE RESERVATION HAVE PARTICIPATED IN THIS STUDY.

THE RED LAKE RESIDENTS ARE RELATIVELY WELL INFORMED ON THE PEAT ISSUE. THEIR ATTITUDES AND OPINIONS ARE BASED ON A GOOD UNDERSTANDING OF THE MANY ASPECTS OF PEAT USE.

THE WATER IMPACTS, SUCH AS THE EFFECT ON THE RED LAKES AND THE FISHING INDUSTRY, ARE, BY FAR, THE GREATEST CONCERN TO RESERVATION RESIDENTS. OTHER CONCERNS IN ORDER OF MAGNITUDE ARE; THE IMPACT ON FORESTRY, WILDLIFE, LAND, WILD RICE AND THE AIR.

THE RESERVATION RESIDENTS WERE EXTREMELY INTERESTED IN THE INFORMATION CONTAINED IN THIS REPORT. THEIR ATTITUDES AND OPINIONS TOWARD PEAT UTILIZATION IN THE RED LAKE AREA WERE CLEARLY EXPRESSED.

THE TRIBAL COUNCIL UNANIMOUSLY OPPOSES ANY FORM OF PEAT DEVELOPMENT IN THE AREA, INCLUDING PEAT DEVELOPMENT BY THE TRIBE. THIS IS BASED UPON THE BELIEF THAT THE POTENTIAL VALUE OF THE PEAT RESOURCE DOES NOT EXCEED THE RISK OF ADVERSELY AFFECTING THE RESERVATIONS PRINCIPLE RESOURCES OF FORESTRY, FISHING, WILD RICE AND WILDLIFE. THE TRIBE FEELS THEY ARE PRESENTLY UTILIZING THEIR PEAT RESOURCE IN THE BEST MANNER POSSIBLE: AS A HABITAT FOR WILDLIFE, LAND FOR FORESTRY AND A WATER SOURCE FOR THE RED LAKES.

THE MAJORITY OF RESOURCE PEOPLE AND INDIVIDUALS SERVING IN VARIOUS PROFESSIONAL CAPACITIES ON THE RESERVATION HAD A POSITION ONLY SLIGHTLY MORE MODERATE THAN THE TRIBAL COUNCIL. THEY WOULD FAVOR ONLY LIMITED DEVELOPMENT IF THE ADVERSE IMPACTS WERE MINIMIZED AND THE TRIBE REALIZED SUBSTANTIAL ECONOMIC BENEFIT.

ON-SITE DEVELOPMENT WAS PREFERED TO EXTRACTIVE USES OF PEAT.

In this study considerable effort was expended in the information transfer process. One of the most important aspects of the information transfer was to record the Reservation Residents' attitude toward peat development. The strategy developed to solicit this input was effective and resulted in a clear statement of Reservation opinion. The project team rejected the typical approach of a community-wide attitude survey.

The effectiveness of developing a questionnaire and inteviewing Reservation residents at large was severely doubted. This approach suffers from lack of response, unavailability of respondents and potential biasness of the questionnaire. Also, this method does not faciliate any transfer of information to the Residents. These problems are often more severe in communities such as Indian Reservations. The idea of an "outsider" comming in and "asking questions" often creates hostility toward the survey. The Project team selected an attitude inventory strategy more suited to this project and this community. The strategy used has been called the Opinion Leader Approach.

The Opinion Leader approach is based upon the premise that each community is made up of certain people who reflect, and in many cases lead, public opinion. This is particularly true for public reaction to a special project. Public meetings to receive citizen impact are a form of the Opinion Leader approach. An Opinion Leader is anyone who expresses an active interest in a particular issue. However, the results of public meetings can be greatly fortified by a recognition of the fact that opinion generators usually exist outside the public meetings. A loosely structured interview with the opinion leader can provide a wealth of information about the community and the issues. The content of several interviews are compared to identify concerns and reactions that occur frequently.

The value of the Opinion Leader approach lies in the realization that often it is not the opinion of the general public that causes conflict with proposed projects. Typically, a particular group of individuals that are specifically interested in the project react most strongly. The Opinion Leader approach directly addresses their questions and concerns. This approach is especially effective in situations of good citizen participation as was the case with this study.

