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PRELIMINARY REPORT
PROTECTION OF
ECOLOGICALLY SIGNIFICANT PEATLANDS
IN MINNESOTA



MINNESOTA DEPARTMENT OF NATURAL RESOURCES

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PROTECTION OF ECOLOGICALLY SIGNIFICANT PEATLANDS
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Minnesota Department of Natural Resources

June 1984

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FOREWORD

This report is a preliminary summary of the information on which the Minnesota Department of Natural Resources' recommendations for the protection and management of Minnesota's ecologically significant peatland complexes will be based. Identification and evaluation of the state's ecologically significant peatlands greater than 3,000 acres began in 1978 as part of the DNR's Peat Program. In 1981, 22 peatland complexes were identified as candidates for protection by the Task Force on Peatlands of Special Interest and formally recognized in the policies of the Peat Program. Legislation passed in 1983 directed the department to review the information compiled on these 22 candidate peatlands to determine whether these areas qualify as units of the Outdoor Recreation System. To carry out this task, the Commissioner of DNR appointed the DNR Peatland Protection Task Force. This work was to have been completed by July 1, 1986; however, legislation passed in 1984 changed this mandate, directing that final recommendations for the protection of the candidate areas be completed on an accelerated schedule by November 15, 1984.

Although an extensive effort has gone into the study of the peatland candidate areas, there is still much to be learned about these peatlands and others. Peatlands are still the least understood ecosystem in the state and in North America. A full understanding of peatlands will only result through long-term research.

This report is a summary of the information compiled to date about these peatlands. It includes a preliminary ecological assessment of each of the candidate areas, a preliminary discussion of management guide-

lines for these areas and the administrative and legislative options available for implementing these guidelines, and a general discussion of the potential impacts of protection on other natural resources management. At this time, it is important to solicit review and comment on the contents of this document so that the issues raised by this review can be addressed during the formulation of the department's final recommendations. It should be noted that data on some of the peatland candidate areas are incomplete and will continue to be gathered during the next few months. A final report containing recommendations will be completed for the 1985 legislative session.

Two task forces have played an integral part in the department's peatland protection program. The first is the Task Force on Peatlands of Special Interest, who acted as an advisory group to the DNR and nominated the 22 peatlands as candidates for protection. Following is a list of the members:

Norm Aaseng, DNR Peat Program, Division of Minerals (co-chair)
Barbara Coffin, DNR Natural Heritage Program (co-chair)
Bill Berg, DNR Wildlife Research
Dr. Paul Glaser, University of Minnesota
Dr. Eville Gorham, University of Minnesota
Dr. Miron Heinselman, University of Minnesota
Dennis Ingvaldson, DNR Division of Forestry
Paul Rundell, DNR Division of Parks and Recreation
Dr. Donald Siegel, U.S. Geological Survey (now Syracuse University)
Dr. Herbert Wright, University of Minnesota

The second is the DNR Peatland Protection Task Force, appointed by the commissioner in 1983, whose members have been instrumental in the preparation of this report. Following is a list of the members:

Dennis Asmussen, Peat Program, Division of Minerals (chair)
Norm Aaseng, Peat Program, Division of Minerals
Jim Brooks, Division of Forestry
Barbara Coffin, Natural Heritage Program
Bob Djupstrom, Scientific and Natural Areas Program
Kim Hennings, Division of Fish and Wildlife

Mary Keirstead, Peat Program, Division of Minerals
Jon Parker, Division of Wildlife
Stephanie Warne, Bureau of Lands
Bruce Zumbahlen, Division of Forestry

INTRODUCTION

Minnesota's peatlands are a natural resource of importance for many reasons, ranging from their representation as a major component of the state's natural heritage to their potential as an energy source. Adding to the significance of the peatland resource is its size--approximately 6 million acres. The fact that only about 10 percent of this area has been developed offers an unusual opportunity to protect ecologically significant peatlands as part of a comprehensive plan for management of peatland resources. Most often the preservation of ecosystems, for example, Minnesota's prairie or the "Big Woods", has been more difficult because development has proceeded to the point where only isolated remnants of former ecosystems remain intact.

Although most of Minnesota's peatlands are now undeveloped and many are undisturbed, it is important to realize that the nature of the peatland ecosystem is such that it can be irretrievably damaged, sometimes by as little as a drainage ditch. Unlike other ecosystems, the conditions under which a peatland formed cannot be easily recreated. Peatlands are a resource comparable in some respects to ore deposits or coal seams--once destroyed peatlands cannot be replaced (Goodall 1983).

Identification and protection of significant peatlands before the pressures of development have restricted options allows for the systematic evaluation of their ecological significance and a careful assessment of potential land-use conflicts. A balance can then be found between protection, existing uses, and development.

PEATLANDS IN MINNESOTA

Peatlands occur throughout Minnesota except in the extreme southwestern and southeastern corners of the state (see fig. 1). The largest contiguous areas of peatland are located in the northern part of the state, where glacial erosion and deposition formed topography favorable for peat accumulation in the beds of Glacial Lakes Agassiz, Aitkin, and Upham. Smaller, scattered peatlands occur throughout other parts of the state.

The peatland environment is a product of interactions among plants, topography, climate, and water. The result is an ecosystem distinctly different from a more familiar system, the uplands. In the peatland ecosystem, the lack of oxygen in the water-saturated environment limits the activity of microorganisms that digest dead plant material. The accumulation of these materials is the process by which peat is formed.

Peatlands in Minnesota can be classified by water chemistry according to the origin of their surface waters: minerotrophic and ombrotrophic. Minerotrophic peatlands receive water from precipitation and ground water that has percolated through mineral soil. These waters are circumneutral or slightly acidic and have comparatively high concentrations of dissolved minerals such as calcium. Two major peatlands types, fens and swamps, occur in minerotrophic conditions. Fens are usually meadowlike, dominated by sedges, reeds, and grasslike plants; occasionally shrubs and scattered, stunted trees are present. Swamps are wooded wetlands that can be dominated by either trees or tall shrubs.

Ombrotrophic peatlands, on the other hand, are isolated from ground

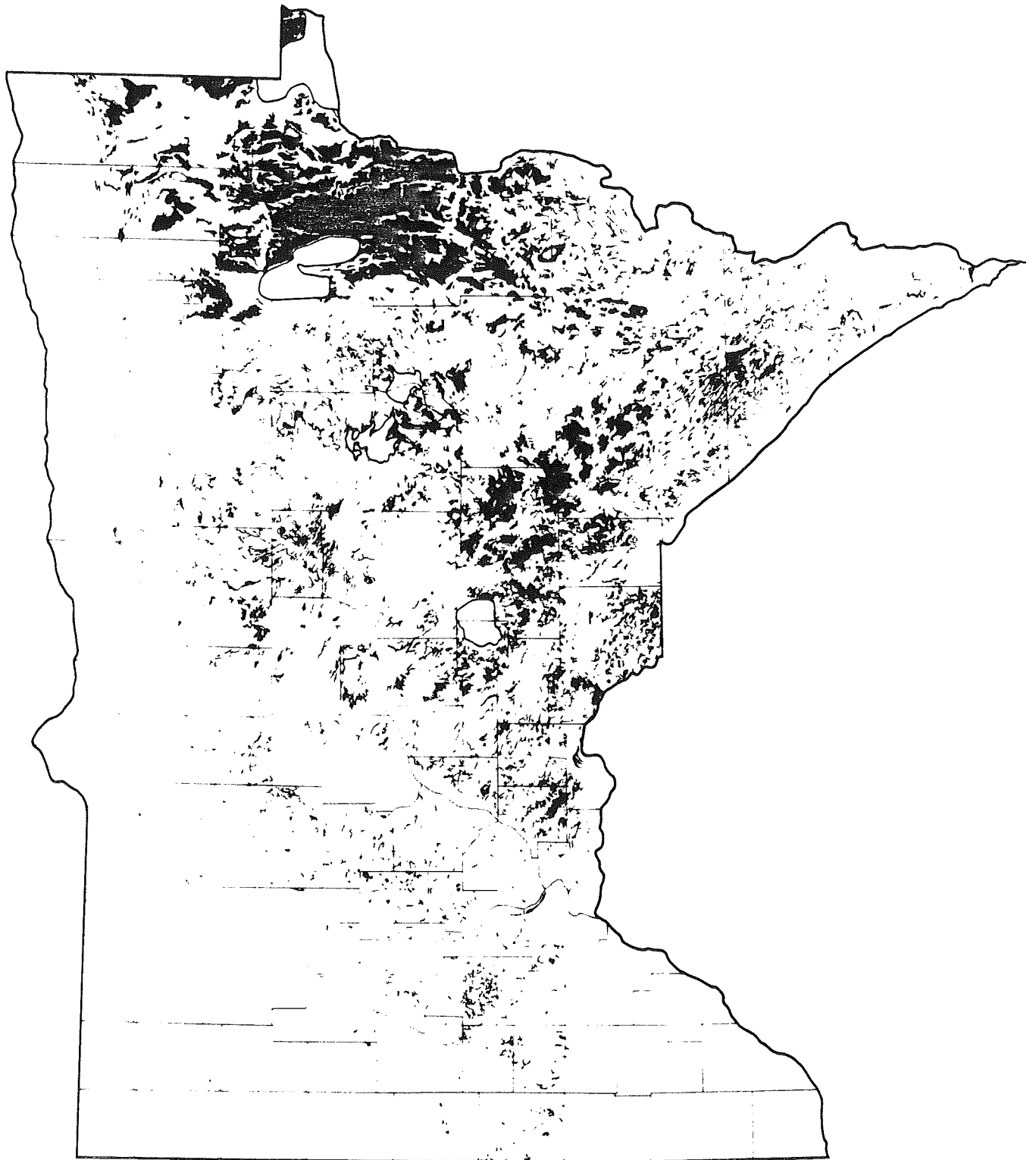


Figure 1. Distribution of peat resources in Minnesota

water and receive water only from precipitation. These waters are acidic and have low concentrations of dissolved minerals. These conditions result in the formation of bogs. Bog vegetation is characterized by a hummocky surface layer of mosses, predominately sphagnum moss, ericaceous shrubs, and varying occurrences of sedges; bogs may be forested or unforested. Since few species can tolerate the extreme acidity and nutrient-poor conditions, bogs have a very low species diversity compared to fens and swamps.

Differential rates of peat accumulation and surface-water flow have resulted in the formation of distinct peatland landforms. The various types of these landforms, which are evident on aerial photos (see cover photo), are associated with specific types of peat-forming environments. One of the most prominent landform types in Minnesota is the raised bog, a dome-shaped accumulation of sphagnum moss peat, which is characterized by a pattern of black spruce radiating outward from a central point or axis. Landform types and other aspects of the ecology of Minnesota's peatlands are discussed in more detail in the "Ecological Resources Evaluation" section of this document.

Significance of Minnesota's Peatlands

Regional and International Significance. Minnesota's peatlands are located within the boreal zone of worldwide peatland systems (see fig. 2). The largest peatlands in this zone occur in the broad continental lowlands of North America and Eurasia, where peat has formed over large landscapes extending for hundreds of miles (Glaser 1983; Sjors 1961). The patterns that have developed in these peatlands dramatically express variation in the interacting agents--topography, hydrology, vegetational processes, and climate--across the range of this

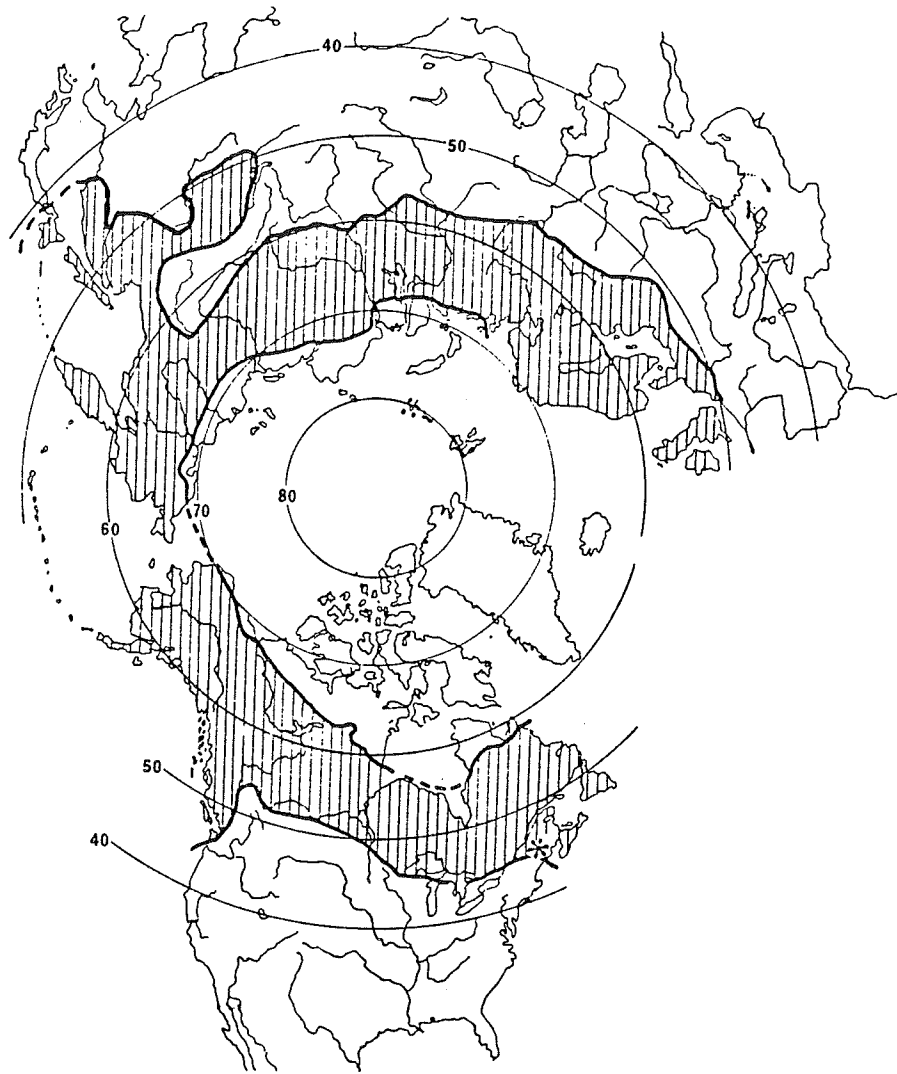


Figure 2. Boreal peatland regions of the world (Damaan 1983)

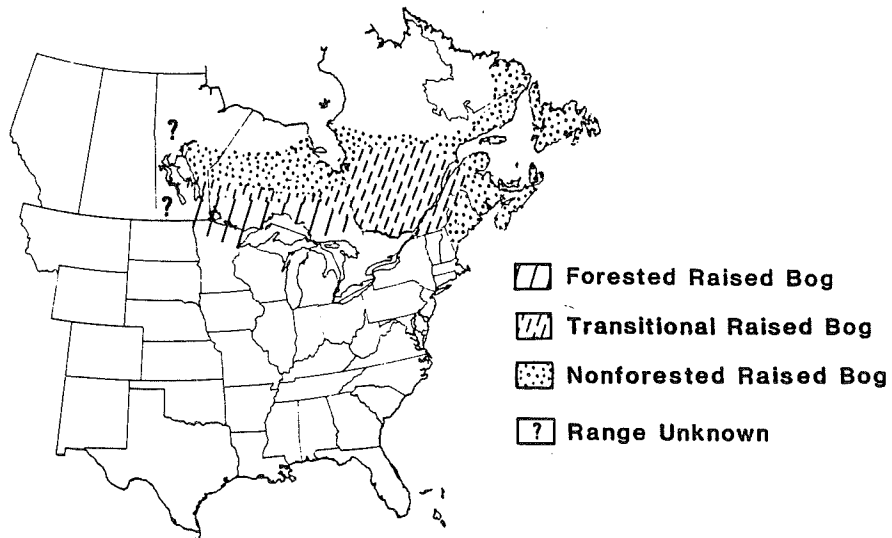


Figure 3. Range of raised bog types in northeastern North America (Glaser 1984)

ecosystem. Thus, these large continental peatlands that exhibit the greatest diversity of surface patterns represent an important tool for understanding the potential direction of and controls on the basic processes of peatland development (Glaser 1983).

In an international context, the peatlands in Minnesota of the Glacial Lake Agassiz region represent a very significant component of the continental peatlands. These peatlands exhibit unique landforms and examples of certain developmental stages, which are found in comparable size and complexity only in the peatlands of the Hudson Bay Lowlands and possibly in Siberia.

In addition, the geographical position of Minnesota's peatlands at the edge of three major biomes has given rise to a flora and fauna with an unusual assemblage of species. In this region of North America, these peatlands are the southern limit of the boreal peatlands, the western limit of eastern peatlands, and a northeastern extension of the prairie peatlands.

In a nationwide context, Minnesota's extensive peatlands can only be compared to those of Alaska, although in this regard the high levels of precipitation and the presence of permafrost have created peatland types distinct from those found in Minnesota. In the United States, continental raised bogs with radiating forest patterns are found only in Minnesota. In addition, the southernmost examples of raised bog complexes in North America occur in Minnesota (see fig. 3). Although similar features occur in Canada, the more northern bogs are often associated with permafrost, which is entirely absent from Minnesota. The lack of permafrost is significant because its presence only complicates the interpretation of ecological and developmental processes.

Significance for Rare and Unusual Species. The factors discussed above place Minnesota's peatlands in a general manner in the context of peatlands nationwide and worldwide. In addition to these broad ecological values, it is important to understand the significance of the peatland systems to individual rare or uncommon species.

Although peatlands lack the diversity and richness of species present in upland habitats, environmental conditions ranging from extremely acid and low in nutrients to highly calcareous have created unique habitats for plant and animal species. Twenty-four species that occur in peatlands of northern Minnesota have been identified by the department's Minnesota Natural Heritage Program as being endangered, threatened, or of special concern on a state-wide level.

The peatlands also provide habitat for plants with unusual adaptations to the harsh environment. These are the insectivorous pitcher plants, sundews, and bladderworts. There are also numerous species of orchids and ericaceous plants that are not found in other Minnesota habitats. The peatlands are also being found to be an important habitat for some bird species such as the palm warbler, Lincoln's sparrow, Connecticut warbler, and the great gray owl.

Significance for Scientific Research. Minnesota's peatlands provide an important laboratory for ecological research on developmental processes and regional hydrology of the peatland ecosystem. The opportunity for research is especially good in Minnesota because of the wide range and highly developed form of peatland types, the pristine nature of the peatland complexes, and the accessibility of these peatlands compared with those in the Hudson Bay Lowlands and Siberia.

The intricate peatland patterns interconnected over large areas in response to the water chemistry and flow patterns of both surface and ground water are particularly important to scientists in formulating hypotheses on peatland developmental processes. These efforts not only add to knowledge of the poorly understood peatland ecosystem, but also are important for the successful environmental management of peat mining and other development. In particular, there are many unanswered questions about peatland hydrology. Intact, undisturbed peatland systems are essential as study areas for hydrologic research.

Peatlands also offer an unusual opportunity for research on cultural history and cultural impacts. Because the peatland environment inhibits decomposition, peat can be valuable in the preservation of fossil remains that are of historical significance. Pollen and other plant remains that have been laid down over thousands of years provide information on past climatic changes and vegetation history. In Europe, nearly perfectly preserved remains of humans have been uncovered in peatlands and have provided detailed information on past cultures (Glob 1969). In Minnesota, the shores of former glacial lakes and rivers that existed before peat formation began are known to have been occupied by prehistoric cultures. Although Minnesota's peatlands may hold interesting archaeological opportunities, as yet no extensive effort has been made to explore potential sites.

A REVIEW OF EFFORTS TO PROTECT PEATLANDS WORLDWIDE

Although peatland research has been conducted in other countries for many years, recognition of the need for protection of peatlands is as recent in these countries as it is in the United States. The only other program in the United States comparable to Minnesota's is being conducted in Maine, where a state-wide evaluation of peatlands is in the beginning stages (Worley 1981 and Davis et al. 1983). As in Minnesota, efforts to protect peatlands have been spurred by interest in development of the peatland resource.