There were four group meetings and several individual interviews held on the Reservation to exchange information relative to this study. The first three meetings presented report findings as they were developed. These meetings were largely attended by individuals serving in various professional capacities on the Reservation. Attendance included representatives of the Red Lake Agency, Bureau of Indian Affairs, Tribal Enterprises, Tribal Planning, and Local Specialists in Soils, Wildlife and Forestry. These resource people served as valuable sources of information about the Reservation. The questions and reactions of these people were carefully noted. This feedback established the focus of the report.

General meetings were held on the Reservation on October 18, 1977, December 1, 1977, and February 10, 1978. These meetings were held at the Tribal Council Offices and the Red Lake Agency Building. The following people attended one or more of these meetings:

Sheldon Anderson	BIA, Red Lake Forestry
Mike Branchaud	Red Lake Soil Survey
J.B. Eisenrich	Red Lake Fisheries
Joe Head	Bureau of Indian Affairs, Red Lake
Stewart W. Irwin	Sawmill Manager, Red Lake Indian Mills
Floyd W. Jorgenson	Director, University of Minnesota Agricultural Extension Service, Red Lake
Rod Jourdain	Red Lake Tribal Planning
Roger Jourdain	Chairman, Red Lake Tribal Council
George Kelly	Tribal Reality
Jim Lowmaster	BIA, Red Lake Forestry
C.P. Maus	Superintendent, Red Lake Agency, BIA
Ervin L. Moore	Indian Health Service, Red Lake
Paul Otte	Red Lake Agency
Richard E. Rolling	Red Lake Soil Survey
James Strong	Red Lake Tribal Planning
Pete Strong	Tribal CETA Program

The fourth meeting was before a Special Meeting of the Tribal Council of the Red Lake Band of Chippewa Indians. Other members of the Tribe also attended this meeting. The information generated in this Study was presented at this meeting. The reaction toward Peat Utilization was recorded for presentation in this report. Throughout this series of meetings a considerable amount of information was exchanged between the Project Team and the Reservation Residents. The majority of the key resource people, opinion leaders and policy makers of the Reservation have been involved in this project.

During the general Reservation meetings, concerns about the impact of peat use on the water, fish, land, forestry, and wildlife, dominated the discussion. Questions about the water impacts were asked much more frequently than questions about other topics. Concern for the impact on Red Lake was continually expressed throughout the project. The following are representative of the comments and questions raised concerning water and the Red Lakes.

> *"Lake of the Woods is 100 feet lower then the Red Lakes. The ridge separating the Red Lake and Lake of the Woods watersheds is only twenty feet high and is in the middle of the Red Lake Bog. The removal of peat in the Red Lake Bog could, if it were more than 20 feet deep, drain the Red Lakes to the north."*

> *"The Red Lake is our most valuable resource. It should be maintained as it is above any other resource development consideration."*

> *"Will fertilizers from on-site use get into the Lake? What will be the effect of these chemicals?"*

> *"The level of Red Lake is not very well controlled now. It takes a month to change the level a few inches by using the Red Lake River Dam. The Lake changes this much after a good rain. Alteration of water coming to the Lake from the Red Lake Bog could worsen Lake level control."*

> *"A few years ago, the Corps of Engineers came in with all sorts of studies to say their flood control project on the Red Lake River would not harm our lands. However, the groundcover and wildlife all changed. Even their own Environmental Impact Statement admitted they were mistaken. Red Lake has a history of similar events. Now they want to make major alterations in the source of water to the Red Lakes. It would be difficult to convince us that there would be no negative impacts."*

> *"Even though the official records do not indicate it, the Red Lakes flood often. Also, over the years the level has been rising to where the Lake is now at a desirable level. Fishing is good and the Lake is clean. Leave it alone."*

> *"Bog water is coming to the Lake now. Maybe the fish are at their limit for tolerating this water. Even small amounts of additional bog water may exceed safe levels and kill the fish."*

"What about toxins that have been accumulating in peat. Will they get into the water?"

"What about Indian Water Rights. The law gives us total rights to area water!"

"Will peat extraction areas form ponds? How will these ponds affect water flow through the water shed?"

Forestry was the second topic that generated much discussion. The following are representative of the comments and questions raised concerning forestry.

"Many peatlands would be more valuable as timber lands. The swamp species are becoming more commercially important."

"Peat fires are a major problem in forest fire control. Would peat development end or make worse peat fires?"

"In 10,000 years those peatlands will be good stands of Tamarack. You have to consider the future when you plan to alter this much land."

"Much of the peatland is not good for forestry. When the economics are such that even good forest land is not given proper management, it is unlikely that forest economics will dictate peatland coversion to forest land."

Other general comments included the following:

"What type of soil is under peat? How will exposing this soil affect our environment?"

"What is the current status of the Minnegasco Peat Project?"

"The idea to use peat extraction sites as fish ponds will not work. Similar ponds freeze solid and fish would have to be removed."

"Peat is a non-renewable resource; how long until it is used up if it is used for energy?"

"Peat will generate 6,000 BTU per pound for fuel, but we can get 9,000 BTU per pound of fuel from wood. Also, wood is a renewable resource. From an energy point of view, peatland would be better for growing wood."

"How deep would they dig to extract peat?"

"U.S. and Canada raised the water level of the Lake of the Woods 5 feet with no Indian input. This flooded acres and acres of Indian Land; we will not let this happen again."

"A critical issue is not the use of peat as much as the reclamation of the land. A natural resource should be used. The Tribe should benefit but we should be "damn" sure about reclamation."

A questionnaire was distributed at the end of the final general meeting with Reservation resource people. This Survey was designed to compliment the information on attitudes obtained previously by noting concerns and questions. The following are the questions and the responses to the questionnaires. The numbers in parentheses are the actual number of responses. Percentages are based on the proportion of those responding to that question.

1) There are basically two types of peat use. The on-site uses include growing wild rice and vegetables. The extractive uses involve removing the peat to produce energy and horticultural products. Which of the following statements best described your opinion of these two uses:

   67% (4) In favor of large scale on-site use if negative impacts are minimized.
   33% (2) Opposed to on-site peat use.
   50% (3) In favor of large scale extractive use if negative impacts are minimized.
   17% (1) In favor of small scale extractive peat use.
   33% (2) Opposed to extractive peat use.

2) What do you feel will be the impact of extractive peat use on the following Reservation resources:

	Severely Negative Impact	Modest Negative Impact	Neutral Impact	Modest Positive Impact	Very Positive Impact
Wildlife	43% (3)	43% (3)	-	-	14% (1)
Forestry	57% (4)	29% (2)	14% (1)	-	-
Wild Rice	29% (2)	29% (2)	29% (2)	14% (1)	-
Fish	57% (4)	-	43% (3)	-	-

3) What do you feel will be the impact of on-site peat use on the following Reservation resources:

	Severely Negative Impact	Modest Negative Impact	Neutral Impact	Modest Positive Impact	Very Positive Impact
Wildlife	14% (1)	43% (3)	-	29% (2)	14% (1)
Forestry	29% (2)	14% (1)	14% (1)	29% (2)	14% (1)
Wild Rice	14% (1)	29% (2)	14% (1)	14% (1)	29% (2)
Fish	29% (2)	29% (2)	14% (1)	29% (2)	-

4) Do you feel the negative impacts from large scale peat development can be controlled as to not harm the Reservation?

Yes	33% (2)
No	50% (3)
Don't Know	17% (1)

5) Do you feel you have been kept properly informed about peat use proposals (such as Minnegasco) by State Agencies?

Yes	17% (1)
No	67% (4)
No Opinion	17% (1)

6) Do you feel the Tribe will receive any of the economic benefits of peat development off the Reservation?

Yes	33% (2)
No	67% (4)
Don't Know	-

7) Which of the following best represents your view on peat development:

29% (2)	Against any peat use.
43% (3)	Favor limited use if benefits exceed negative impacts.
14% (1)	Favor large scale if negative impacts are controlled.
14% (1)	Favor Tribal development of the peat resource..