In contrast to Minnesota and Maine's efforts, programs to protect peatlands in other countries began after many peatlands were already developed. In a recent publication on world peatlands, the editor points out that the world area of peatlands in accessible regions is decreasing fast, at a rate comparable probably with that of tropical forests. Thus, from an international perspective, protection of peatlands is viewed as an urgent task (Goodall 1983).

An international effort to preserve peatlands, Project TELMA, was begun in 1966 by the International Union for Conservation of Nature and Natural Resources and the International Biological Programme. This effort led to the creation of national programs in Finland, Great Britain, Ireland, Norway, Sweden, Poland, Czechoslovakia, and the USSR. The programs have resulted in the protection of some peatlands in most of these countries.

Common to these efforts is the attempt to classify peatland types and to develop criteria for evaluating individual peatlands from regional, national, and international perspectives. Major goals of

these programs are to protect sites representative of different types of peatlands, to protect sites that are noteworthy because of an ecological attribute or because of their rarity, and to protect wildlife habitat and rare species of plants and animals.

One of the most comprehensive of these programs has been undertaken in Finland, a country heavily dependent on its peatlands for timber and fuel. In 1976, the Finnish government set up a working group to develop a program for protecting peatlands. This group developed a classification system to group the identified sites according to the following criteria (Ruhijarvi 1978):

- representativeness of the peatland complex
- abundance of sites
- variety of bird populations in the area
- presence of threatened animal and plant species, value for education and research, geological structure, and scenic value.

Peatland sites were then classified into four groups:

- I. Internationally important peatland areas, which represent a peatland complex type typical in Finland but rare in other countries.
- II. Nationally important peatlands, which are large and complete complexes that are examples of the ecological variation of peatland complexes. The most important bird sanctuaries, sites of threatened fauna, and permanent research areas are in this class.
- III. Regionally important peatlands, which are examples of local scenery, habitats of regionally threatened plant and

animal species, and important educational sites.

- IV. Locally important peatlands, which are small conservation sites of peatland complexes or individual peatland types.

The Finnish program has also developed a management program with three categories, which vary in their intensity of protection:

1. Nature reserves, which require total protection from peatland development, some as national parks established by legislation.
2. Nature management areas, in which a part of the peatland is in a nature reserve and part in economic use.
3. Areas protected only from drainage.

By 1980, 300,000 hectares of peatland in Finland had been protected, with the intention of eventually protecting 700,000 hectares (1.7 million acres) of both state and acquired private peatlands (about 7% of Finland's 10.4 hectares of peatland) (Heikurainen and Laine 1980). This goal is part of an overall plan to allocate peatlands among the following uses:

Forestry (drained)	65%
Agriculture	7%
Energy	10%
Preservation	7%
	<hr/>
	89%

The experience of other countries has been useful in developing the DNR's program for peatland protection. In particular, this information has contributed to the development of the evaluation process and the management guidelines. More detailed and current information has recently been obtained about peatland protection in Finland and Sweden and will be translated this summer.

THE DNR'S PEATLAND PROTECTION PROGRAM

The DNR's effort to identify and protect ecologically significant peatlands grew out of the Peat Program's research efforts, begun in response to interest in development of the resource for energy. Early in this program, begun in 1975, it became apparent that basic information about the ecology of peatlands was sadly lacking. Thus, with the decision to fund research to obtain this information, the department began a five-step process:

1. Data Collection--Phase I
2. Nomination of Candidate Areas and Assessment of Data Needs
3. Data Collection--Phase II
4. Evaluation of the Ecological Significance of Candidate Areas
5. Recommendations

The first three steps are described below.

Data Collection--Phase I

In 1978, DNR staff began to gather existing data from both the biological literature and individual researchers on ecologically significant peatlands and peatland types in Minnesota. To assist in this process, an advisory group composed of representatives from within the department and experts from outside the department was appointed as the Task Force on Peatlands of Special Interest.

Data were gathered and reviewed from a variety of sources including (1) scientific literature; (2) information from individuals knowledgeable about peatlands; (3) previous state surveys such as the Minnesota Resource Potentials in State Outdoor Recreation (DNR and SPA 1971), Potential Critical Areas Inventory (EQB 1978), and files from the State

Scientific and Natural Areas Program and the Natural Heritage Program.

In addition, contracts to gather needed data were initiated. A list of these contracts and publications resulting from them is provided in the reference section.

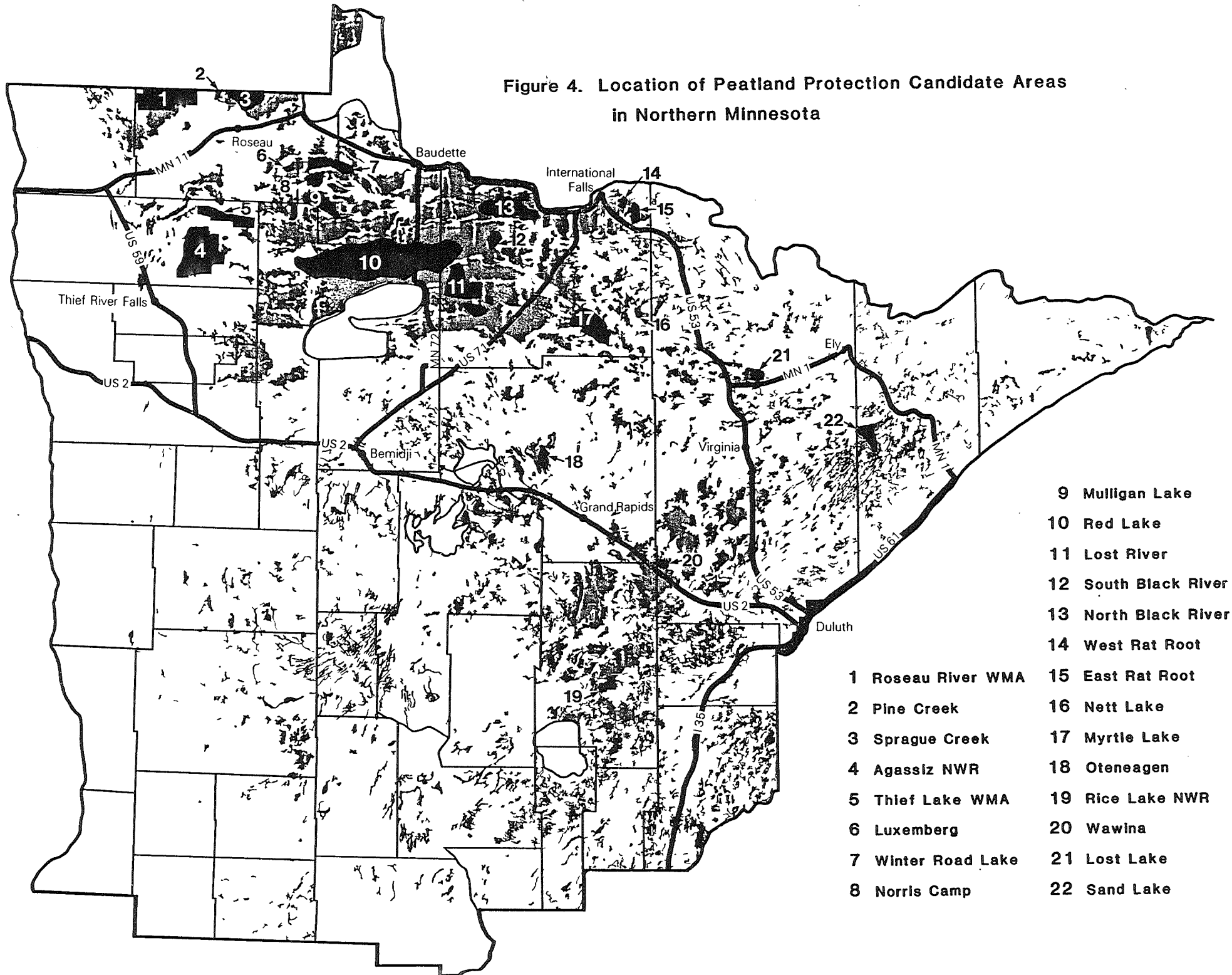
Nomination of Candidate Areas and Assessment of Data Needs

After reviewing data gathered from Data Collection--Phase I, the Task Force on Peatlands of Special Interest, working with DNR staff, compiled a list of candidate peatlands for potential protection status. Because of the limited time and data and the immediate need of the Peat Program to determine potential conflicts between protection and large-scale development, the Task Force decided to focus on peatland complexes greater than 3,000 acres. The evaluation of peatlands smaller than 3,000 acres is an important task to be conducted in the future.

Twenty-two peatland complexes were identified as ecologically significant areas and recommended for special protection (fig. 4). Of these peatlands, six were especially significant for their value to wildlife. Four of these wildlife areas occur within established state Wildlife Management Areas or National Wildlife Refuges. Because these areas already receive specific management directed to wildlife and because they do not contain high ranking examples of peatland landforms, these four areas were not evaluated in a similar fashion as the remaining 18 areas. However, specific recommendations have been made for these four areas in Appendix A.

To more closely evaluate the remaining 18 areas required more data. An assessment of the available information on these areas identified a lack of comparable data for all of the peatland complexes. The emphasis on research in the Red Lake Peatland had produced extensive data on the

Figure 4. Location of Peatland Protection Candidate Areas in Northern Minnesota



- 9 Mulligan Lake
- 10 Red Lake
- 11 Lost River
- 12 South Black River
- 13 North Black River
- 14 West Rat Root
- 15 East Rat Root
- 16 Nett Lake
- 17 Myrtle Lake
- 18 Oteneagen
- 19 Rice Lake NWR
- 20 Wawina
- 21 Lost Lake
- 22 Sand Lake

- 1 Roseau River WMA
- 2 Pine Creek
- 3 Sprague Creek
- 4 Agassiz NWR
- 5 Thief Lake WMA
- 6 Luxemburg
- 7 Winter Road Lake
- 8 Norris Camp

species, communities, and landforms of this peatland complex. However, without similar data for other peatlands it was impossible to fairly evaluate the ecological significance of the peatland complexes. In addition, a need was identified to develop a classification system for peatland watershed types so that peatland complexes could be compared on all levels: regional, national, and international. Concurrently, the need for a better understanding of the hydrology of Minnesota's peatlands was recognized as necessary for identifying the ecological requirements for protection of the peatlands.

Data Collection—Phase II

The second phase of data collection was designed to gather the missing comparable data, to develop a peatland classification system, and to further study the complex hydrologic systems of Minnesota peatlands. The contract initiated in 1978 with Drs. Gorham and Wright to survey the vegetation and floristics of the Red Lake Peatland was expanded to include other large peatland complexes in northern Minnesota. To supplement this work, DNR staff from the Peat Program and the Natural Heritage Program conducted additional intensive field studies.

A contract for the development of a peatland watershed and landform classification was also initiated with Drs. Wright and Glaser. And, a contract with Dr. Siegel of the U.S. Geological Survey was developed to study the hydrogeologic setting of the Glacial Lake Agassiz peatlands.

These data, collected during field seasons 1982-84, have greatly improved the quality of information available for ecological evaluation of Minnesota's peatlands. However, the study area is large--many thousands of acres--and the time available for data collection has been

short--three field seasons. In comparison with knowledge of peatlands in European countries, where peatlands have been studied for over a century, the work conducted in Minnesota's peatlands must be considered a general survey. Nevertheless, this work, which is on the forefront of peatland research in North America, has established a firm basis for the fourth step of the process, the evaluation of the ecological significance of these peatlands.

ECOLOGICAL RESOURCE EVALUATION

The ecological resource evaluation of Minnesota's peatlands combines together many factors. These factors have been presented earlier in this document in "Peatlands in Minnesota", which provides an overview of the ecological values of Minnesota's peatlands. That section discusses the relationship of Minnesota's peatlands to other peatlands of North America and to peatlands worldwide. In addition, it describes briefly the major biological factors (rare and unusual species, landforms and complex types, and significance for scientific research) that define the ecological significance of Minnesota's peatlands. This section describes the process by which the ecological significance of each candidate area is being evaluated and the preliminary results of this process.

Identification of Peatland Features of Ecological Significance

The first step in the evaluation of the ecological significance of peatland candidate areas is the identification of the features that will be used in the evaluation process. The process of identification utilized information from the Natural Heritage Program, including the official state list of endangered and threatened plants and animals, information from the University of Minnesota studies, and data gathered by the Peat Program staff. The list of features includes plants, animals, landforms, and peatland complex types. The list is a revision of the preliminary lists presented in the DNR Peat Program Final Report (1981) that more accurately identifies the features that best indicate ecological significance in the 18 areas being evaluated. All of the species used in the ecological evaluation are protected species under

Minnesota Statute 94. The landforms and peatland complex classifications are based primarily on the work of Dr. Paul Glaser (in preparation).

Plants. Figure 5 lists the rare plant species that are found in the large peatlands of northern Minnesota. Each of the fourteen species is considered to be a protected species and is listed as endangered, threatened, or special concern on Minnesota's official state list. All but Rubus chamaemorus (baked apple berry) and Geocaulon lividum (northern comandra) are known to occur in one or more of the candidate areas. These two species could occur in the candidate peatlands; but because they are not associated with a specific landform, they are difficult to locate, and the true status of these species is not known.

A status sheet has been prepared for each of these species, which includes a description of the species' distribution in Minnesota, its range in North America, the basis for its state status, and a description of preferred habitat. Examples of some of these status sheets can be found in Appendix B.

Although mosses (bryophytes) make up a significant component of the peatland vegetation, very little data exist on their distribution in Minnesota's peatlands. This condition is primarily due to difficulties in species identification and the lack of professional bryologists in the state for the past 80 years. Consequently, there are no peatland mosses listed on the state protected list. Current research sponsored by the DNR has provided a wealth of information including the discovery of ten new state species and one new North American species. Appendix C lists the peatland mosses currently proposed for official state status.

Animals. Figure 6 lists the rare animal species that have been

<u>Scientific Name</u>	<u>Common Name</u>
ENDANGERED	
<u>Cypripedium arietinum</u>	Ram's-head Lady's slipper
THREATENED	
<u>Drosera anglica</u>	English Sundew
<u>Drosera linearis</u>	Linear-leaved Sundew
<u>Eleocharis rostellata</u>	Small-beaked Spike-rush
<u>Nymphaea tetragona</u>	Four-angled Water-lily
<u>Rhynchospora capillacea</u>	Hair-like Beak-rush
* <u>Rubus chamaemorus</u>	Baked Apple Berry
SPECIAL CONCERN	
<u>Arethusa bulbosa</u>	Dragon's Mouth
<u>Carex exilis</u>	(a species of sedge)
<u>Cladium mariscoides</u>	Twig Rush
* <u>Geocaulon lividum</u>	Northern Comandra
<u>Juncus stygius</u>	American Bog Rush
<u>Rhynchospora fusca</u>	Sooty Beak-rush
<u>Tofieldia glutinosa</u>	Sticky False Asphodel
<u>Triglochin palustris</u>	Marsh Arrow-grass
<u>Xyris montana</u>	Mountain Yellow-eyed Grass

* species was not found in candidate peatlands

Figure 5. State status of rare plants found in large peatlands in northern Minnesota

<u>Common Name</u>	<u>Scientific Name</u>
THREATENED	
Eastern Timber Wolf	<u>Canis lupus</u>
SPECIAL CONCERN	
Northern Bog Lemming	<u>Synaptomys borealis</u>
Greater Sandhill Crane	<u>Grus canadensis</u>
Sharp-tailed Sparrow	<u>Ammodramus caudatus</u>
Short-eared Owl	<u>Asio flammeus</u>
Wilson's Phalarope	<u>Phalaropus tricolor</u>
Yellow Rail	<u>Coturnicops noveboracensis</u>
Bog Copper Butterfly	<u>Epidemia epixanthe michiganensis</u>

Figure 6. State status of rare animals found in large peatlands in northern Minnesota

found in peatland candidate areas. These species, like the plants, are protected on the official state list of endangered, threatened, and special concern species. Data on animal species have been very difficult and expensive to obtain and therefore are not available for most of the candidate areas. Status sheets, similar to those of plant species, have been compiled for these animal species. Examples of status sheets for some of these species can be found in Appendix B.

Landforms. Figure 7 lists the landform elements that are included in the evaluation of the candidate peatlands. Data sheets, diagrams, and aerial photos are currently being compiled for each type and should better explain these concepts to those who are unfamiliar with them. The landform classification for Minnesota peatlands was developed by Dr. Paul Glaser and DNR Peat Program staff.

Peatland Classification - Peatland Complex Types. The peatland complex classification for Minnesota peatlands is described in Appendix D. This system is an ecological classification based on genesis that was developed by Glaser (in preparation). It combines the major factors interacting in the development of these patterned peatland complexes--vegetation, hydrology and topography.

The task of classifying the diverse continuum of peatland types that occur in Minnesota in a meaningful system has been difficult. Earlier attempts to classify peatland types have been unsatisfactory. This classification based on peatland complex types has been developed from a growing understanding of peatland development, and thus it insures that the full range of peatland development types are represented.

Evaluation Criteria

After identifying the peatland features of greatest ecological

Bog Landforms

Featureless Raised Bog
Crested Raised Bog
Ovoid Island
Semi-Circular Raised Bog

Fen Landforms

Featureless Water Track
Patterned Water Track
 Ribbed Fen
 Tear Drop Islands
 Circular Islands
Spring Fen

Figure 7. Preliminary landform classification of patterned peatlands in northern Minnesota

significance, it is necessary to develop criteria to guide the evaluation of the peatland candidate areas. The following criteria were considered in the process of evaluation:

1. RARITY - This criterion includes the presence of rare plants, animals and plant communities, unusual or unique peatland landforms and/or well-expressed peatland complex types.
2. QUALITY - The quality of peatland features depends on several factors.
 - a) Representativeness - This criterion includes how close a plant community or landform corresponds to our idealized concept of typical continental peatland types. This may include the degree of definition or distinctiveness of peatland features.
 - b) Completeness - This criterion includes the degree to which the full range of peatland features are present.
 - c) Extent of Disturbance - This criterion includes the degree to which the features are free from man-caused impacts.
3. VIABILITY AND DEFENSIBILITY - This criterion includes the prospects for long-term survival of the peatland features of significance. Protection efforts are better spent on features that are relatively stable than those that are merely transitory or ephemeral. In addition, peatlands that are less susceptible to disturbance from man-caused impacts are more desirable than vulnerable ones.
4. SCIENTIFIC VALUE - This criterion includes the value of the peatland for current and future research.
5. GEOGRAPHIC REPRESENTATIVENESS - It is desirable that typical

peatland features be protected across their range of variability. This includes an evaluation of the regional, national, or international significance of the peatland area.

Limitations in the Application of the Evaluation Criteria

The most valid application of these criteria to peatland candidate areas requires an extensive knowledge of peatland flora, fauna and community types as well as an understanding of the process of peatland development. European peatlands have been studied for over a century in some areas, and much detailed data have been accumulated to enable a detailed evaluation of ecologically significant peatlands. In contrast, except for a few studies conducted in the 1960s, neither ecological research nor systematic surveys of flora and fauna had been carried out in the large patterned peatlands of Minnesota or, for that matter, anywhere in the United States before the research sponsored by the DNR Peat Program was conducted. Compounding the problem of the lack of data is the fact that the peatland ecosystem with its complex ecological interrelationships remains one of the most poorly understood ecosystems in North America.

Interpretation of the results of the evaluation and the subsequent recommendations of DNR staff should take into account the limitations of the data and the difficulties of conducting research in Minnesota's peatlands:

1. The study area for research in Minnesota peatlands is very large. Although this evaluation was limited to peatlands over 3,000 acres, it still required surveying over 4 million acres of peatland spread out over nearly 30,000 square miles.
2. Access to most of Minnesota's peatlands is very difficult, and

many could only be reached efficiently by helicopter. Thus field work was very time-consuming and expensive.

3. The near total lack of information on these sites required field research to start with basic survey and inventory.
4. A relatively short time period was available for field work and analysis.

Recognizing the large scale of the task at hand and, thus, the limitations inherent in the project, methods other than intensive field survey were sought to complement and supplement field research. For example, because the opportunity for intensive vegetation studies was so limited, advantage was taken of the interrelationship of peatland vegetation with water level and water chemistry and the resulting landform patterns that are identifiable on aerial photos. The ability to correlate vegetation types and potential rare plant locations with various landform types made it possible to identify the most promising sites for field survey work. In this manner, the number of acres that needed field survey were greatly reduced.

However, this method of obtaining data has a limitation. The problem with using peatland landforms as the basis for classification of peatland vegetation is that the patterns are generally confined to bog and fen vegetation types. Thus, certain featureless vegetation types such as swamp forest and swamp shrub types are not dealt with in any detail. However, since the swamp vegetation types are generally associated with shallow peat or wet mineral soil, they would not usually be sought for peatland development; thus, they have not received high priority in this evaluation process.

Application of Evaluation Criteria

Although the evaluation process is an attempt to objectively evaluate the significance of the candidate peatlands, it requires many subjective judgments. The purpose of this section is to show how candidate peatlands were evaluated and what factors and considerations were included in the process. The evaluation that follows is the first attempt at quantifying relative significance.

Each of the candidate peatlands were first evaluated for their significance with respect to peatland features such as plant species, animal species, peatland landforms, and peatland complex types. Secondly, characteristics of the candidate peatlands—viability, defensibility, lack of disturbance, and value for scientific research—were evaluated.

Plant Species. The rare plants found in candidate peatlands were evaluated based on factors that are particularly relevant to peatland systems of Minnesota:

1. the number of townships in which the species is found in Minnesota,
2. the percentage of these township occurrences that occur in patterned peatlands, and
3. the number of sites that are currently partially or completely protected.

Based on this evaluation each species was assigned an "Importance Value" of 0-5 (see table 1). Each peatland was then evaluated based on the importance value of the species that occurred there (see table 2). Up to two additional points were given for a particularly significant occurrence of a rare species population.

TABLE 1
 Determination of Importance Value for Rare Plants Found
 in the Peatland Candidate Areas

	Rarity (1-10)	Dependence on Patterned Peatlands (1-10)	Current Degree of Protection (1-5)	Importance Value (1-5)
<u>Carex exilis</u>	8	10	5	5
<u>Drosera linearis</u>	8	10	5	5
<u>Juncus stygius</u>	8	10	5	5
<u>Drosera anglica</u>	5	10	5	4
<u>Eleocharis rostellata</u>	10	6	4	4
<u>Rhynchospora fusca</u>	8	8	5	4
<u>Xyris montana</u>	9	7	5	4
<u>Nymphaea tetragona</u>	10	6	4	3
<u>Cladium mariscoides</u>	5	5	4	2
<u>Cypripedium arietinum</u>	9	1	3	2
<u>Rhynchospora capillacea</u>	5	2	3	1
<u>Tofieldia glutinosa</u>	4	1	3	1
<u>Triglochin palustris</u>	4	2	3	1
<u>Arethusa bulbosa</u>	1	5	3	1

TABLE 2
Evaluation of Rare Plants Found in the Peatland Candidate Areas

	<u>Carex exilis</u>	<u>Drosera linearis</u>	<u>Juncus stygius</u>	<u>Drosera anglica</u>	<u>Eleocharis rostellata</u>	<u>Rhynchospora fusca</u>	<u>Xyris montana</u>	<u>Nymphaea tetragona</u>	<u>Cladium mariscoides</u>	<u>Cypripedium arietinum</u>	<u>Rhynchospora capillacea</u>	<u>Tofieldia glutinosa</u>	<u>Triglochin palustris</u>	Subtotal	Significant Populations ¹	Total
IMPORTANCE VALUE	5	5	5	4	4	4	4	3	2	2	1	1	1	-	-	-
1. Red Lake	5**	5**	5*	4**		4**	4**		2**					29	13	42
2. Myrtle Lake	5	5	5	4					2*					21	1	22
3. Lost River		5*		4	4				2		1		1	17	1	18
4. N. Black River		5	5	4										14	-	14
5. Sand Lake	5*		5**											10	3	13
6. Mulligan Lake		5		4				3						12	-	12
7. Lost Lake	5		5											10	-	10
8. S. Black River		5		4										9	-	9
9. Pine Creek				4					2	2				8	-	8
10. Nett Lake					4**				2					6	2	8
11. Luxemburg				4										4	-	4
12. E. Rat Root River														0	-	0
13. Norris Camp														0	-	0
14. Oteneagen														0	-	0
15. Sprague Creek														0	-	0
16. Wawina														0	-	0
17. W. Rat Root River														0	-	0
18. Winter Road Lake														0	-	0

¹ *Indicates significant populations (add 1 point)

**Indicates highly significant populations (add 2 points)

Field study on the distribution of peatland bryophytes is continuing during summer 1984. If comparable data are available for each candidate site, the information on rare bryophytes may be used in the final evaluation process.

Animal Species. Since it was not possible to get equivalent data on all candidate areas, animal species will have a minimal role in determining significance of these peatlands. A preliminary evaluation of the candidate peatlands for rare animal species is shown in table 3. Red Lake is the peatland in which the most work has been conducted, but even there only a fraction of the area has been surveyed. It is probable that the peatlands in the northwest part of the state, which have large open fen areas, may also provide habitat for wet prairie species such as the greater sandhill crane, Wilson's phalarope, short-eared owl, and yellow rail.

Peatland Landforms. The evaluation of landforms for each candidate area is shown in table 4. Evaluation of landforms was initially based on the assessment of the various features evident on black-and-white infra-red aerial photographs at a scale of 1:90,000. In 1983 and 1984, color infra-red aerial photographs at a scale of 1:60,000, which show much greater detail, became available for evaluation. This information was supplemented by observations in the field.

The factors that were applied in the evaluation of both fen and bog landform features include:

1. areal extent,
2. pattern distinction, both from aerial photos and field observations, and
3. completeness of the range of features.

TABLE 3
 Evaluation of Rare Animals Found in the
 Peatland Candidate Areas

Level of Data	E. Timber Wolf ¹	N. Bog Lemming	G. Sandhill Crane	Sharp-tailed Sparrow	Short-eared Owl	Wilson's Phalarope	Yellow Rail	Bog Copper Butterfly	Total
1. Red Lake	1		1	1	1	1	1		6
2. Mulligan Lake	1		1			1			3
3. Myrtle Lake	1							1	2
4. Sand Lake	2								2
5. Lost River	1								1
6. S. Black River	1								1
7. Sprague Creek		*	*						1
8. Luxemburg			*						1/2
9. Norris Camp			*						1/2
10. Pine Creek			*						1/2
11. Winter Road Lake			*						1/2
12. E. Rat Root River									0
13. Lost Lake									0
14. Nett Lake									0
15. N. Black River									0
16. Oteneagen									0
17. Wawina									0
18. W. Rat Root River									0

¹ 1 point for Wolf Management Zone 3
 2 points for Wolf Management Zone 2
 * found in surrounding area, may also occur in peatland (1/2 point)

TABLE 4
Evaluation of Landforms in the Peatland Candidate Areas

	LANDFORMS											Total
	FEN					BOG					Sub Total	
	Water Track (0-2)	Ribbed Fen (0-10)	Tear Drop Islands (0-5)	Circular Islands (0-3)	Spring Fen (0-5)	Sub Total	Raised Bog (0-5)	Bog Drain (0-5)	Ovoid Island (0-5)	Schlenke (0-3)		
1. Red Lake	2	10	5	3		20	4	4	5		13	33
2. Myrtle Lake	2	8	1	1		12	5	5	1	2	13	25
3. Lost River	1	8	2		5	16	4	2		3	9	25
4. N. Black River	2	4				6	3	4	4		11	17
5. S. Black River	1	2				3	4	3			7	10
6. Mulligan Lake	1	7	1			9					0	9
7. Sand Lake	1	5				6	2				2	8
8. Lost Lake	1	3				4	2	2			4	8
9. Pine Creek		3			4	7					0	7
10. Winter Road Lake	1	4				5					0	5
11. E. Rat Root River	1					1	3				3	4
12. Luxemborg	1	3				4					0	4
13. Nett Lake					4	4					0	4
14. Oteneagen						0	4				4	4
15. Wawina	1					1	2				2	3
16. Norris Camp	1	1				2					0	2
17. W. Rat Root River	1					1	1				1	2
18. Sprague Creek					1	1					0	1

Peatland Complex Types. The peatlands were evaluated according to the degree to which they exemplify the various peatland complex types. The best example of each type was given a value of 5, others were rated from 1 to 4. Table 5 ranks the peatland candidate areas by significance under each peatland type.

The second part of the evaluation process examines general characteristics that influence the evaluation of the ecological significance of a candidate area. These include viability, defensibility, lack of disturbance and value for scientific research. Results of this evaluation are shown in table 6.

Viability. This category is intended to give an indication of the long-term stability of the peatland and the degree to which it can be securely protected. Although peatland succession is poorly understood, the following factors were considered influential in providing a secure habitat or environment for the peatland features of interest:

1. size of peatland - The assumption is that larger peatlands are more stable and less likely to undergo significant changes in a short period of time.
2. complexity or diversity of habitats - It is less likely that rare species or plant communities will be displaced if a variety of habitat types exist.

Defensibility. Defensibility is an indication of how conducive the physical peatland setting is to successful and feasible management for protection. The factors considered in this evaluation include:

1. hydrologic isolation of peatland area - According to our current understanding of peatland hydrology, peatlands that are completely confined by mineral soil are much more assured of

TABLE 5
Evaluation of Peatland Complex Types in the Candidate Areas

	Peatland Complex Types*											Total
	1	2	3	4	5	6	7	8	9	10	11	
N. Black River		5**	5	4								14
Lost River							2	5			5	12
Red Lake									5	5		10
Sand Lake			4			2						6
Myrtle Lake				5								5
Mulligan Lake						5						5
Lost Lake					5							5
Pine Creek							5					5
Oteneagen	4											4
S. Black River								4				4
Winter Road Lake						4						4
E. Rat Root River					4							4
Nett Lake							4					4
Wawina			3									3
Luxemberg						3						3
Norris Camp						3						3
Sprague Creek							3					3
W. Rat Root River			2									2

* See Appendix D

** Watershed types are rated from 1 (lowest) to 5 (highest).

TABLE 6
Evaluation of Peatland Characteristics of the Candidate Areas

	Viability	Defensibility	Lack of Disturbance	Scientific Research Value
1. Myrtle Lake	8*	9	10	10
2. Red Lake	10	8	7	10
3. Sand Lake	7	9	9	7
4. Mulligan Lake	7	9	10	5
5. N. Black River	8	7	9	7
6. Pine Creek	7	9	10	5
7. Lost Lake	5	9	10	5
8. Winter Road Lake	7	9	6	6
9. E. Rat Root River	6	8	10	2
10. Sprague Creek	7	9	5	4
11. Lost River	8	1	9	7
12. S. Black River	7	3	10	5
13. Nett Lake	1	8	10	5
14. Wawina	5	2	5	5
15. Oteneagen	6	7	4	4
16. Luxemburg	3	10	3	2
17. Norris Camp	4	10	1	2
18. W. Rat Root River	3	6	3	4

* Peatlands are rated for these characteristics from 1 (lowest) to 10 (highest).

protection than those situated in the middle of an expanse of peatland.

2. location in relation to peatland watershed - Since hydrologic impacts are much greater downstream than upstream, features that occur near the source of the peatland watershed are more secure than those downslope.

Scientific Value. The scientific value assigned to each candidate peatland is based on the following:

1. past research activity,
2. current or proposed research,
3. potential of an area for answering future research questions,
and
4. accessibility and proximity to research institutions.

Lack of Disturbance. Although disturbance has been included to some extent in the evaluation of peatland features, it is a very important consideration and should actually be evaluated on its own. This category measures the extent to which significant pristine areas still exist in each candidate peatland.

Summary of Results

The 18 candidate peatlands were evaluated based on the significance of peatland features and on peatland characteristics. Table 7 summarizes the preliminary values assigned in each category. Although the peatlands are arranged according to total points, caution should be used in interpreting the results of this table. It is very difficult and artificial to characterize the ecological significance of a peatland with a single value. The total point values are shown only to provide a relative ranking and to give an indication of the validity of the

TABLE 7
Summary of Evaluation of Peatland Candidate Areas

	Peatland Features					Peatland Characteristics					Total	
	Plant	Animal	Fen Landform	Bog Landform	Peatland Types	Subtotal	Viability	Defensibility	Lack of Disturbance	Scientific Research Value		Subtotal
1. Red Lake	42	6	20	13	20	101	10	8	7	10	35	137
2. Myrtle Lake	22	2	12	13	10	59	8	9	10	10	37	96
3. Lost River	18	1	16	9	24	68	8	1	9	7	25	93
4. N. Black River	14	0	6	11	28	59	8	7	9	7	31	90
5. Sand Lake	13	2	6	2	12	35	7	9	9	7	32	67
6. Mulligan Lake	12	3	9	0	10	34	7	9	10	5	31	65
7. Lost Lake	10	0	4	4	10	28	5	9	10	5	29	57
8. Pine Creek	8	.5	7	0	10	25.5	7	9	10	5	31	56.5
9. S. Black River	9	1	3	7	8	28	7	3	10	5	25	53
10. Nett Lake	6	0	4	0	8	18	1	8	10	5	24	42
11. Winter Road Lake	0	.5	5	0	8	13.5	7	9	6	6	28	41.5
12. E. Rat Root River	0	0	1	3	8	12	6	8	10	2	26	38
13. Sprague Creek	0	1	1	0	6	8	7	9	5	4	25	33
14. Oteneagen	0	0	0	4	8	12	6	7	4	4	21	33
15. Luxemburg	4	.5	4	0	6	14.5	3	10	3	2	18	32.5
16. Wawina	0	0	1	2	6	9	5	2	5	5	17	26
17. Norris Camp	0	.5	2	0	6	8.5	4	10	1	2	17	25.5
18. W. Rat Root River	0	0	1	0	4	5	3	6	3	4	16	21

evaluation process. An assessment as to the relative weight of the factors being considered or the accuracy with which an individual site or parameter is being quantified still must be conducted. In addition, the process, criteria, and ratings will be subject to change as the work is reviewed and field work continues. However, the results obtained so far appear to correspond to an intuitive perception of the relative significance of the candidate peatlands.*

Based on this preliminary evaluation, the peatlands can be grouped into the following categories:

1. National or International Significance

This includes those peatlands that are ranked significantly above all others and best represent the most significant peatlands found in the North American continental peatland ecosystem.

Red Lake

Myrtle Lake

Lost River

North Black River

It is apparent from the evaluation that the Red Lake peatland is the most significant peatland in the state. It is one of the largest and most complex and diverse peatlands of the continental peatland ecosystem. Comparable peatlands are not known from Europe

*Because of the high ratings of the Red Lake Peatland relative to most of the other peatlands, many of the peatlands became skewed towards the low end of the scale. This unfairly represents the peatlands at the lower end of the scale as insignificant. It is also important to note that this evaluation includes only a select group, the 18 candidate areas, of Minnesota's peatland complexes greater than 3,000 acres in size. If data and time permitted, a more accurate reflection of the relative ecological significance of Minnesota's peatland complexes would include an evaluation of all such complexes. Also, it may be helpful to do an evaluation of peatlands other than the candidate peatlands so that a comparison of significance can be made.

or Asia. Only the Hudson Bay Lowlands may have peatlands of similar stature, and these are of the northern non-forested peatland type.

Both the Sand Lake and Mulligan Lake peatlands are also rated as highly significant. In the past, they have been ranked with the first group as two of the top six peatlands in the state. However, since they are currently numerically closer to Pine Creek and South Black River, they will not be included as nationally significant at this time.

2. Regional Significance - Best Examples of Peatland Complex Types

This group includes those peatlands that best exemplify the range of peatland types that occur within Minnesota and the surrounding areas. The classification of peatland complex types was used as a tool to ensure that the range of peatland types in the state are represented. The peatland candidate areas that best represent the complex types are listed either in Group 1 or below:

Sand Lake - type 3

Mulligan Lake - type 6

Lost Lake - type 5

Pine Creek - type 7

Oteneagen - type 1 (It is felt that additional work should be carried out on type 1. This type is relatively common in Minnesota. Oteneagen was the only peatland of this type considered in this evaluation. Before a decision is made about which example(s) are to be protected, a more comprehensive review of all type 1 peatlands should be conducted.

3. Regional Significance - Geographic Representation

This group is significant because it represents the range in ecological variability of peatlands in this region of North America. Subtle climatic differences in the peatlands can range

from the conifer forest in the northeast to prairie in the west. Many of these peatlands represent the peripheral limits of certain peatland complex types or species occurrences.

Currently there are no geographic peatland regions identified for Minnesota or this region of North America. The Minnesota landscape regions are not directly applicable to peatland regions with the possible exception of the Agassiz Lowlands and the Tamarack Lowlands. An assessment of peatland regions of the state will be explored in the future.

Because many of the peatland complex types are confined to the Agassiz Lowlands, only three peatland complex types occur extensively enough in Minnesota to require consideration for geographic variability. Peatlands that are significant because of their geographic representativeness include:

Wawina - southernmost example of type 3

Nett Lake - easternmost example of type 7

E. Rat Root River - the Agassiz Lowland representative of type 5

Types 1 and 6 are found in peatlands smaller than 3,000 acres and should be added to this group.

4. State Significance

These peatlands fall into peatland types of which the best example has already been identified in a previous group. These peatlands are still significant and represent the second or third best example of a particular peatland complex type.

S. Black River - type 8

Winter Road Lake - type 6

Sprague Creek - type 7

Luxemberg - type 6

W. Rat Root River - type 3

One peatland, Norris Camp, is not included in the group above. It is of a type that is already represented by three examples. In addition, it occurs in an area where several other peatlands of similar type are found and therefore does not contribute to geographic representativeness.

MANAGEMENT OF PEATLAND PROTECTION CANDIDATE AREAS

Peatland Management Areas

Unlike terrestrial ecosystems, adequate long-term protection of unique peatland features cannot be achieved merely by restricting disturbance to the immediate area in which the features occur. Protection of peatland ecosystems is much more complicated because of the intimate interdependence between the features and the surrounding hydrology. The processes that perpetuate the peatland ecosystem, as well as plant communities and rare species, are extremely sensitive to changes in water levels and water chemistry. Even slight alteration in the surrounding water quantity and quality can cause significant change in the vegetation. Minnesota's patterned peatlands resemble riverine systems in that water is constantly flowing across a very gently sloped landscape. Consequently features in the center of a peatland are particularly vulnerable to hydrological disruption occurring upstream or laterally.

Adequate protection of significant peatland features requires two types of protection. First, the peatland features must be protected directly from onsite physical disturbance. Secondly, the hydrology of the surrounding peatland area must be sufficiently protected in order to maintain the ecological integrity of the features under special protection.

To accommodate this two level-management approach, the Task Force on Peatlands of Special Interest defined two management zones, a core preservation zone and a watershed protection zone, now referred to as core area and watershed protection area. The areas were defined as

follows:

CORE AREA - The area within each candidate peatland area that contains the features of greatest ecological significance. Management guidelines within this area are concerned with onsite disturbance.

WATERSHED PROTECTION AREA - The peatland area surrounding the core area that is the buffer required to maintain the ecological integrity of the core area. Management guidelines in this area are confined to those activities that may have a significant hydrological impact, such as ditching and peat mining.

The preliminary boundaries of the watershed protection areas have been drawn, based on the data available and on educated assumptions, to indicate the area within which alterations of the peatland hydrology should be excluded. Much is still not known regarding the hydrology of large contiguous peatlands or the exact extent to which impacts may occur. Therefore, the boundaries of those watershed protection areas in which the boundary is marked by mineral soil uplands, shallow peat, or rivers could be drawn with more confidence than those watershed boundaries drawn for candidate areas that occur in a great expanse of peatland.