Space was provided at the end of these surveys for comments. The following are the comments made on these surveys.

"Have to be firm on taking care of the area after any peat has been mined. Red Lake Tribes should have final recommendation from this area as final say."

"Release of toxins and nutrients into the lake must be controlled completely before any development is allowed."

"Peat resources should be developed on a sustained yield basis."

"Peat bog areas are gradually developing into timbered swamps, this may take another 10,000 years but extracting the peat will break up the vegative climatic change."

"Interesting facts to be known:
Value of peat area now and present use?
Benefits produced from peat utilization.
Resulting land value and use.
Cost to recondition the area utilized."

"Reclaiming area is most important."

The information generated during this study was presented to the Red Lake Tribal Council at a special meeting on February 10, 1978. The Council was intently interested in the presentation. The questions and concerns closely paralleled those outlined in the general meetings. The following are representative of the comments made at this meeting:

"How is fertilizer associated with peat?" Will sludge and residue from peat use get into the Lake? Will algae growth be stimulated by potassium and nitrogen in fertilizers?"

"How much land that we claim as ours (aborigional lands) is in the Minnegasco request?"

"Virtually all the land in this area (Northern Headwaters Region) is our land. The Courts are returning this land plot by plot. This is the origin of the Ceded lands. The State should not grant permits to use land that may ultimately be determined to belong to the Tribe."

"Aren't the peat bogs better for growing timber than for other things?"

"It seems that 9 out of 10 people in this area are against major peat use. But this doesn't seem to stop people in the Twin Cities from trying to develop peat."

"We object to any peat development in the strongest possible terms. Our greatest resource is our lakes. We take over a million and a half pounds of fish out of there a year. It is one of the major sources of income for the Tribe. We will not risk this resource for peat development."

At the end of the Tribal Council Meeting, a questionnaire identical to the one distributed at the General Meeting was distributed to the members of the Council. The following are the results of that survey:

1) There are basically two types of peat use. The on-site uses include growing wild rice and vegetables. The extractive uses involve removing the peat to produce energy and horticultural products. Which of the following statements best describes your opinion of these two uses:

   100% (7) Opposed to on-site use
   100% (6) Opposed to extractive use

2) What do you feel will be the impact of extractive peat use on the following Reservation resources:

	Severely Negative Impact	Modest Negative Impact	Neutral Impact	Modest Positive Impact	Very Positive Impact
Wildlife	83% (5)	17% (1)	-	-	-
Forestry	83% (5)	17% (1)	-	-	-
Wild Rice	83% (5)	17% (1)	-	-	-
Fish	100% (6)	-	-	-	-

3) What do you feel will be the impact of on-site peat use on the following Reservation resources:

	Severely Negative Impact	Modest Negative Impact	Neutral Impact	Modest Positive Impact	Very Positive Impact
Wildlife	80% (4)	20% (1)	-	-	-
Forestry	80% (4)	20% (1)	-	-	-
Wild Rice	80% (4)	20% (1)	-	-	-
Fish	100% (5)	-	-	-	-

4) Do you feel the negative impacts from large scale peat development can be controlled as to not harm the Reservation?

Yes	-
No	67% (4)
Don't know	33% (2)

5) Do you feel you have been kept properly informed about peat use proposals (such as Minnegasco) by State Agencies?

Yes	-
No	83% (5)
Don't know	17% (1)

6) Do you feel the Tribe will receive any of the economic benefits of peat development off the Reservation?

Yes	-
No	67% (4)
Don't Know	33% (2)

7) Which of the following best represents your view on peat development:

88% (7)	Against peat use on, or near, the Reservation
17% (1)	Would consider peat use if benefits outweighed costs.

The following are the comments written at the end of the survey:

"The environment should be left as is. This peat development would severly injure our fishing industry as a main part of our economics on the Reservation. Go do the peat mining up in Canada."

"Harmfull!!!"

"I'm against any disturbance of the peat bogs near or adjacent to Red Lake because there are too many questions not answered as to the effect on our lake and fishing industry."

"Send Minnegasco to Finland where a State Delegation did on-site study."