This report presents the preliminary boundaries of the core area and watershed protection area within each of the candidate areas (see Appendix F) for review and comment by resource managers and other concerned individuals so that the boundaries may be critically reviewed and the impacts on all natural resource management activities can be assessed. Table 8 shows an estimate of the acreage within the core

TABLE 8
 Acreage of Core and Watershed Protection Areas
 in Candidate Peatlands

	Core Area	Watershed Protection Area	Total
Red Lake	83,000	150,800	233,800
Lost River	8,800	53,200	62,000
Myrtle Lake	23,000	13,300	36,300
N. Black River	8,700	32,300	41,000
Mulligan Lake	4,400	14,700	19,100
Winter Road Lake	3,400	14,600	18,000
S. Black River	5,700	9,900	15,600
Sand Lake	3,400	8,600	12,000
Sprague Creek	600	11,800	12,400
E. Rat Root River	2,200	7,600	9,800
Oteneagen	3,800	5,500	9,300
Wawina	3,600	5,000	8,600
Lost Lake	1,600	6,300	7,900
Norris Camp	1,600	4,700	6,300
W. Rat Root River	1,000	2,600	3,600
Luxemberg	700	2,500	3,200
Pine Creek	800	1,400	2,200
Nett Lake	300	1,100	1,400
TOTALS	156,600	345,900	502,500

areas and the watershed protection areas for each of the 18 candidate peatlands. Some peatlands have more than one watershed protection area, and some watershed protection areas contain more than one core area.

Management Guidelines

One of the primary objectives of the peatland protection program is to assess the minimum restrictions that are necessary to adequately protect ecologically significant peatlands. Activities that might take place in Minnesota's peatlands can affect a peatland in several ways. The impact of these activities can be detected by alteration or elimination of ground vegetation and tree cover, compression or disturbance of the peat surface, alteration of water level and flow, or alteration of the water chemistry.

The ultimate assessment of significance of the impacts will depend on several factors including:

- the areal extent of disturbance,
- the sensitivity of the peatland feature being protected, and
- the location of the disturbance relative to sensitive features.

Table 9 shows a list of the activities that may occur in peatlands and a very preliminary assessment of the potential of these activities for producing significant impacts on peatlands. This table is necessarily subjective. The estimation of the level of impact is provided only for discussion purposes in order to give an indication of the activities that are of greatest concern and may require restriction. The assessment of impacts will be dealt with in greater detail in the final report.

Activities with disturbance levels of 2 to 5 are those that are most likely to be restricted from core areas. Activities that produce a

TABLE 9
Preliminary Assessment of the Level of Disturbance Caused
by Certain Activities in Peatlands

	LEVEL OF DISTURBANCE (increasing impact →)					Comments
	1	2	3	4	5	
NON-MOTORIZED ACTIVITIES						
1. hiking, canoeing, etc.	*					a
2. hunting, trapping	*					a
3. camping	X	*				a
MOTORIZED ACTIVITIES						
4. snowmobiling	X	*				b
5. 3-wheelers	X	*				c
6. large vehicles (logging skidders, drilling rigs)	X	X	*	*		c,d
MANAGEMENT ACTIVITIES						
<u>Wildlife Habitat Improvement</u>						
7. prescribed burning	X	X	?	?		
8. shearing	X	X	X	*		d,e
9. dugouts	X	X	X	*		e
10. impoundments	X	X	X	X	*	e
<u>Timber Management</u>						
11. selective cutting (Christmas tree or sanitation cutting)	X	X	X			
12. mechanical logging	X	X	X	*		d,e
13. mechanical site preparation	X	X	X	X		
14. herbicides, pesticides	X					
15. fertilizers	X	X	X	X		
DEVELOPMENT ACTIVITIES						
16. geophysical exploration (brush cutting)	X	X	*			d
17. exploration drilling	X	X	X	*		d
18. powerline R-O-W	X	X	X	X		
19. underground utility corridors	X	X	X	X	*	f
20. ditching	X	X	X	X	*	e,f
21. land clearing	X	X	X	X	*	e,f
22. agriculture	X	X	X	X	*	e,f
23. new winter roads	X	X	*			f
24. new permanent roads	X	X	X	X	X	
25. peat mining	X	X	X	X	*	e
26. mineral mining—underground (access from outside peatland)						
27. mineral mining—surface	X	X	X	X	X	

KEY

- X - significant disturbance would occur at this level
- * - disturbance at this level could be moderated or negated if certain constraints are imposed (see comments)
- ? - degree of disturbance uncertain

Comments:

- a. Disturbance can be minimized if activity is limited.
- b. Disturbance can be eliminated if adequate snow cover exists.
- c. Disturbance can be minimized if activity is confined to existing trails.
- d. Disturbance can be minimized if activity is confined during winter months.
- e. Disturbance may be minimized if areal extent is very small.
- f. Disturbance may be minimized depending on location.

disturbance level of 1 would produce a significant impact only in very small and sensitive peatlands and are not of concern in these patterned peatlands of 3,000 acres or greater. Activities with a disturbance rating of 5 are those activities that are particularly disruptive to peatland hydrology and would most likely be excluded from the watershed protection areas as well as from the core areas.

As the "comments" in Table 9 indicate, impacts can often be greatly minimized or negated under certain conditions. For example, confining certain activities to the winter months, confining activities to existing trails, and limiting the areal extent of an activity can all greatly reduce the extent of impacts.

There are several options for the application of these management guidelines. First, the activities allowed within a core and watershed protection area could be determined and applied uniformly to all peatlands. Most probably the management guidelines for a core would be more restrictive than those for a watershed protection area. However, there may be cases where the guidelines for the core and the watershed protection area could be the same; that is, the entire area would be managed as a "core" or as a "watershed protection area."

Second, the restrictions that would be imposed could vary from core to core depending on such factors as (1) the ecological significance of the area, (2) its sensitivity to disturbance, and (3) the purpose for which it is being protected. This approach may be appropriate because certain features, such as rare plant populations and ribbed fens, and unique natural areas require greater protection than macro-features. Certain large landforms, for example, have a uniform vegetation type extending for miles and are more resistant to impacts.

The third option, which is the most complex, would allow individual core areas to be subdivided into units in which activities would be restricted depending on the sensitivity of individual features within the core area.

The final decision on the extent to which these management guidelines will be implemented in the the candidate areas should be based on the considerations described above and the final determination of the appropriate balance between protection and development of Minnesota's peatland resources.

POTENTIAL IMPACTS OF PEATLAND PROTECTION ON NATURAL RESOURCES MANAGEMENT

Introduction

Peatlands have a variety of resource values. They are currently managed for some of their resources and have the potential to be developed for other uses. These resources include the peat resource itself with its potential value for energy, horticultural products, and industrial chemicals; wildlife resources, forest resources, and mineral resources. Protection of the peatland candidate areas will have an effect on these resources and their management. The extent of the impact will vary from site to site depending on the specific resource, and its existing and potential use. Another factor that influences both the protection and the use of the candidate areas is the ownership status of the lands.

The following sections will examine in a general way the possible impacts of protection on these other resources and their management. Some of the relevant data (e.g. land ownership, commercial timber, and mineral potential) have been mapped for three of the areas (see Appendix F). Similar sets of maps for all the areas will be included in the final report. Data sheets for all of the areas are also provided (see Appendix E). Collection of more detailed data, further analysis, and review by resource managers and developers during the next few months will allow a more comprehensive assessment of possible conflicts. The issues raised by this assessment can then be considered during the formulation of the final recommendations for the protection and management of the candidate areas.

Land Ownership within Peatland Protection Candidate Areas

The lands lying within the peatland protection candidate areas are made up of state, federal, and private ownerships with the large majority falling into various categories of state ownership (see table 10). A breakdown of the ownership for each candidate area is shown in Table 11.

Consolidated Conservation Lands. Consolidated Conservation Areas (Con-Con) make up the largest percentage of state ownership. Mostly during the 1930s, the state acquired these lands through payments to the counties, to save the counties from bankruptcy due to ill-advised agricultural drainage projects. These lands are primarily dedicated to conservation uses. Revenues from the sale or use of these lands are split between the state and the county in which the lands are located.

Con-Con lands are administered by the Commissioner of Natural Resources and if dedicated as Wildlife Management Areas (WMA's) or State Forests are more secure from sale and development than if undedicated due to the public recognition afforded them. None of the Con-Con lands in the candidate areas are dedicated for WMA's, and 50% are within State Forests.

School Trust Lands. School Trust Lands are lands that were given to the state by the federal government through land grants. These lands, which include School, Indemnity School, Swamp, and Internal Improvement lands, form the Permanent School Fund. Revenues from the sale or use of the lands are deposited in the Permanent School Fund for the support of the common schools of the state.

The DNR goal for the management of school trust lands is to secure the maximum long-term economic return from the lands consistent with

TABLE 10
 Summary of Land Ownership in Peatland Candidate Areas

	OWNERSHIP	
	(%)	(acres)
STATE		
Consolidated Conservation	57	283,800
School Trust	26	131,440
Volstead	1	7,240
Acquired	<0.1	240
COUNTY		
Tax-forfeited	2	11,120
Forest	1	7,000
FEDERAL	9	43,080
PRIVATE	4	17,680
TOTAL	100.1	501,600

TABLE 11
Land Ownership in Peatland Candidate Areas

	Total Acres (CA & WPA)	OWNERSHIP				
		State		County	Federal	Private
		Total	(Trust Other)			
W. Rat Root River	3,600	100%	(100% -)	-	-	-
Myrtle Lake	36,300	99%	(97% 2%)	2%	-	1%
Red Lake	233,800	94%	(- 94%)	-	4%	2%
Sprague Creek	12,400	97%	(6% 91%)	-	-	3%
Pine Creek	2,200	96%	(89% 7%)	-	-	4%
S. Black River	15,600	96%	(2% 94%)	1%	-	3%
Lost River	62,000	93%	(75% 18%)	2%	-	5%
Oteneagen	9,300	86%	(86% -)	-	7%	6%
Norris Camp	6,300	86%	(- 86%)	-	3%	12%
Mulligan Lake	19,100	84%	(- 84%)	-	14%	3%
E. Rat Root River	9,800	79%	(- 79%)	4%	14%	2%
Sand Lake	12,000	77%	(77% -)	1%	15%	6%
Luxemberg	3,200	73%	(- 73%)	-	26%	1%
Winter Road Lake	18,000	69%	(- 69%)	-	25%	6%
N. Black River	41,000	33%	(5% 28%)	10%	51%	7%
Lost Lake	7,900	28%	(28% -)	57%	-	15%
Wawina	8,600	1%	(1% -)	81%	-	17%
Nett Lake	1,400	0%	(- -)	3%	88%	9%

sound natural resource conservation and management principles and specific policy guidance as provided in state law. When new developments on school trust lands are proposed that would restrict or prohibit income to the Permanent School Fund, the DNR's policy is to compensate the Fund at the time of designation of the management unit or establishment of the activity.

Volstead Lands. Volstead lands are lands that the state purchased from the federal government in 1963. In the early 1900s the state established liens against these lands to assist with the cost of drainage. These lands are similar to "acquired" lands in that they were purchased and have no restriction on their sale or use unless they are placed in management units of the Outdoor Recreation System.

Acquired Lands. Acquired lands are lands that the state owns through gift, purchase, land exchange, transfer of title from local governments, and condemnation. These lands, like Volstead lands, have no restrictions on their sale or use unless they are placed within a management unit of the Outdoor Recreation System. They were usually acquired for some strategic resource purpose and are part of a management unit.

Tax-forfeited Lands. Tax-forfeited lands are owned in fee title by the state but administered by the county and held in trust for its taxing districts. Revenues from the sale or use of these lands belong to the county. The Commissioner of the DNR has the authority to review tax-forfeited lands that the county wishes to sell and to withhold from sale those lands that are most suitable for conservation purposes. These lands are less vulnerable to disposal if the county places them in some kind of retention status such as a county memorial forest or a

"recreation area".

Federal Lands. Federal ownership comprises approximately 8.6% of land in the protection areas. The following federal agencies administer the lands in these areas:

Bureau of Land Management	20,440 acres (all in N. Black River)
Bureau of Indian Affairs	15,840
Leased to state (LUP)	3,000
National Forest	2,400
Voyageurs National Park	1,400

The DNR may propose land exchanges with the federal agencies involved or negotiate an agreement of understanding concerning management and protection of those lands in federal ownership. The North Black River peatland complex contains extensive federal land holdings administered by the Bureau of Land Management (BLM). In the last three years, the BLM has been divesting itself of lands it administers east of the Mississippi through transfers to other public agencies. The BLM has expressed a willingness to transfer lands in North Black River peatland to the State of Minnesota to be managed for "recreational purposes" as defined in the Federal Land Management Planning Act of 1976 (90 STAT. 2758).

Federal Land Utilization Project (LUP) lands are leased to the state and are managed by the Division of Fish and Wildlife for wildlife, forest resources, and recreation. The division has requested the transfer of these lands to the DNR for inclusion under the wildlife management area program.

Private Lands. Private ownership comprises approximately 3.6% of lands in the protection areas. If the designated areas become part of the Outdoor Recreation System, the DNR would have the authority to acquire private lands within the described boundaries of the areas by

gift, purchase, or land exchange.

Summary. The DNR administers about 84% of the land within the candidate areas. The Con-Con, Volstead, and Acquired lands, which comprise about 69% of the state-owned lands, could be set aside through legislation or possibly through a commissioner's order. The School Trust lands, which comprise about 31% of the state-owned lands, have constitutional restrictions on their sale and use and will therefore require special consideration prior to any designation for protection.

Management of Peat Resources

Peat Resources and Use Options. Minnesota contains approximately 6 million acres of peatland, of which about 50% are state-owned or administered. By statute, the state can lease but not sell peatlands in state ownership. (Minn. Stat. 1982, Sec. 92.461 states that "all lands now or hereafter owned by the state which are chiefly valuable by reason of deposits of peat in commercial quantities are hereby withdrawn from sale.) The state has leased small amounts of peatland for development of the resource for energy, horticultural use, and agriculture. Potential additional uses include development for industrial chemicals, bioenergy crops, intensive forest management, and sewage treatment. While not all of these uses require the removal of the peat soils, they would require manipulation of the water levels and alteration of the vegetation.

To develop a peatland for a specific use requires matching the resource characteristics with the requirements of the particular use. The location, areal extent, and depth of the deposit, as well as the physical and chemical properties of the peat are the first criteria

considered. If an adequate resource is present, economic factors are examined. These factors can include a determination of potential markets for the product, transport costs, and access.

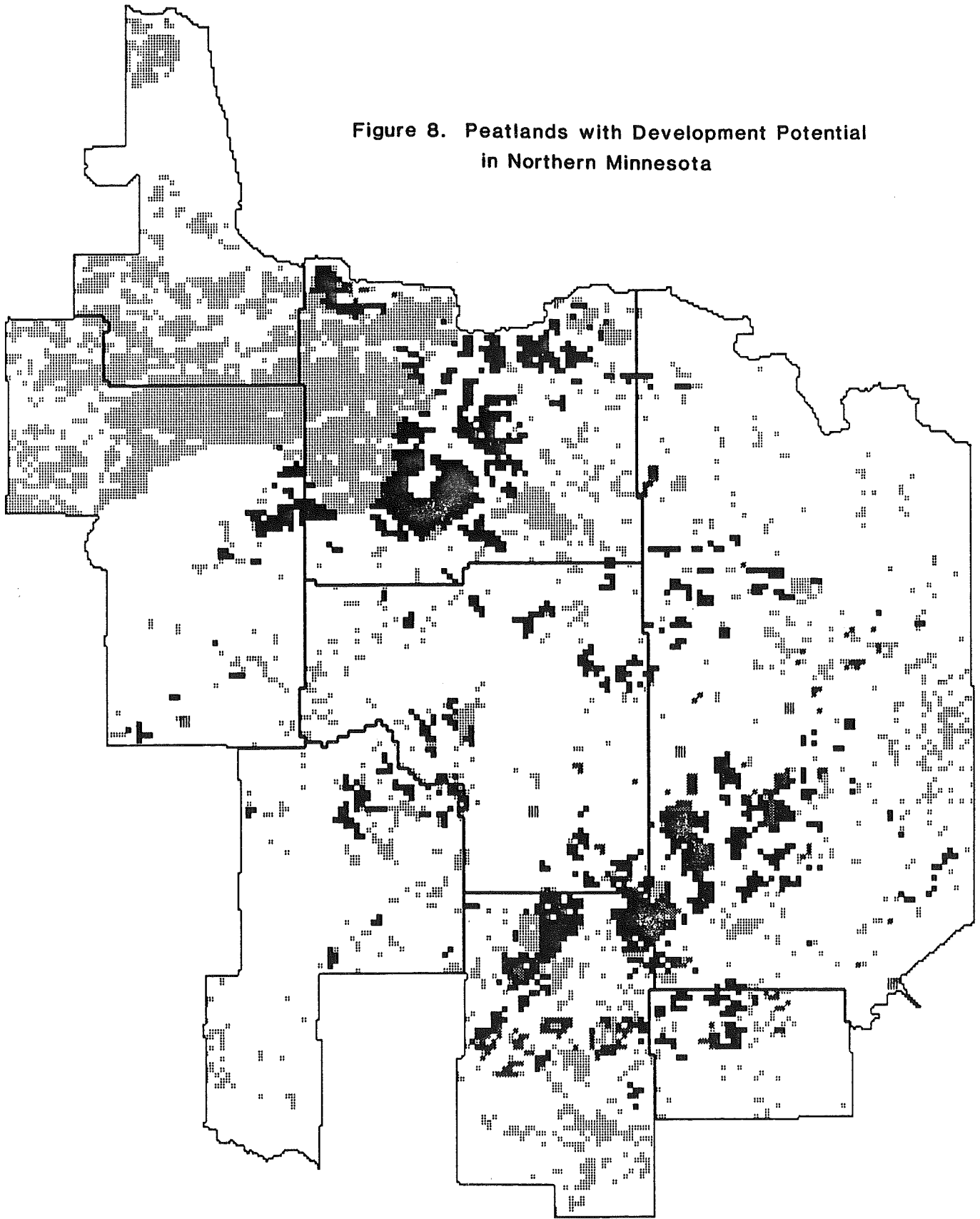
Effect of Protection on Peatland Development. The effect of peatland protection on peat development depends on the location of the proposed development within the peatland. The protection of the core areas would preclude development for both extractive and nonextractive uses since they require drainage and alteration of the vegetation.

In the watershed protection areas, development may be possible with some restrictions on the drainage of the peatland and the location of the development with regard to the core area. For example, it may be possible to have some small-scale development operation in a watershed protection area that is downstream from the core.

The policy of the Minnesota Peat Program has been to manage the state's peatlands for a variety of uses, including protection. Towards this objective, the Peat Program developed a preliminary model to identify peatlands with development potential, especially for energy, in an eight-county area of northern Minnesota. The model considered the areal extent of the peat resource, ownership, access to the peatlands, distance from six northern Minnesota cities along paved roads, and the locations of the protection areas. The modelling effort illustrates that even if the protection areas are totally excluded from peat mining, a large resource base on publicly-owned lands remains for potential development (see fig. 8).

Protection may limit or exclude development in some peatlands, but it is consistent with the current management objectives for a variety of uses of Minnesota's peat resource. In addition, based on the current

Figure 8. Peatlands with Development Potential
in Northern Minnesota



	SYMBOL	COUNT	PERCENT	ACRES	LEGEND
	1	95	0.1	15200.0	CITIES: BEMIDJI, DULUTH, GRAND RAPIDS, HIBBING, INTERNATIONAL FALLS, VIRGINIA
	2	6334	6.8	1013440.0	STATE AVAILABLE
	3	704	0.8	112640.0	PRIVATE
	4	13445	14.5	2151200.0	OTHER PEATLANDS
	5	72260	77.8	11561600.0	MINERAL OR WATER

trends in the possible development of peatlands, there are no major conflicts between development of some peatlands and protection of others. For the most part, the present peat development pressure is focused on areas that do not include the candidate areas, because these areas are too distant from markets to be considered for current exploitation.

Management of Timber Resources

Timber Resources in Peatlands. Lowland conifers such as black spruce, tamarack, and northern white cedar are the predominant timber resources in peatlands. Based on commercial value, black spruce is the most important of the three species because of its long fibers and bleachability, which are sought after in the manufacture of high-quality printing papers. Tamarack, though not as abundant or valuable as black spruce, has desirable characteristics for the manufacture of high-strength chemical pulps and papers. The commercial value of white cedar lies in its importance for local speciality products, such as decay-resistant fence posts and lumber. This species is also valuable as winter cover for deer.

Detailed estimates of the timbered acreage in the peatland protection candidate areas are available for only three of the areas at this time. The DNR's Division of Forestry is conducting an intensive forest inventory of the 18 peatland complexes as part of the Phase II inventory. Inventory information for all of the areas should be available by August 15, 1984 and will allow for a more complete analysis of impacts.