The attitudes and opinions on peat development are clearly expressed by these comments and the results of the survey. These is evidence that these opinions have existed for some time. The residents are much better informed on the peat issue but continue to be apprehensive about development. In 1976, the Tribal Council passed the following resolution:

RESOLUTION NO. 91-76

WHEREAS, the State Department of Natural Resources intends to conduct a peat inventory and mapping program in Koochiching County to survey peat type, depth, stratification, biological and glacial context and hydrology, and;

WHEREAS, the State DNR, by letter dated September 7, 1976, has requested permission to enter upon Red Lake Band lands within Koochiching County to conduct the same peat inventory and mapping (peat) program, and;

WHEREAS, it is the sense of the Tribal Council that this area be retained in its present form; that any effort to disturb and deface the area will be strongly opposed by the Red Lake Tribal Council.

NOW, THEREFORE, BE IT RESOLVED, that the request by the State DNR to enter upon Red Lake lands in Koochiching County for the purposes as stated herein, is hereby denied.

For: 9

Against: 0

We do hereby certify that the foregoing resolution was duly presented and enacted upon the regular meeting of the Tribal Council held on Friday, September 24, 1976 with a quorum present, at the Red Lake Tribal Council Hall, Red Lake, Minnesota.

Roger A. Jourdain, Chairman

Royce Graves, Sr., Secretary

SUMMARY: RESERVATION OPINION

The Red Lake Reservation is considerably more active and involved in the peat issue than the average community. Red Lake has a substantial number of involved and informed residents who have clearly expressed their opinion on peat development. These opinions are based on a basic knowledge of the potential benefits and costs of peat use.

Red Lake is unique as a community to have such a narrow range of opinion by virtually all of the Opinion Leaders, policy makers and resource people on the Reservation. The most moderate positions would allow only limited on-site use, and then only if the Tribe realizes benefits that exceed the harm to the environment. However, the majority of residents are strongly opposed to any development in the area. Most believe that all the land in the Northern Headwaters region is their land by aboriginal right. To deface this land would be viewed as a great personal tragedy by the Red Lake Indians. They do not feel they will share in the economic benefits of peat development. Roger Jourdain, Tribal Chairman, summed up the Tribal Council's opinion with the following statement:

> *"Peat Utilization? We are using the peat right now. Peat provides habitat for our wildlife. Much of our forests grow on peat. Water for our Lakes comes from peat bogs. The wildlife, timber and fish are our greatest resource. We harvest over a million and a half pounds of fish out of the Lakes a year. The sawmill produces 5 million feet of lumber a year. These are a primary source of employment and income for the Tribe. Our people hunt and fish for much of their food. We are using the peat in the best possible manner now - maintaining our vital resources."*

CONCLUSION

Any rational evaluation of peat utilization must involve a cost and benefit analysis of the potential development. Although it is beyond the scope of this report to conclude the net benefit or cost of peat use, this report does suggest a great number of variables that should be in the cost/benefit equation.

The costs of peat use center around alteration in the ecosystems and the resulting impacts on people. The key concepts in evaluating peat's environmental costs are *CONTAINING* the impacts and ***RECLAIMING*** the land. The developer must demonstrate that the adverse impacts from peat use can be contained to the utilization site. If the peat utilization strategy involves peat extraction, the site must be reclaimed to a desirable condition.

The ability to contain peat impacts is mostly determined by the nature of the project area. This analysis has described a project area with characteristics that would make impact containment extremely difficult. A wildlife and forest area with an abundant surface water flow is more susceptible to peat use impacts being transferred through the environment. The environmental, social and economic systems of the Red Lake Reservation are so interrelated that the adverse impacts of peat use have a high probability of being transferred to the people of the area.

Although reclamation technology exists in foreign countries, it has not been demonstrated that large scale reclamation is feasible in the project area. The nature of the land and water in the project area strongly suggest that reclaiming expended Red Lake peatlands will be difficult. Also, the land economics of the United States are quite different from the countries that have demonstrated peatland reclamation. The relative scarcity of land in these countries provides strong economic incentive for reclaiming the sites used for peat extraction. The primary motivation for reclamation in the United States has been governmental regulation. In other surface mining operations, regulation has often failed to effect optimal land reclamation. It remains to be demonstrated that adequate reclamation will occur in large scale extractive peat projects in the Red Lake area.