Effect of Protection on Commercial Timber Management. The significance to the local economies relying upon these tree species, will depend upon the amount of commercial timber included in the candidate areas and the kind of protection they are assigned. Protection of core areas that would prohibit alteration of the vegetation and hydrology of the area would preclude harvesting timber. However, since features that need total protection in a core area are often associated with poor sites for timber production, it is likely that protection of these areas would not have a significant impact on the availability of timber from the core areas. In some cases protection of a core area might prevent access to merchantable timber and productive forest land outside of the core area. This impact will be assessed during the review of candidate areas by forestry field staff.

Protection of watershed protection areas would probably not prohibit timber harvesting. Since timber harvest and hauling of wood products is conducted in the winter and reforestation of harvested peatland areas relies heavily on natural seeding from nearby seed sources or direct seeding from helicopters, none of these timber management activities should have a significant impact on watershed protection areas.

Effect of Protection on Administrative Activities. Twelve of the candidate areas occur wholly or partially within State Forests. In addition, two of the candidate areas (Sprague Creek and Pine Creek) lie within the proposed Lost River State Forest (MDNR Div. of Forestry 1983). If an area is to be administered by the Division of Forestry, special management guidelines may have to be developed to ensure protection. Designation of peatland areas in state forests as units of the

Outdoor Recreation System would also require specific management actions. Rules (except for SNA's) would have to be formulated, adopted, and enforced. The rules would have to be posted at appropriate locations and area boundaries signed, in some cases. Some regulatory actions such as limiting access may require additional demands on the time of DNR personnel.

The Division of Forestry has adopted a planning process, in cooperation with other Divisions of the DNR, to make land management decisions as part of its unit planning process. The unit planning process could be used to incorporate management guidelines for the protection of the candidate areas. This process will take into account any peatland designations that occur before this process is complete.

Management of Wildlife Resources

Wildlife Resources and Management in Peatlands. Minnesota's peatlands are important to the ecology of a variety of wildlife species. Studies indicate that at least 20 mammals and 27 game and nongame bird species are partially or wholly dependent on various peatlands habitats. Peatland habitat is critical to the survival of certain wildlife species that are specially adapted and restricted to the peatland environment. Even for many wildlife species not solely dependent on peatlands, these areas provide crucial habitat during certain periods of the year.

Of the 18 peatland candidate areas, management specifically for wildlife purposes is active in four of the areas. Two of the candidate areas, Red Lake and Mulligan Lake, lie wholly or partially within the Red Lake Wildlife Management Area. The other two peatlands, Winter Road Lake and Norris Camp, contain federal lands leased to the state for

wildlife conservation purposes. Little, if any, management specifically for wildlife occurs on the other 14 areas.

Most wildlife management techniques are aimed at setting back plant community succession to earlier stages that benefit many wildlife species. Because of the slow successional rate of peatlands communities and the difficulty of converting peatland types to more productive wildlife habitat, major manipulation of peatland habitat has not been implemented. The inaccessibility of the peatlands and the low numbers of game species limit hunting and trapping opportunities. For these reasons, wildlife management on these areas has generally been limited to the periphery of these peatlands. Management of peatland interiors has been directed to maintaining these areas in an undisturbed natural state.

Current management activities on peatlands (primarily the periphery) include timber harvesting, shearing, road development, management of deer wintering areas, and construction of impoundments for waterfowl production. Logging is used to improve timber stand diversity and age-class composition. Priority is given to regenerating over-mature stands on upland "islands" and peatland edges. Shearing is done on willow and off-site aspen to improve habitat for moose and sharp-tailed grouse. Roads are constructed to provide access for logging activities and public hunting and trapping. Management of deer yards involves the protection of existing cover, attempts to regenerate deteriorating stands, and cutting of adjacent deciduous stands to provide felled browse and regenerating sprouts for deer. No impoundments have been constructed in any of the four peatlands. Furthermore, the potential for creating new impoundments is very limited because of

inaccessibility and low waterfowl productivity. One impoundment site is located just west of the Mulligan Lake peatlands on the Roseau River and probably affects the hydrology of the peatland.

A large portion of the Red Lake peatland was recently deleted from the Red Lake WMA in the 10-year master plan developed for this unit. The limited wildlife management potential and the inaccessibility of this area were the major reasons for this deletion.

Effect of Protection on Wildlife Management. The effect of protection of these four candidate areas on current wildlife management activities and public use would depend on the degree of protection implemented. Full protection of the core areas would probably have little effect. Little, if any, disturbance on core areas presently occurs from wildlife management, and public use is already severely limited by inaccessibility. The main wildlife objective in the core areas is to maintain these areas in an undisturbed state.

Some wildlife management activities (roads, timber harvest, shearing) may have to be curtailed in the watershed protection areas if they affect the ecological integrity of the core areas. These activities would have to be evaluated on a case by case basis. Overall, protection of these peatlands would have minimal effect on existing or planned management practices.

No regulatory or administrative problems would be anticipated as a result of the proposed protection. Protection strategies would be consistent with the Red Lake WMA Master Plan. No major developments that may be affected by the protection of these peatlands are proposed.

Management of Recreational Resources

Recreational Resources in Peatlands. Given the nature of the peatland environment and the inaccessibility of many of these areas, recreational use of peatlands is limited to low-density activities such as hunting, fishing, trapping, and botanical and zoological observation and study. Camping, except at the ends of roads and along water routes is virtually nonexistent.

Restriction of these activities in either the core areas or the watershed activities is probably not necessary in most cases for the protection of these areas. The nature of the activities and the limited opportunities for them make the possibility of impact remote.

Use of motorized vehicles such as all-terrain vehicles (ATV's) and snowmobiles, sometimes associated with hunting and trapping, may have detrimental effects on sensitive peatland areas and may have to be restricted or prohibited. All-terrain vehicles have been shown to leave tracks that may last for decades. The use of ATV's and snowmobiles will probably need to be restricted in the core areas to existing winter roads and trails.

Effect of Protection on Recreation. The responsibility for managing Minnesota's recreational resources is dispersed among the many groups within the DNR that are charged with the management of the units of the Outdoor Recreation System. These divisions and programs include Forestry, Parks and Recreation, Fish and Wildlife, Trails and Waterways, and Scientific and Natural Areas.

The impact, then, of protection on recreational resources in peatlands depends on the final recommendations for management of these areas. It is unlikely, however, that recreation will be adversely

affected by protection activities. If anything, recreational use and opportunities in peatlands will probably be enhanced by the public's expanded awareness of Minnesota's peatlands.

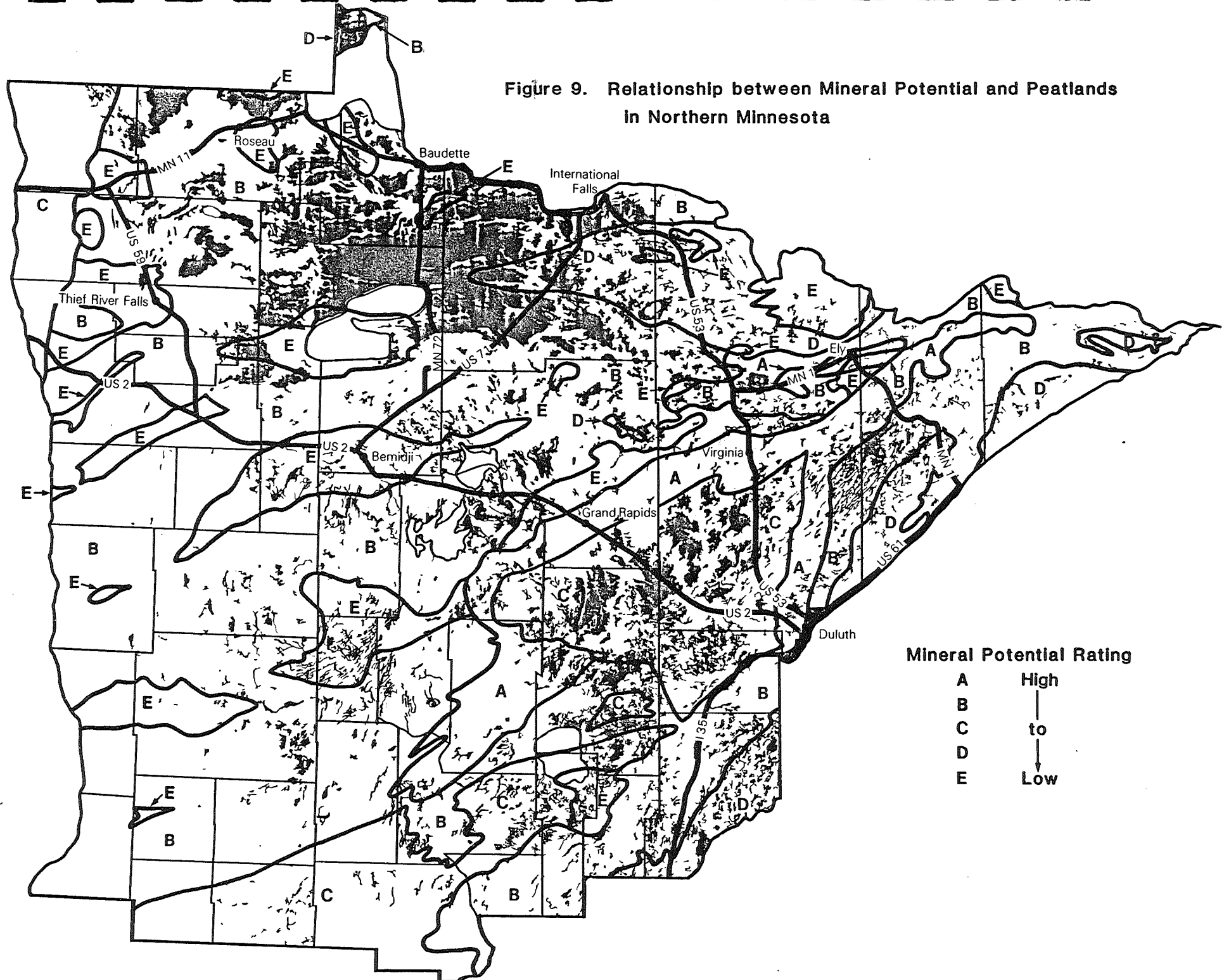
Management of Mineral Resources

Mineral Resources in the Peatland Protection Candidate Areas. The bedrock underlying most of the peatland protection candidate areas consists of Archean aged greenstone or mafic intrusive rocks, which are the same rock types that contain the majority of the mineral wealth in Canada. Some of the candidate areas possess some of the highest mineral potential in Minnesota (see fig. 9) It is reasonable to expect that economic mineral deposits occur under some portions of the candidate areas. Considering the area of greenstone in Minnesota (60,000-70,000 sq. mi.) and Ontario and the mineral discovery statistics in Ontario, at least 50 commercial mineral deposits might be expected to occur in the greenstones in Minnesota. A typical deposit could provide about 300 jobs for about 25 years, would require 300-500 acres of land, and have a gross value of \$1.6 million.

No commercial non-ferrous metallic mineral deposits have been discovered in Minnesota to date largely due to the difficulty of exploration in areas where there are few bedrock outcrops. However, there is currently a great deal of exploration activity in Minnesota including some activity in the peatland candidate areas (see data sheets in Appendix E).

Exploration Activity. The first step in exploration is to select an area within which it is reasonable to expect mineral deposits, based upon the bedrock geology. Then physical measurements such as magnetics

Figure 9. Relationship between Mineral Potential and Peatlands in Northern Minnesota



Mineral Potential Rating

A High
 |
 B to
 |
 C Low
 |
 D
 |
 E

and conductivity are recorded by flying at low altitude over the land. An examination of any exposed bedrock along with geochemical sampling of various types is next. Further geophysical measurements are then recorded with hand-held instruments by walking along narrow survey lines on the ground. This activity may require brush cutting to provide line-or-site survey lines. On the most promising sites evaluated by these methods, one or more holes are drilled to obtain samples of the bedrock. In all cases existing roads or trails are used wherever possible to gain access to land for mineral exploration. A case study of exploration activity on a peatland in the Thief Lake Wildlife Management Area found that no long-term impacts were associated with exploration activities. However, special review of exploration activities should be provided to ensure that certain peatland features such as rare plant populations are not affected.

Leases that are located in core areas of some of candidate areas have been granted "subject to Natural Heritage site", which requires the company exploring to submit exploration plans for working on these leases for review and approval by DNR staff. The purpose is to provide protection, in addition to that provided by the lease, that ensures that exploration is conducted on these sites with the least impact. The company may be required to limit activity to the winter months or to avoid certain areas. The lease sites are inspected by DNR staff both during the work and on completion. This special review is in addition to the requirements of state copper-nickel leases and the Exploratory Borings Law. Lands and minerals not administered by the state are subject to the Exploratory Borings Law.

Effect of Protection on Mineral Exploration and Development. To assess the impact of prohibiting exploration in the candidate areas is difficult because of the uncertainties about the mineral resources. An economic mineral deposit is a rare occurrence where a wide variety of physical and chemical conditions must be favorable for its formation. The types of mineral deposits that are likely to occur in the candidate areas are generally relatively small, possibly on the order of 40 acres, but very valuable. These conditions coupled with the fact that any mineral deposits in Minnesota are probably covered with glacial overburden makes their discovery an extremely difficult task. The locations of these economic mineral deposits are not currently known, and the probability of finding one decreases with the amount of area closed to exploration.

The effect of protection of the candidate peatlands on mineral exploration and development depends, then, upon the kind of restrictions on surface use for these areas. Exploration by itself could occur with minimal impacts in watershed protection areas and core areas if carried out under a procedure for special review of the exploration work, as is currently happening in areas "subject to natural heritage sites."

The impact of mining on a candidate area, on the other hand, would vary in significance depending on the location of the deposit, its size, and the method of mining. The range of possibilities extends from an underground mining operation located at the edge of a candidate area, which could have very little impact, to an open-pit mining operation in a core area, which would have a much larger impact. It has been suggested by some that because a mineral deposit might be found in an area where development might be difficult or inappropriate, it would be

better to not have explored and discovered the deposit than to face the difficult issues that would be raised in the environmental review and permitting process. Depending on the significance of the deposit, the significance of the peatland, and the impacts to the peatland, the permits should be granted or denied with the benefit of the knowledge of all the resources identified. The odds of discovering mineral resources are very low, but reducing the area where exploration can occur will have the impact of reducing the opportunity for discovery.

**ADMINISTRATIVE AND LEGISLATIVE OPTIONS
FOR PEATLAND PROTECTION**

A variety of administrative and legislative options exist that could provide long-term protection of the peatland candidate areas. The following provides a review of those options thought to offer the most effective means of providing protection.

Administrative Options

Three units of the Outdoor Recreation System (ORS), authorized by Minn. Stat. Secs. 86A.05-.11, offer an existing means of protection that could be applied to some of the candidate areas: scientific and natural areas, state wilderness areas, and state wildlife management areas. Under existing law, all three of these units may be established by the authority of the Commissioner of Natural Resources on lands under his administration. However, in view of the extensive peatland acreages (500,000) being reviewed, the department will request legislative review of any administrative actions dealing with protection of the candidate areas.

State Wildlife Management Areas. Wildlife management areas (WMA) may be established by the Commissioner of Natural Resources under the authority granted to the commissioner by Minn. Stat. Sec. 97.481. County board approval is necessary, however, to purchase or lease lands in an approved WMA project. Minn. Stat. Sec. 86A.05, Subd. 8, lists three criteria for the establishment of a WMA: (1) to include lands and habitat that permit the propagation and management of desired wildlife, (2) to develop and manage lands for the production of wildlife, and (3) for public, hunting, trapping, fishing, and other compatible outdoor

recreation uses. All or portions of two of the 18 candidate areas, Mulligan Lake and Red Lake peatlands, are located in existing WMA's.

Management of WMA's for the purposes noted in the legislation could conflict with protecting core areas of the candidate peatlands. Some wildlife management activities, such as the establishment of impoundments for waterfowl production and site conversion to enhance browse conditions for large mammals, would alter the vegetation and hydrology of the peatland. However, protection of a core area located within a WMA could be administratively accomplished if the management plan were to specify that the core area be managed as natural habitat, thus precluding certain management activities from this area. No restrictions on wildlife management activities in the watershed protection areas would be necessary as long as the activities did not affect the core areas.

To further ensure that a candidate peatland area in a WMA is protected, such an area or its core area could be legislatively designated as a scientific and natural area, a state wilderness area, a watershed protection area (to be discussed later), or a combination of these. However, the ORA would have to be amended to allow such designations in WMA's.

State Wilderness Area. State wilderness areas may be established by the Commissioner of Natural Resources under the authority of Minn. Stat. Sec. 86A.05, Subd. 6 for those lands under the commissioner's authority. The primary purpose for this designation is to preserve areas that offer outstanding opportunities for solitude and primitive types of outdoor recreation. Such areas are to be managed primarily by the forces of nature. Development is not permitted except for recreational

use.

State wilderness status would provide peatland protection. The only negative impacts would occur at developed wilderness campsites. However, these would be of such a localized nature that they would not pose any threat to the overall peatland. Peatlands, however, because of their characteristic flat topography, water conditions, locations, and inaccessibility would, for the most part, offer little in the way of primitive outdoor recreational opportunities. Candidate areas that would fit this designation are those that are accessible by canoe along river systems.

State Scientific and Natural Areas. State scientific and natural areas (SNA's) may be established by the Commissioner of Natural Resources under the authority of Minn. Stat. Sec. 84.034. These areas are protected and managed under the authority of Minn. Stat. Sec. 86A.05, Subd. 5 and Minnesota Rules NR 300-303. The primary purpose for state scientific and natural areas is to preserve and perpetuate in an undisturbed natural state those natural features that possess exceptional scientific or educational values. These features include plant communities, rare and endangered plant and animal species, geologic features, and unique landforms. Management of SNA's is carried out by the forces of nature or, in certain cases, management activities that replicate natural processes so as to maintain or enhance a species or community. State scientific and natural areas can only be altered in designation and use through a public hearing process.

The establishment of a core area as a scientific and natural area would provide peatland protection. Furthermore, protection of a repre-

sentative number of peatlands as scientific and natural areas is consistent with the overall purpose of the Outdoor Recreation System to preserve an accurate representation of the state's natural heritage. Development in scientific and natural areas is limited by law to facilities absolutely necessary for protection, research, and educational projects. Motorized activities, camping, hunting, logging, and other types of consumptive activities are prohibited by Natural Resource Regulations. Exceptions to these regulations for pre-existing activities such as existing winter haul roads and for low-impact activities such as hunting may be made by the commissioner in the establishment and management of specific scientific and natural areas.

Legislative Options

State Forests. State Forests are established by the legislature for purposes outlined in Minn. Stat. Sec. 89.021. As well as timber production, these purposes include management of the forest resources for wildlife habitat, recreation, and the protection and maintenance of rare flora and fauna. In addition, the Forest Resources Management Act (1982) emphasizes the protection of rare and unique species as one of the primary purposes for the establishment of state forests. Twelve of the 18 candidate areas are partially or wholly in existing state forests. In addition, two of the areas (Sprague Creek and Pine Creek) are within the proposed Lost River State Forest (MDNR Div. of Forestry 1983).

Some forest management activities and allowed uses may conflict with protecting candidate areas. Timber cutting, timber haul roads (temporary and permanent), reforestation activities, recreation, site

conversion, mining, and wildlife habitat enhancement could affect these peatlands. However, a candidate area could be administratively identified and could be managed under administrative guidelines developed specifically to protect the core area and watershed protection area. A core area in a state forest could also be designated as a state wilderness area or a scientific and natural area.

Watershed Protection Areas. Because of the complicated hydrological interactions in peatland ecosystems, protection of a peatland complex would not necessarily be achieved by protecting only the core area. As previous discussions have pointed out, some degree of protection of the watershed protection area would be necessary to protect the core area. A possible means of achieving this protection is by creating a new designation called "watershed protection area."

Authority for designating peatlands as "watershed protection areas" does not presently exist and thus would have to be sought in legislation, regardless of the administering division or management unit. Administrative management guidelines for the watershed protection areas could be developed through DNR internal policy or promulgated by DNR rules, if necessary. These guidelines would most likely specify conditions under which activities that would disrupt the hydrology could occur.

SUMMARY

This report has presented the history of the peatland protection program, the ecological evaluation and ranking of the candidate areas, possible impacts on natural resources management, and administrative and legislative options for protection of these areas. Although some data necessary for the November report are missing, a substantial amount of data have been compiled.

As part of a larger plan for the balanced management of Minnesota's peatland resources, it is important to evaluate each candidate peatland independently. No one option is suitable for all areas. Rather, a combination of mechanisms for protecting these peatland areas, approximately 10% of Minnesota's total peatland resource (see table 12), may be the most effective and appropriate action.

Based on the data compiled and evaluated to date, the department offers the following guidelines for the reviewers of this document:

1. The ranking of the candidate areas according to their ecological significance (see section on Ecological Resource Evaluation) should be used as a basis for establishing priorities.
2. The groupings established by the ecological ranking should be used as a guideline in determining which peatlands should receive greater protection from disturbances associated with resource management, economic development, and recreational activities.
3. The impact of the various administrative and legislative options on all resource management activities should be considered in the process of evaluating the appropriate design-

TABLE 12
Acreages in Peatland Candidate Areas Grouped by Significance

	Core Area	Watershed Protection Area	Total Area
1. NATIONAL OR INTERNATIONAL SIGNIFICANCE			
Red Lake	83,000	150,800	233,800
Myrtle Lake	23,000	13,300	36,300
Lost River	8,800	53,200	62,000
N. Black River	8,700	32,300	41,000
TOTAL			373,100
PERCENTAGE OF MN'S PEAT RESOURCE			6.2%
2. REGIONAL SIGNIFICANCE (Peatland Complex Types)			
Sand Lake	3,400	8,600	12,000
Mulligan Lake	4,400	14,700	19,100
Lost Lake	1,600	6,300	7,900
Pine Creek	800	1,400	2,200
Oteneagen*	3,800	5,500	9,300
TOTAL			50,500
PERCENTAGE OF MN'S PEAT RESOURCE			0.8%
3. REGIONAL SIGNIFICANCE (Geographic Representation)			
Wawina	3,600	5,000	8,600
Nett Lake	300	1,100	1,400
E. Rat Root River	2,200	7,600	9,800
TOTAL			19,800
PERCENTAGE OF MN'S PEAT RESOURCE			0.3%
4. STATE SIGNIFICANCE			
S. Black River	5,700	9,900	15,600
Winter Road Lake	3,400	14,600	18,000
Sprague Creek	600	11,800	12,400
Luxemberg	700	2,500	3,200
W. Rat Root River	1,000	2,600	3,600
TOTAL			52,800
PERCENTAGE OF MN'S PEAT RESOURCE			0.9%

* either this peatland or another example of this type will be included in this group

nation for each core area and watershed protection area. In addition, the impact of these options with regard to the issues of trust fund lands and state-owned or state-administered mineral rights should be considered. In view of the constitutional constraints regarding trust fund lands, inclusion of such lands in units of the Outdoor Recreation System will require compensation to the trust.

4. The identification of appropriate resource and recreational activities within the core and watershed protection areas needs to be defined for each candidate area.

The preliminary evaluation can be summarized as follows:

1. The core areas of Group 1 and Group 2 peatland candidate areas may best be protected by designation as Scientific and Natural Areas (SNAs) or Wilderness Areas. The watershed protection areas surrounding these core areas may best be protected by designation as "watershed protection areas."
2. The core and watershed protection areas of the candidate areas in Groups 3 and 4 and those areas in Groups 1 and 2 that are not designated as SNAs or Wilderness Areas may best be protected by using a variety of mechanisms. These may include either administrative or legislative options.

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APPENDIX A
Peatland Areas of Special Wildlife Significance

Of the 22 peatlands identified as ecologically significant by the task force, six were included because of their significance to peatland wildlife. Subsequently, the Pine Creek and Sprague Creek Peatlands have been identified as having significant peatland vegetation and landforms. The remaining four areas, Thief Lake, Agassiz, Rice Lake, and Roseau River, are not known to contain significant rare plants or exemplary landforms.

These four areas, however, are extremely important to peatland wildlife. They are large enough to maintain regionally significant populations of game species such as moose and sharp-tailed grouse whose critical habitat is diminishing. These peatlands also provide sufficient habitat potential for significant populations of rare and uncommon species such as the eastern timber wolf, great gray owl, yellow-rail, greater sandhill crane, short-eared owl, and sharp-tailed sparrow.

Most importantly, these four areas are in regions of highly developed and/or developing agricultural activity. Land-use studies have shown an increasing trend in the conversion of wildlife habitat to agricultural lands in these regions. As a result, peatlands are rapidly becoming "islands of refuge" for peatland wildlife in areas which have been stripped of their wildlife diversity and productivity. As such, these peatlands become more valuable each year.

A large percentage of the four "wildlife" peatlands are in state or federal control which has offered a degree of protection. Further protection from destruction has resulted from the designation of major

portions of them as National Wildlife Refuges (NWR) and State Wildlife Management Areas (WMA).

A majority of the Agassiz and Rice Lake peatlands are owned in fee-title by the United States and are managed as National Wildlife Refuges for wildlife protection and habitat management. Most of the remaining peatlands in these two areas are designated state WMA. The majority of this state land is Consolidated Conservation Area (ConCon) lands under the administrative control of the DNR's Division of Fish and Wildlife. Some of the peatland is in private ownership, is tax forfeit, or is Consolidated Conservation land not dedicated to a management unit.

All of the Thief Lake and Roseau River peatland which is necessary for peatland wildlife habitat preservation has been acquired, placed under the custodial control of the Division of Fish and Wildlife, or identified in WMA acquisition proposals. Over one-third of the presently designated Thief Lake WMA is Consolidated Conservation Area Land. Over 27,000 additional acres, much of which is peatland, is proposed for addition to the Thief Lake WMA. Eighty percent of this addition is ConCon or Trust Fund Land. Proposed additions to the Roseau River WMA, which are predominately peatlands, total over 24,000 acres. Half of this acreage is State Trust Fund Land, about 10 percent is privately owned, and the remainder is county-administered tax-forfeited land. Half of the tax-forfeited land has been designated as "Recreation Area" by the county. Other portions of the Roseau River peatland are designated or proposed as smaller WMA's.

The protection afforded the Agassiz and Rice Lake peatlands by National Wildlife Refuge status is substantial. The portions of the

peatlands in NWR can be expected to be managed for migratory birds as well as resident wildlife, in perpetuity. NWR management generally gives high priority to rare and "unusual" species or communities. No further protection is considered necessary.

WMA lands which have been acquired in fee title have a degree of protection practically equivalent to NWR's. They have been and will continue to be managed for peatland wildlife. Lands acquired or managed using Pittman-Robertson (federal aid) funds are monitored by the U.S. Government to ensure that they are managed for the purposes intended. No further protection is needed on these lands.

Recommendation: Since these areas do not contain sufficient exemplary landforms or assemblages of rare plant species or communities, they will not be evaluated further for the development of core areas and watershed protection areas. However, these peatlands merit continued and expanded protection against destruction. Following are recommendations for the protection of these areas:

1. All or portions of these peatlands which provide habitat for peatland wildlife or are necessary to protect the peatland from drainage should be delineated.
2. All undedicated Consolidated Conservation Area lands within these delineated peatlands should be designated by the Commissioner as WMA's or other management units or referred to the legislature for establishment as state forests.
3. County-administered lands within established units should be managed by cooperative agreement with the county.
4. Private lands within these areas should be acquired for

wildlife management by the United States or the State as funds and willing sellers are found.

5. Other peatlands which are critical for peatland wildlife should be systematically identified and protected in a like manner.

6. Management plans, if not already prepared, should be written for these areas. The plans should be directed toward management for peatland wildlife species. Cooperative agreements with the Division of Forestry, according to the Forestry/Wildlife Coordination Policy, will be required where timber management is desirable.

APPENDIX B
Species Status Sheets

SCIENTIFIC NAME: Drosera anglica Huds.

FAMILY: Droseraceae

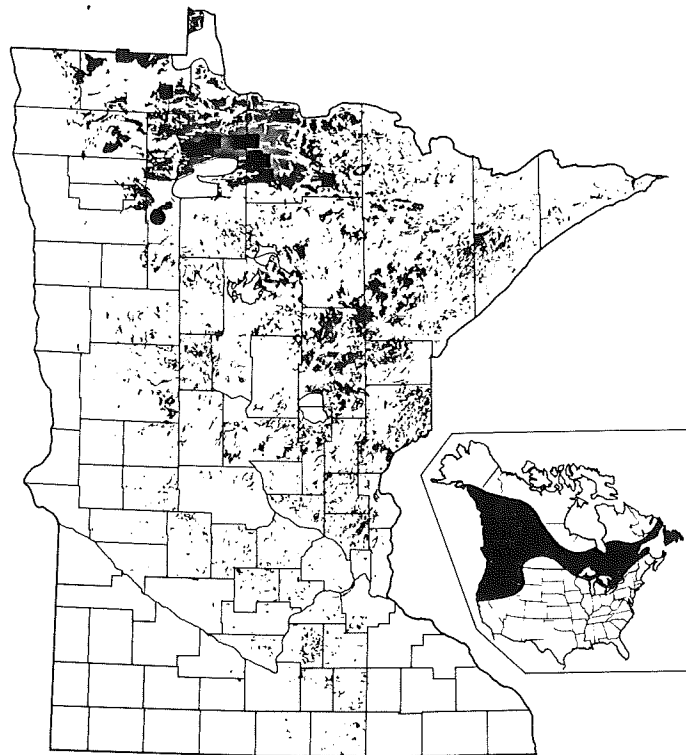
COMMON NAME: English Sundew

STATE STATUS: Threatened

FEDERAL STATUS: None

BASIS FOR MINNESOTA STATUS: The numerous collections of this species are the result of a recent and intensive botanical inventory of its habitat. The inventory revealed that this species has very restrictive habitat requirements and a narrow ecological amplitude. Populations are limited to small microhabitats within large hydrological systems. Even limited human activity could disrupt these systems and indirectly destroy remote populations of Drosera anglica. Expansion of commercial peat mining could increase the scale of destruction to a critical level.

PREFERRED HABITAT IN MINNESOTA: This species appears to be restricted to minerotrophic water tracks in patterned peatlands, where it occurs in the wettest portions of flark formations. It is often associated with Drosera linearis and Drosera intermedia.



- Historical (before 1950)
- Recent occurrences (after 1950)
- Recent occurrences in a peatland protection candidate area
- ▲ Occurrences in a protected area

Map 4. Distribution of *Drosera anglica* (English Sundew) in Minnesota and Range in North America

SCIENTIFIC NAME: Drosera linearis Goldie

FAMILY: Droseraceae

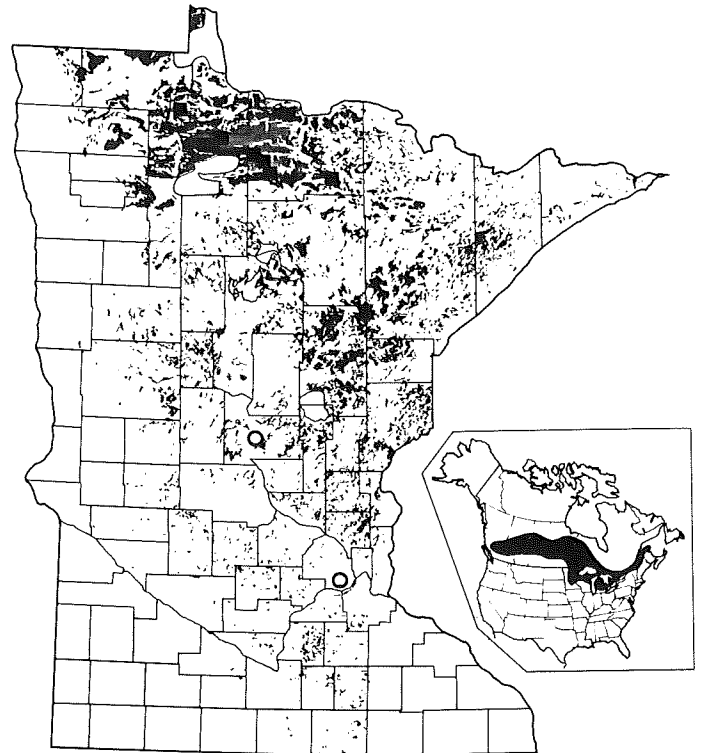
COMMON NAME: Linear-leaved Sundew

STATE STATUS: Threatened

FEDERAL STATUS: None

BASIS FOR MINNESOTA STATUS: Like the previous species, Drosera linearis is restricted by specific habitat requirements. It is extremely sensitive to disturbance of its environment and will not persist when the water level in its habitat is altered. The Hennepin County population was located somewhere near Minneapolis and was last collected in 1878. The Morrison County collection is without location and is dated 1891.

PREFERRED HABITAT IN MINNESOTA: Like the preceding species, Drosera linearis occurs in flark formations in minerotrophic water tracks in patterned peatlands. Historically, however, it also occurred in calcareous fens in Morrison and Hennepin Counties.



- Historical (before 1950)
- Recent occurrences (after 1950)
- Recent occurrences in a peatland protection candidate area
- ▲ Occurrences in a protected area

Map 5. Distribution of *Drosera linearis* (Linear-leaved Sundew) in Minnesota and Range in North America

SCIENTIFIC NAME: Nymphaea tetragona Georgi

FAMILY: Nymphaeaceae

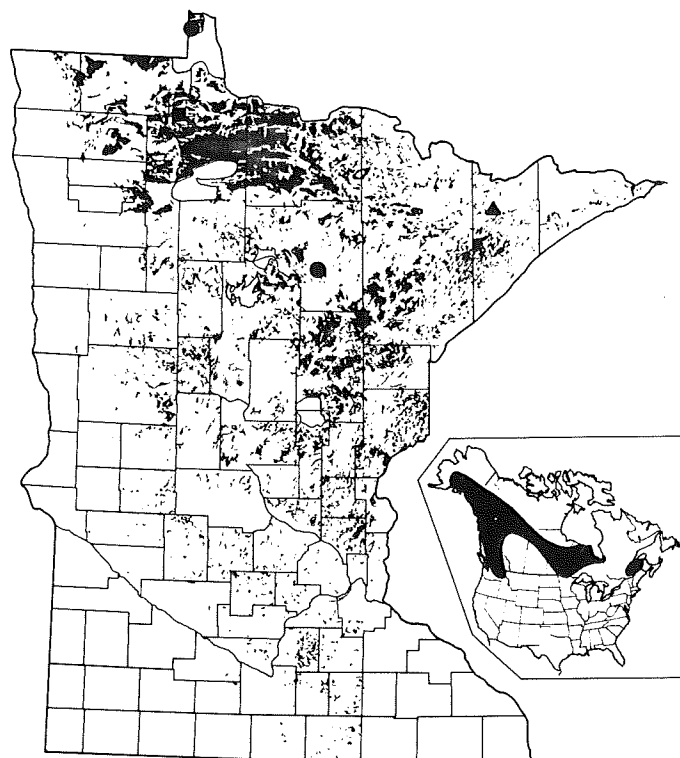
COMMON NAME: Four-angled Water-lily

STATE STATUS: Threatened

FEDERAL STATUS: None

BASIS FOR MINNESOTA STATUS: This is a northern species that reaches the southern limit of its range in Minnesota, and is generally rare or local throughout its range. All of the populations currently known to be extant in Minnesota are small, and they may have difficulty persisting. The site in Itasca County was recently transferred from federal to state ownership and will soon be designated Botany Bog Scientific and Natural Area. The specimen from Lake County was collected in Bald Eagle Lake in 1914 and its current status is unknown. Activities such as peat mining and logging pose potential threats to the habitat of this species.

PREFERRED HABITAT IN MINNESOTA: This species occurs in shallow lakes, bogs, pools and slow moving streams. The population at Botany Bog occurs in a bog pool with an unusual assemblage of rare species that include: Utricularia gibba, Xyris montana and Eleocharis olivacea



- Historical (before 1950)
- Recent occurrences (after 1950)
- Recent occurrences in a peatland protection candidate area
- ▲ Occurrences in a protected area

Map 6. Distribution of *Nymphaea tetragona* (Four-angled Water Lily) in Minnesota and Range in North America

SCIENTIFIC NAME: Carex exilis Dew.

FAMILY: Cyperaceae

COMMON NAME: coast sedge

STATE STATUS: Special Concern

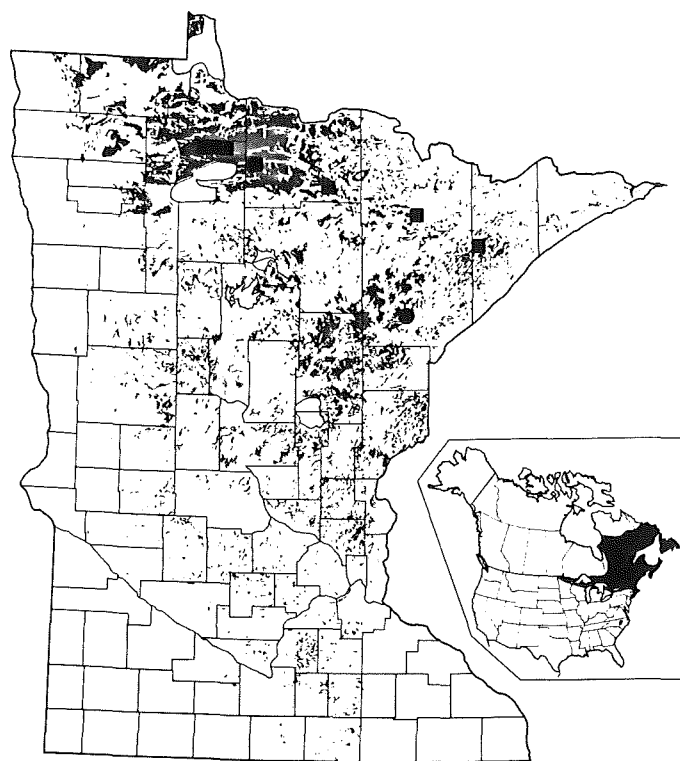
FEDERAL STATUS: None

BASIS FOR MINNESOTA STATUS: The main range of this species is in eastern Canada and northeastern United States; its distribution inland is local and sporadic. The occurrence of this species in the Red Lake peatland marks the western limit of its known range.

An intensive search of its known range in Minnesota has revealed it to be absent from most areas with suitable habitats. Therefore, its sporadic pattern of occurrence cannot be explained entirely by the presence or absence of apparently suitable habitat. One theory that C. exilis originated on the Atlantic Coastal Plain, and that its occurrence in Minnesota represents the leading edge of its westward migration. This implies that it is rare because it is a recent arrival and that it will become better established in time. This theory is challenged by others who believe its distribution is controlled by climatic factors, and that its rarity is due to narrow ecological tolerances. This theory assumes that C. exilis is poorly adapted to compete where the climate is only marginally suitable for its establishment.

PREFERRED HABITAT: Currently, Carex exilis in Minnesota is known to occur only in well developed patterned peatlands. It is uncertain, however, if this accurately reflects this species' distribution, or if it is an artifact of biased search techniques. We may not have conclusive evidence until all wetland habitats have been searched as thoroughly as patterned peatlands.

Within the range of peatland habitats, C. exilis appears to be restricted to minerotrophic sites. It does, however, tolerate a pH as low as 4.5 and Ca⁺ concentrations as low as 4 mg/l. These chemical conditions are experienced at the ecotone where the minerotrophic fen meets the ombrotrophic bog. This is exactly the habitat noted at most of the collection sites of C. exilis in Minnesota as well as in Michigan.



- Historical (before 1950)
- Recent occurrences (after 1950)
- Recent occurrences in a peatland protection candidate area
- ▲ Occurrences in a protected area

Map 7. Distribution of *Carex exilis* (A species of Sedge) in Minnesota and Range in North America

SCIENTIFIC NAME: Cladium mariscoides
(Muhl.) Torr.