The analysis of the benefits must be expanded beyond consideration of the number of jobs created. It must consider what types of jobs, what level of income will be produced, and who will realize these benefits. It remains to be demonstrated that the Red Lakers will realize any substantial economic benefits from major peat development adjacent to the Reservation. The benefit analysis must also consider more than the value of extracted peat. The lands of the Red Lake area have value in maintaining other resources. The value of extracted peat, which is a one-time use, must be compared with the on-going uses, such as forestry.

The apprehension of the people of the Red Lake area toward major extractive peat uses adjacent to the Reservation is based on a knowledge of peat use and their environment. Such development has significant potential to force the Red Lakers to *"pay the price"* of peat development without *"reaping the rewards"*. Such inequitable arrangements have great potential to germinate hostile public reaction.

Although it will be extremely difficult to demonstrate that large scale extractive peat use can occur in the Red Lake area without severe environmental and social consequences, there remains a wide variety of uses for this resource. The State of Minnesota Peat Information Program is the necessary approach for selecting the appropriate use of peat and in which area of the State peat use should occur.

GLOSSARY

Aquifer: A body of rock (or rock materials) that contains sufficient saturated permeable material to conduct groundwater and to yield economically significant quantities of groundwater to wells and springs.

Artisian: Any system incorporating a water source, a body of permeable rock (rock materals) bounded by bodies of distinctly less permeable rock, and a structure enabling water to percolate into and become confined in the permeable rock under pressure distincly greater than atmospheric.

Ash Content: The ash or mineral residue remaining after a peat sample has been burned, expressed as a per cent (%) of dry weight.

Bog: A water-logged area with a surface vegetative cover composed of less than 75% moss with greater than 25% trees; an open bog has greater than 5% tree cover with or without shrubs.

BTU: (British Thermal Unit) The quantity of heat required to raise the temperature of one pound of water $1^{o}F$ at or near its point of maximum density.

Bulk Density: Equal to the mass of dry material per unit bulk volume.

C^{14}: (Carbon -14) age - a radiometric age expressed in years and calculated from the quantitative determination of the amount of carbon -14 remaining in an organic material.

Cation: A positive atom or group of atoms, one which is deficient in electrons.

Cation Exchange: A reaction in which cations absorbed on the surface of clay or zeolite crystals are replaced from cations in the surrounding solution.

Degree of Decompsition: A relative quantity which is usually approximated by using a measure of one of the chemical or physical characteristics which change with the breakdown of organic materials. With increasing decomposition in peat, the size of organic particles decreases, resulting in smaller pores and more dry material per unit volume.

Evapotranspiration: Loss of water from a land area through transpiration of plants and evaporation from the soil.

Fen: A waterlogged grass-covered area with greater than 50% (per cent) sphagnum mosses and less than 5% (per cent) tree cover.

Fibric: (sphagnum peat)- Residuum of sphagnum and other mosses; fiber content less than 61% (per cent) of which less than 75% (per cent) of sphagnum fibers and greater than 25% (per cent) of reed-sedge, grass or wood fragments; ph varies from 3.5 to 4.5; low degree of decomposition; brown, reddish brown to dark reddish brown; saturation

Gasification: The process by which a natural gas substitute is produced through the reaction of steam, hydrogen, carbon monoxide, carbon dioxide, and methane in contact with the solid carbon in peat. Heat is added to meet the thermal needs of the steam carbon reaction. (water) 85.0 to 92% (per cent); bulk density less than 0.075 g/cc.

Groundwater: Water contained in layers below the surface of the earth.

Hemic: (herbaceous; reed-sedge, peat) Residuum of fibers from reeds, marsh grass, cattails and associated plants; fiber content less than 33%, more than 55%, with less than 20% sphagnum fibers and more than 10% wood fragments; pH 4.0-5.5; medium degree of decomposition; dark reddish brown, brownish black to black, water saturation 82.0 to 88.0%, bulk density 0.75 to 0.195 g/cc.