FAMILY: Cyperaceae

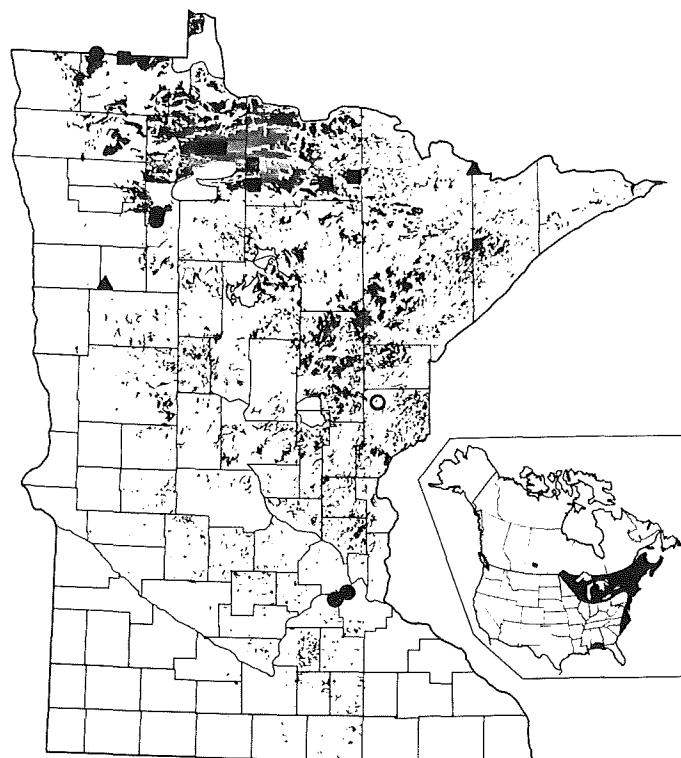
COMMON NAME: Twig-rush

STATE STATUS: Special Concern

FEDERAL STATUS: None

BASIS FOR MINNESOTA: This species currently reaches the western limit of its range in northwestern Minnesota. Even within the forested region of eastern and northern Minnesota, Cladium was never common. Early botanical explorers in this region never reported Cladium; it is only recently that detailed information about its occurrence in Minnesota has been available. This information shows Cladium to occur only locally and to have specific biological requirements. These requirements restrict Cladium to a habitat that is experiencing heavy development pressures. These pressures have already resulted in a rapid decline in suitable habitat and a proportionate decline in the population levels of Cladium is almost certain to follow.

PREFERRED HABITAT: Over much of its range, Cladium occurs in a variety of seemingly non-specific aquatic habitats. On the Atlantic Coastal Plain, it occurs in swamps and marshes in either fresh or brackish water. Inland, it occurs on sandy beaches, in swales or on boggy lake margins where its rhizomes may form dense floating mats. Cladium is widely reported to occur in association with Sphagnum, but it sometimes displays a preference for marly sites. In all cases, Cladium requires a saturated substrate; occasionally occurring in standing water to a depth of twelve or more inches. The only other consistent feature is its preference for somewhat neutral-to-slightly calcareous surface water. In Minnesota Cladium has been found in fens with pH ranging from 6.0 to 9.5.



- Historical (before 1950)
- Recent occurrences (after 1950)
- Recent occurrences in a peatland protection candidate area
- ▲ Occurrences in a protected area

Map 8. Distribution of Cladium mariscoides (Twig Rush) in Minnesota and Range in North America

SCIENTIFIC NAME: Juncus stygius L. var. americanus Buchenau.

FAMILY: Juncaceae

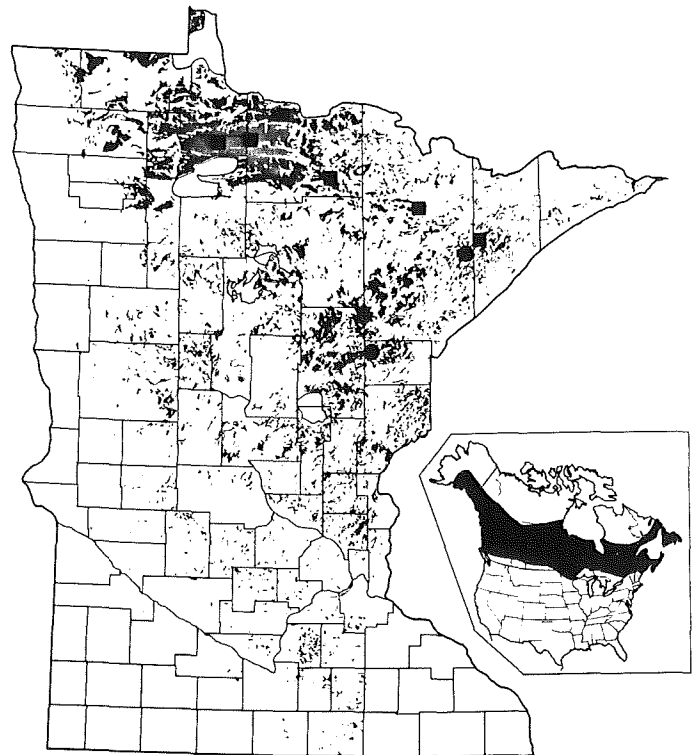
COMMON NAME: American bog-rush, marsh rush

STATE STATUS: Special Concern

FEDERAL STATUS: None

BASIS FOR MINNESOTA STATUS: Although Juncus stygius has wide distribution in boreal North America, its occurrence is remarkably disjunct and local. Even within the main portion of its range in Canada it is never common, and it is considered rare in Saskatchewan, Alberta, and Nova Scotia. In the United States, Juncus stygius is considered rare wherever it occurs. Based on historical evidence and known distribution patterns it appears that it has always been rare in Minnesota.

PREFERRED HABITAT: In Minnesota, Juncus stygius has a strong preference for patterned fens, specifically flark formations and fen pools. These areas are characteristically minerotrophic in nature; however, Juncus stygius shows some tolerance for mineral poor habitats, and has been collected from the border of a poor fen ecotone.



- Historical (before 1950)
- Recent occurrences (after 1950)
- Recent occurrences in a peatland protection candidate area
- ▲ Occurrences in a protected area

Map 9. Distribution of *Juncus stygius* (Marsh Rush) in Minnesota and Range in North America

SCIENTIFIC NAME: Grus canadensis

COMMON NAME: Sandhill Crane

STATE STATUS: Special Concern

Adjacent states/provinces: Extirpated
in Iowa and North Dakota

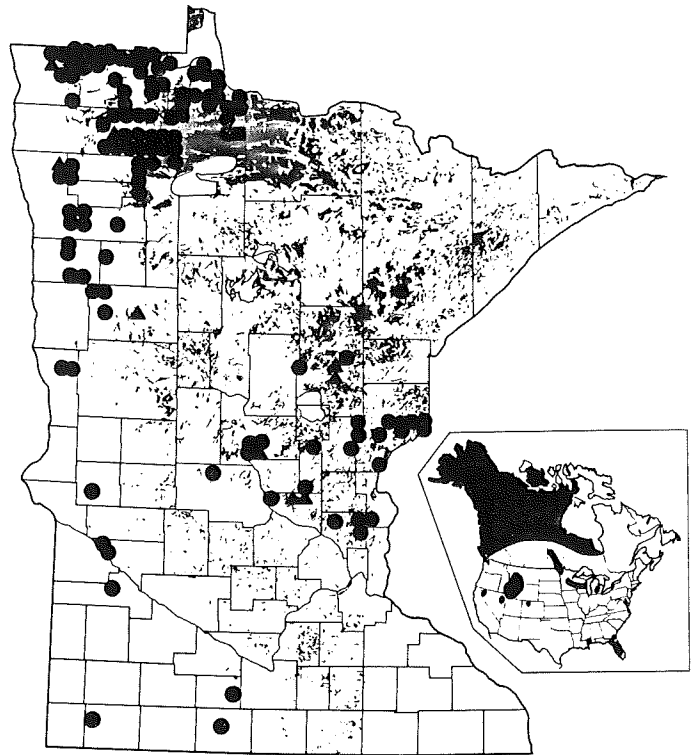
FEDERAL STATUS: Included under the Migratory Bird Treaty Act which occurs in Minnesota. (The subspecies Grus canadensis tabida (Greater Sandhill Crane) was removed in 1973 from the U. S. Fish and Wildlife Service's list of rare and endangered wildlife.

BASIS FOR MINNESOTA STATUS: Sandhill Cranes breed in extensive, shallow wetlands that are relatively isolated with minimal human disturbance. Such wetlands are becoming fragmented by drainage and agricultural development, especially in the major breeding range in northwest Minnesota.

OCCURRENCE IN MINNESOTA: The Sandhill Crane formerly occurred over most of the prairie portion of the State and in extensive, open wetland communities of forested areas. Hunting pressure and habitat alteration reduced populations significantly by the 1930s but recent protection efforts have resulted in population increases throughout portions of its former range (Lewis, 1977). The species presently occurs in northwest and eastcentral Minnesota (Green and Janssen, 1975).

DISTRIBUTION: The subspecies Grus canadensis tabida, or the Greater Sandhill Crane, occurs primarily west of the Rockies. The birds in Minnesota belong to the eastern population of this subspecies which is distributed from southern Manitoba to Michigan. The primary Minnesota range is indicated on the accompanying map. Many breeding areas are located on public lands, e.g. Agassiz, Sherburne and Rice Lake National Wildlife Refuges; and Carlos Avery, Mille Lacs, Kunkel, Kimberly, Grayling, Thief Lake and Roseau River Wildlife Management Areas. Cranes also occur on state trust fund lands in northwest Minnesota as well as on private lands.

PREFERRED HABITAT: Old fields and cropland containing waste grain are used during migration and for summer feeding when they are located near extensive, shallow wetlands that are used for breeding. Lewis (1977) emphasizes the importance of isolation from human disturbance during the breeding season since this may cause nest abandonment. Young cranes feed on animal foods obtained in wetlands and adjacent uplands during the preflight period, but then feed readily on agricultural grain in the fall along with the adults.



- Historical (before 1950)
- Recent occurrences (after 1950)
- Recent occurrences in a peatland protection candidate area
- ▲ Occurrences in a protected area

Map 10. Distribution of Greater Sandhill Crane in Minnesota and Range in North America

SCIENTIFIC NAME: Phalaropus tricolor

COMMON NAME: Wilson's Phalarope

STATE STATUS: Special Concern

Adjacent states/provinces: None

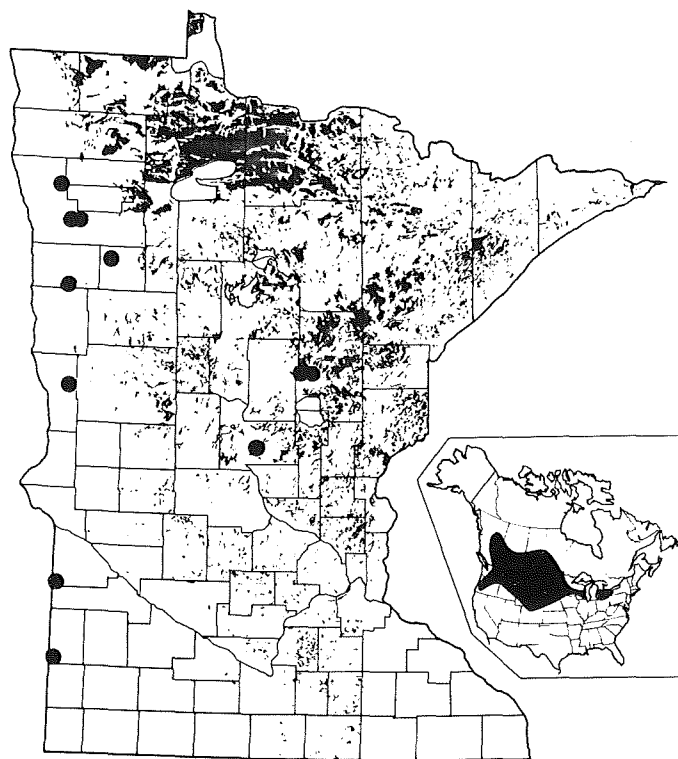
FEDERAL STATUS: Included under the Migratory Bird Treaty Act.

BASIS FOR MINNESOTA STATUS: Although the number of recent summer observations has remained stable, there are very few sites where nesting has been reported. Many birds in summer may be only visitants or migrants. The species grassland habitat is especially vulnerable with the rapid pace of agricultural development currently underway in northwest Minnesota.

OCCURRENCE IN MINNESOTA: This species formerly occurred in most of the prairie region of the state, but is now most common in the western and northwestern counties. It has nested in rice paddies in forested, northern Minnesota.

DISTRIBUTION: The phalarope is associated with prairie sloughs and pools ranging, in Canada, from the meadows of British Columbia across the prairie provinces and into extreme southern Ontario and, in the United States, the grasslands of eastern Washington and Oregon across the northern Great Plains to the marshes of Wisconsin and Michigan.

PREFERRED HABITAT: According to Stewart (1975): "wetlands inhabited by this species include swales along intermittent streams, and various types of ponds and lakes that contain expanses of shallow water that are interspersed with or adjacent to wet-meadow vegetation." Most nests are located in the wet-meadow zone of wetlands or in nearby upland prairie sites.



- Historical (before 1950)
- Recent occurrences (after 1950)
- Recent occurrences in a peatland protection candidate area
- ▲ Occurrences in a protected area

Map II. Distribution of Wilson's Phalarope in Minnesota and Range in North America

SCIENTIFIC NAME: Canis lupus

COMMON NAME: Gray Wolf

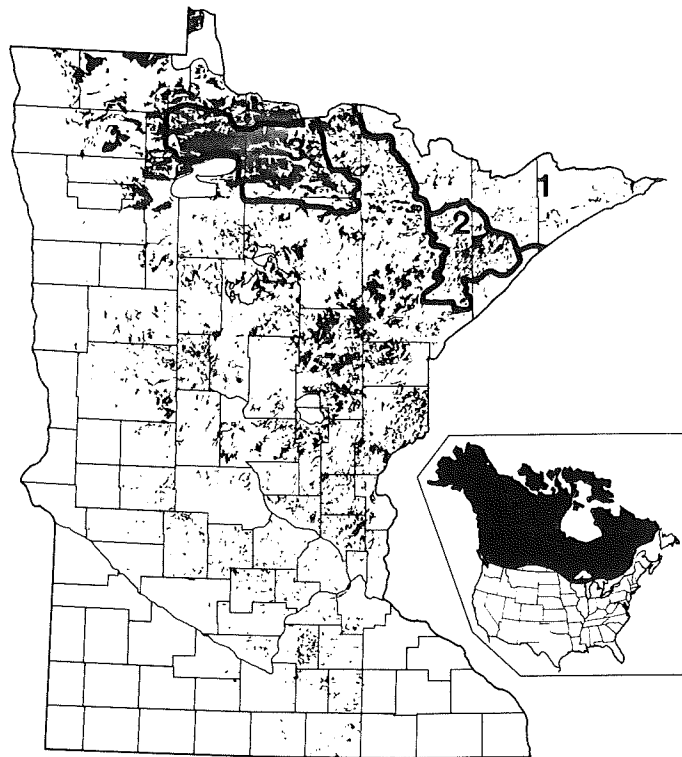
STATE STATUS: Threatened

FEDERAL STATUS: Endangered in 48 lower states except Minnesota, and threatened there.

BASIS FOR MINNESOTA STATUS: The overall reduction of the range of this species in North America that has resulted from conflicts of interest between wolves and humans is a factor in listing this species. Because of this conflict wolves probably would not persist without some form of protection.

OCCURRENCES IN MINNESOTA: The wolf is common in northeastern and northern Minnesota. Recent records exist from as far south as Pine County.

PREFERRED HABITAT: Currently the species is restricted primarily to wooded areas and other protected habitats where prey are available.



Critical Area Management Zones for the Eastern Timber Wolf in Minnesota and Range in North America

APPENDIX C
Rare Bryophytes of Patterned Peatlands in Minnesota

PROPOSED ENDANGERED

Calliergon aftonianum Steere

The only living population of this species was recently discovered in the Lost River Peatland in Minnesota. This "living fossil" has previously only been found as fossils in peat cores in Iowa, Alaska, Yukon and Artic Archipelago.

THREATENED

Calyptogeia fissa (L.) Raddi

Disjunct to Minnesota. Not known from Minnesota before peatland studies. One unconfirmed Minnesota locality.

Cinclidium stygium Sw.

Disjunct to Minnesota. Not known from Minnesota before peatland studies. Two confirmed Minnesota localities, one unconfirmed.

Drepanocladus lapponicus (Norrl.) Smirn.

Disjunct to Minnesota. Not known from Minnesota before peatland studies. One confirmed Minnesota locality.

PROPOSED SPECIAL CONCERN

Calliergon richardsonii (Mitt.) Kindb.

Minnesota is peripheral to its range. One confirmed, one unconfirmed Minnesota locality.

Calliergon trifarium (Web. & Mohr) Kindb.

Minnesota is peripheral to its range. One confirmed Minnesota locality, several unconfirmed reports.

Campylium radicale (P. Beauv.) Grout

Scattered North American range. Two confirmed Minnesota localities.

Catoscopium nigratum (Hedw.) Brid.

Scattered North American range. Not known from Minnesota before peatland studies. One confirmed, one unconfirmed Minnesota locality.

Cephalozia connivens var. compacta (Warnst.) Nichols

Very rare; North American range is imperfectly known. Two confirmed Minnesota localities.

Cephalozia lacinulata Jack

Very rare throughout its range. Three confirmed Minnesota localities.

Cirriphyllum piliferum (Hedw.) Grout

Minnesota is peripheral to its range. Not known from Minnesota before peatland studies. One confirmed Minnesota locality.

Drepanocladus pseudostramineus (Mull.) Roth

Scattered North American range. Not known from Minnesota before peatland studies. One confirmed Minnesota locality.

Helodium paludosum (Sull.) Aust.

Minnesota is peripheral to its range. Not known from Minnesota before peatland studies. Two confirmed Minnesota localities.

Rhizomnium gracile Kop.

Minnesota is peripheral to its range. Not known from Minnesota before peatland studies. One confirmed Minnesota locality.

Rhizomnium magnifolium (Horik.) Kop.

Minnesota is peripheral to its range. One confirmed Minnesota locality.

Rhizomnium pseudopunctatum (B. & S.) Kop.

Minnesota is peripheral to its range. Not known from Minnesota before peatland studies. One confirmed Minnesota locality.

Scorpidium turgescens (Jens.) Loeske

Disjunct to Minnesota. One confirmed Minnesota locality, three unconfirmed.

Sphagnum obtusum Warnst.

Minnesota is peripheral to its range. Two confirmed Minnesota localities.

Sphagnum pulchrum (Lindb.) Warnst.

Minnesota is peripheral to its range. Not known from Minnesota before peatland studies. One confirmed Minnesota locality.

Sphagnum subnitens Russ.

Scattered North American range. One confirmed Minnesota locality.

Tomenthypnum falcifolium Ren.

Scattered North American range. Three confirmed Minnesota localities.

APPENDIX D
PEATLAND COMPLEX TYPES

A. The differentiation of peatland complex types is based on several factors.

(1) The relative areas of bog and water track in a peatland complex.

The area of bog to water track depends upon the volume of runoff entering the peatland from the surrounding upland. The volume of runoff is related to the areal extent of the mineral soil that lies between the upland divide of the catchment basin and the peatland margin.

(2) The path of runoff flowing across a peatland complex. The initial path of runoff across a peatland complex is controlled by a) the topographic features at the crest of the complex, b) the possible topographic features lying within the mineral substrate below the peat accumulation, and c) the position of the tributary streams into which the runoff flows, at the downslope margin of the peatland. With peat accumulation and associated peatland pattern development, runoff becomes increasingly channeled into water tracks, whereas bog development occurs in stagnant areas outside of these water tracks.

B. Peatland complex types can be divided into two classes, discontinuous and continuous, based upon the effect of the topography on flow patterns.

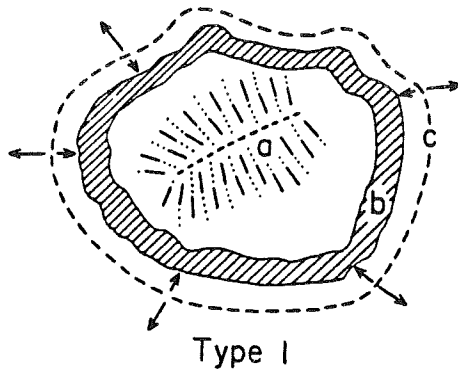
DISCONTINUOUS TYPES

In discontinuous peatlands, runoff from the surrounding uplands controls the pattern development in the peatland downslope.