Hydraulic Conductivity: Rate of flow of water in gallons per day through a cross section of one square foot under a unit hydraulic gradient, at the prevailing temperature or adjusted for a temperature of 60^{o} F.

Hydrologic Cycle: The constant circulation of water from the sea, through the atmosphere, to the land, and its eventual return to the atmosphere by way of evaporation from the sea and land surfaces. (Gary, M., McAffe, R.Jr., and Walf, C.L., eds. 1972, Glossary of Geology: American Geological Institute, Washington, D.C.)

Isostatic Compensation: The adjustment of the earth's crust to maintain equilibrium among units of varying mass and density.

Marsh: Intermittently to permanently water covered area with aquatic and grass-like vegetation; with limited waterlogged areas of bog; less than 25% tree cover.

Mineral Content: Inorganic matter, including numerous mineral species, that range in size from clay to sand.

Minerotrophic: An area that is fed by mineral rich groundwater (waters received directly from mineral soil) which is little modified by either the peat itself or by large inputs of precipitation. Generally of a lower pH.

Moisture Content: Percentage of the total volume of a cubic-foot of peat which is water.

Moraine: A mound, ridge or other distinct accumulation of un-sorted, un-stratified glacial drift, predominantly till, deposited chiefly by direct action of glacial ice in a variety of landforms that are independent of control by the surface on which the drift lies.

Muskeg: A general term used to describe a large water logged area with up to 100% sphagnum moss cover with more than 75% shrub cover.

Ombrotrophic: An area that is isolated from mineral rich groundwater. Input of water and minerals principally derived from precipitation. Generally of a higher pH.

Outwash: The sand and gravel size rock materials removed from a glacier by meltwater streams and deposited in front of the margin of an active glacier.

Palludification: Process of bog expansion caused by gradual raising of water table as peat accumulation impedes drainage.

pH: Considered a measure of acidity and alkalinity. pH values range from 0 to 14. Numbers less than 7 reflect increasing acidity, and numbers greater than 7 reflect increasing alkalinity. The scientific description of pH represents the negative base -10 log of the hydrogen-ion activity in moles per liter.

Porosity: The ratio of the volume of voids of the material to the volume of its mass.

Raised Bog: A bog with an elevated, convex central area caused by peat accumulation. The central area, at least, is isolated from the local water table and thus dependent chiefly upon precipitation for water and minerals.

Reclamation: The process of returning a site to pre-existing conditions or a new desired state.

Sapric: (peat humus) Amorphous, residuum of plastic organic materials with less than 33% fiber; brownish black to black, ph 4.0 to 5.5; bulk density more than 0.195 g/cc.

Substrate: The substance, base or nutrient on (or medium in) which an organism lives and grows, or the surface to which a fixed organism is attached.

Swamp: Intermittently to permanently water covered area with more than 25% tree cover, with or without shrub or moss cover.

Thornthwaite Method: Method of climate classification based on a ratio of precipitation to evaporation. The five humidity provinces of the classification are: per-humid, humid, sub-humid, semi-arid and arid.

Till: Unsorted and unstratified materials deposited directly from glacier ice and consisting of a heterogeneous mixture of various percentages of clay, silt, sand, gravel, pebbles and boulders.

Watershed: The region drained by, or contributing water to, a stream, lake or other body of water.

Water Yield Coefficient: Measure of the quantity of water removed from a peat profile when the water table is lowered. Also referred to as storage coefficient, coefficient of drainage, and coefficient of groundwater level. Typical tables represent it as equal to the difference in water contents at saturation and 0.1 bar suction.

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Standards

1. American Society for Testing and Materials

D2607-69	Standard Classification of Peats, Mosses, Humus and Related Products.
D2944-71	Sampling Peat Materials
D2973-71	Total N in Peat Materials
D2974-71	Moisture, Ash and Organic Matter of Peat Materials
D2975-71	Sand Content of Peat Materials
D2976-71	pH of Peat Materials
D2977-71	Particle Size Range of Peat Materials
D2978-71	Volume of Peat Materials
D2980-71	Volume of Peat; Water-Holding Capacity, and Air Capacity of Water-Saturated Peat Materials

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