Types 1-6 form a sequence of progressively larger areas of water track (fen) relative to bog. The types are identified by (1) the relative area of bog to water track, (2) the location of the bogs in the peatland, and (3) the areal extent and topography of the uplands between the crest of the catchment basin and the peatland margin.

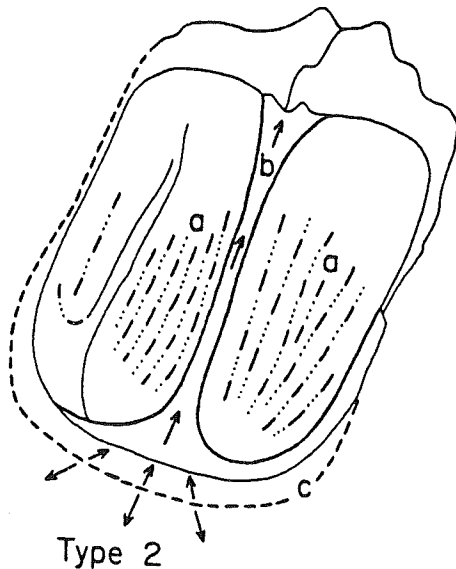
TYPE 1. A single large bog (a) fills most of the peatland complex, except for a lagg area (b) bordering the mineral upland.

- The crest of the catchment basin (c) is close to the peatland complex margin. Therefore, the runoff (←) drains from only a very narrow strip of mineral soil onto the peatland and only a small volume of this minerotrophic runoff enters the peatland, thus the spread of bog is favored.

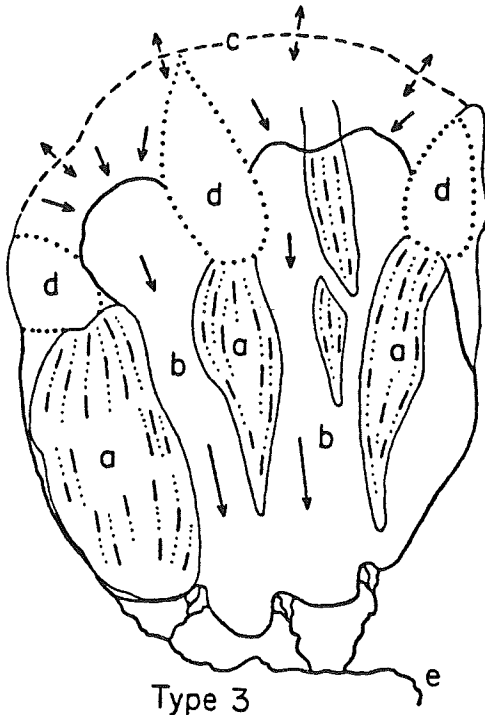


TYPE 2. Several large bogs (a) fill almost the entire complex, except for a few narrow water tracks that bear dilute minerotrophic waters.

- The crest of the catchment basin (c) is close to the peatland complex margin. Therefore, the runoff (←) drains from only a narrow strip of mineral soil onto the peatland downslope.
- The topography of the upland areas may channel the runoff into troughs that determine the position of the water tracks, thus, the bogs will be dissected into narrow ovoid lobes or will spread to form a larger, continuous expanse of bog that has curved, stream-lined margins trimmed by water tracks.



TYPE 3. Several small bogs (a), situated near the upslope margin of the peatland, are separated by wider water tracks (b) with more minerotrophic waters than in Type 2.



Type 3

- The crest of the catchment basin is more distant from the peatland margin than in Types 1 and 2, thus a greater volume of runoff (←) drains from a larger area of mineral soil onto the peatland downslope.

- The discharge of runoff onto the peatland is controlled by topographic features:

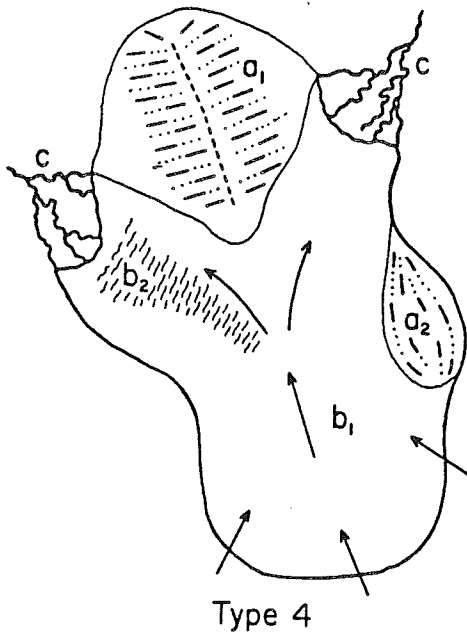
- 1) The runoff is channeled into troughs that feed into the watertracks downslope, which flow toward the tributary stream at the downslope margin of the peatland.

- 2) The runoff is divided around obstructions (d), such as ridges of mineral soil or rock outcrops that create zones of stagnant flow on the peatland downslope. The low flushing rate of these stagnation zones permits the spread of Sphagnum growth and thus bog development, while Sphagnum growth is

restricted by the flow of minerotrophic waters in the adjacent water tracks

- The actual shape and configuration of the bogs may vary in different complexes of this type because of the topography of the upland areas.

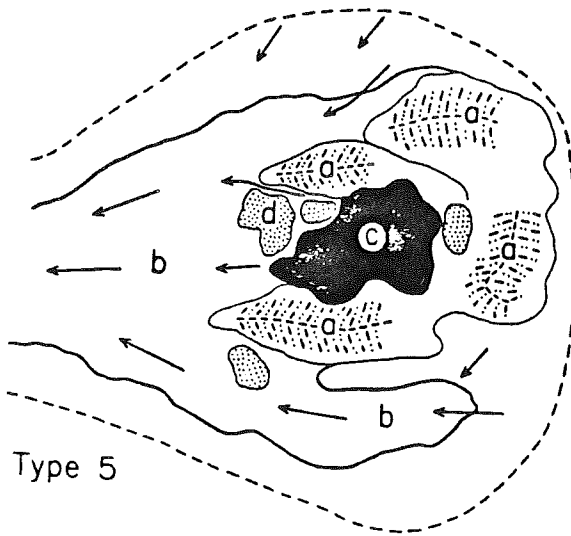
TYPE 4. A single, large, broad water track (b) dominates the center of this complex and flows past small raised bogs (a₂) on the peatland margins and bifurcates around a single bog (a₁) at the downslope edge of the peatland.



The water track can be unpatterned (b₁) or it can be patterned fen (b₂) as it flows toward the tributary streams (c) downslope.

Type 4 peatland complexes can be distinguished from the closely similar Type 10 peatlands because Type 4 has adjacent mineral lateral margins that create local stagnation zones that are conducive for bog development.

TYPE 5. A complex of raised bogs (or a single bog) (a) are concentrated near the upslope margin of the peatland. Runoff from the uplands is channeled around this bog complex and converges into one large water track (b) in the lower portion of the peatland.



- The bogs are located in an area where

- 1) the crest of the catchment basin (---) is close to the peatland margin, thus, little runoff drains directly from mineral uplands onto the bog areas and

- 2) the topography diverts flow away from the bogs and into the adjacent water tracks.

- The water tracks are located in an area that

- 1) receives a larger volume of runoff from the surrounding uplands because it is located downslope from a larger area of mineral soil (i.e., the crest of the catchment basin is located

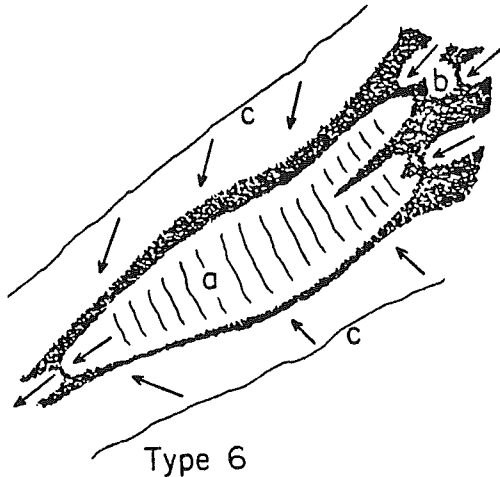
farther away from the peatland margin than it is in the upslope portion of the peatland complex),

- 2) may also receive ions or minerotrophic waters from a lake (c) or mineral outcrops (d) within the peatland, and

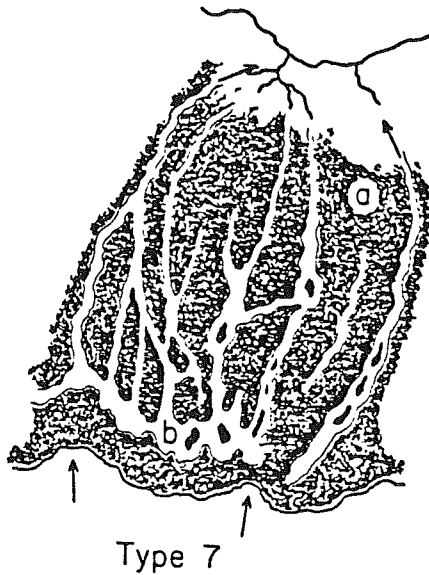
- 3) usually drains to a single outlet.

TYPE 6. A patterned fen (a) is surrounded by swamp forest or brushland (b). Mineral-rich runoff (←) drains directly off of the mineral uplands (c) and onto the peatland.

- May occupy a topographic depression
- This type of peatland is not associated with other types of peatland landforms, such as raised bogs



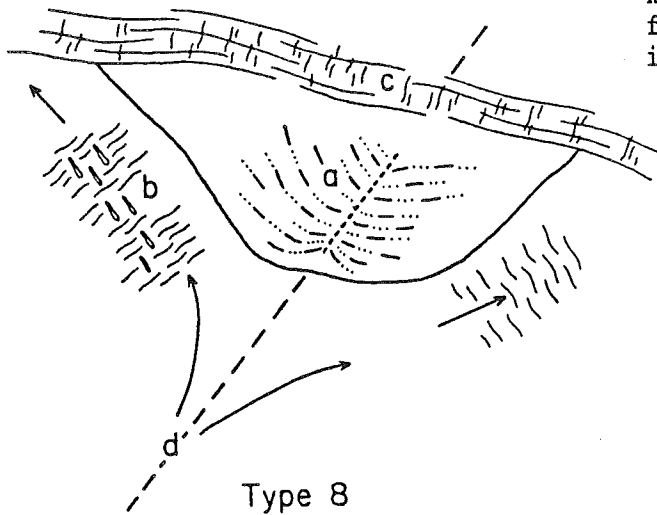
TYPE 7. A spring fen that contains an anastomosing network of non-forested channels (b) that drain through a swamp forest (a). Remnants of the swamp forest occur in the water tracks as teardrop tree islands.



CONTINUOUS PEATLANDS

In continuous peatlands, the influence of topography on the flow patterns in these peatland complexes is obscured because most of the landscape is covered by peat.

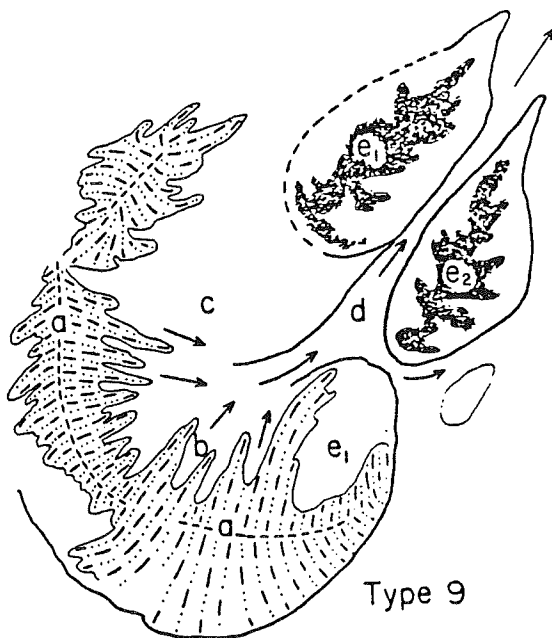
TYPE 8. A semi-circular raised bog (a) that has a beach ridge (or mineral uplands) (c) on its downslope edge and a water track that bifurcates around its upslope margin. The water track may be unpatterned or patterned fen (b) with teardrop-shaped islands.



- The bog crest is generally oriented along a topographic complex divide (--d--), which accounts for the bifurcation of the water track.

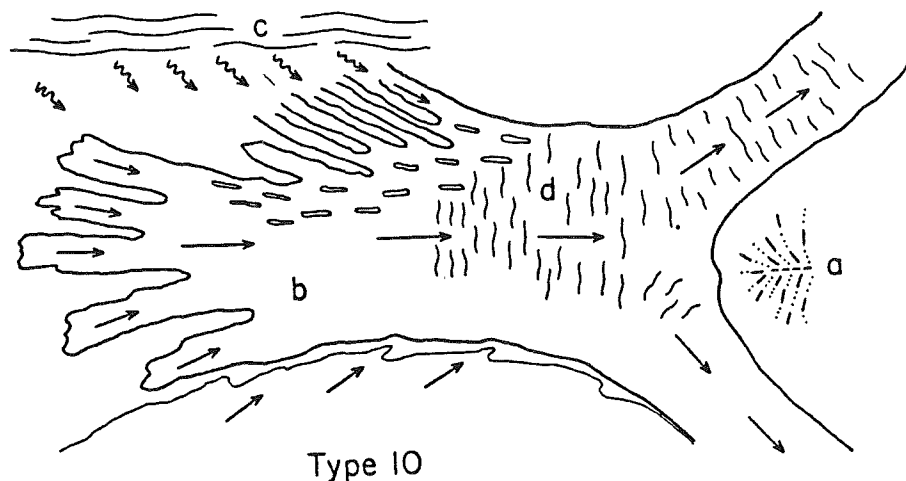
TYPE 9. A large bog complex that has a central bog crest (a).

- The radiating lines of forest at the crest give way downslope to:
 - 1) bog drains (b),
 - 2) featureless Sphagnum lawns (c), and
 - 3) narrow water tracks (d) flowing between large ovoid bog islands (e₁ and e₂).

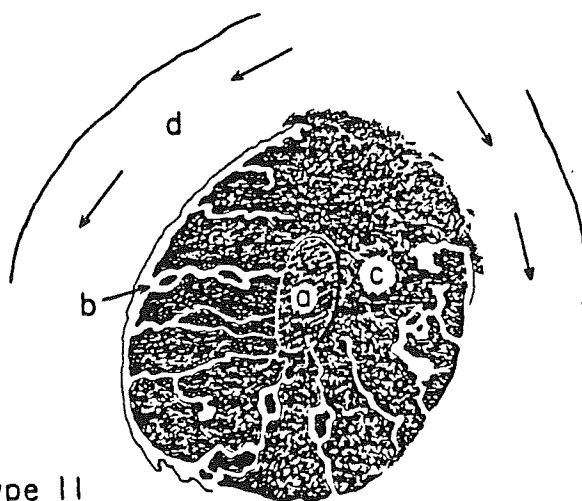


Type 9

TYPE 10. A large water track (b and d) that (1) is surrounded by a wide belt of swamp forest around its upslope margin and (2) bifurcates around a raised bog complex (a) toward its downslope margin. Type 10 superficially resembles Type 4, but is distinguished from Type 4 by the absence of mineral uplands around its margins, the absence of raised bogs in stagnation zones along the lateral margin of the peatland complex and the presence of marginal swamp forest fingers which grade into the teardrop islands within the central portion of the water track.



TYPE 11. A spring fen on a raised peat mound. Nonforested channels (b) radiate from the crest of the mound (a) and drain through a rich swamp forest (c). Water flows around the spring fen in water tracks (d).



APPENDIX E
Peatland Candidate Area Data Sheets

This appendix contains a summary of pertinent data for each of the 18 peatland candidate areas based on available information. An explanation of the data sheets is given below.

NAME: Although several names often apply to the same peatland, an attempt was made to use the most frequently used name. Synonyms have been added where applicable. In instances where no name was known, the peatland was named after an adjacent river, lake, or township.

LOCATION: A legal description down to the section level is given. Sections marked with an asterisk (*) indicate that only a portion of it is included in the peatland boundaries.

SIZE: An estimate of the Watershed Protection Area (WPA) and Core Area (CA), as they are currently drawn, and the combined totals are given in acres. These estimates are only approximate.

OWNERSHIP: An estimate of the percentage of land in various ownership categories is given. State ownership is subdivided into school trust fund and other land. Current administrative designations such as state forest (SF) or Wildlife Management Areas (WMA) are also given. County land includes tax-forfeited land that is actually owned by the state, but administered by the county.

SIGNIFICANCE:

This summarizes the significant aspects of the peatland.

ELEMENTS:

State listed rare plant and animal species occurring in the peatland are listed as well as peatland landforms.

DISTURBANCE:

An indication of the extent and type of disturbance is given.

FORESTRY POTENTIAL:

Where information is available an estimate of the commercial forest land within the core area is given. This information

is obtained from DNR Phase II inventory data and will be completed for each of the candidate areas by the end of the summer.

PEAT DEVELOPMENT POTENTIAL:

This includes an estimate of the potential for developing the peatland for energy or horticultural uses. Currently this estimate is based on access and nearness to markets. A more refined model of peatland development potential will be developed later this summer.

MINERAL POTENTIAL:

The mineral potential rating was used as an indication of the potential of the bedrock of the area for containing mineral ore deposits. The potential is rated on a scale of A-E. A description of the categories is given below. Also included is an indication of the past and current lease and drilling activity on state land within the area.

A - This category is used for geologic units or portions of geologic units where significant metallic mineralization is known to occur.

B - Represents geologic formations where metallic mineral bearing units are known to occur in the geologic formation. This category is also used for areas where the geology is very similar to that in areas elsewhere in the world containing major metallic mineralization.

C - The geology of these areas is generally not well known, although it is similar to geologic environments in other areas of the world that are known to contain a variety of economic mineral deposits.

D - From what is known about the geology of the rocks in these areas, the possibility of metallic mineral deposits is present but somewhat less than the more potential geologic formations.

E - Bedrock type and extent in these areas is poorly known and the available formation suggests that these rocks have a relatively low metallic mineral potential.

RED LAKE PEATLAND

The Red Lake Peatland is located in the middle of the Agassiz Lowland peatland area in the north central part of the state. Situated north of Upper Red Lake, this peatland is in area known as the "big bog" which extends for about 50 miles length and over 12 miles in width. This peatland contains a diverse and highly complex display of patterns including a large water track, patterned fens, and raised bog patterns, but is best characterized by its elaborate ovoid island development.

LOCATION: Approx. 25 mi S of Baudette

Beltrami Co.

T155N	R30W	Sec. 1*
T155N	R31W	Sec. 1-2*, 3-10, 11-12*, 14-18*
T155N	R32W	Sec. 1-12, 13-16*, 17-18, 19-21*
T155N	R33W	Sec. 1-15, 16-18*, 21-24*
T155N	R34W	Sec. 1-6, 7-9*, 10-12, 13-16*, 18*
T155N	R35W	Sec. 1-5, 6-7*, 8-12, 13-18*
T155N	R36W	Sec. 1*
T156N	R30W	Sec. 1-25, 26-28*, 29-30, 31-33*, 35-36*
T156N	R31W	Sec. 1-34, 35-36*
T156N	R32W	Sec. 1-36
T156N	R33W	Sec. 1-36
T156N	R34W	Sec. 1-2, 3-5*, 7-8*, 9-17, 18*, 19-36
T156N	R35W	Sec. 13*, 21-24*, 25-27, 28-30*, 31-36
T156N	R36W	Sec. 25*, 36*

Koochiching Co.

T155N	R29W	Sec. 4-6*
T156N	R28W	Sec. 5*, 6, 7-8*, 18*
T156N	R29W	Sec. 1-12, 13*, 14-22, 23-24*, 26-27*, 28-32, 33*
T157N	R28W	Sec. 29-30*, 31, 32*
T157N	R29W	Sec. 25-28*, 31-32*, 33-36

Lake of the Woods Co.

T157N	R30W	Sec. 19*, 25-30*, 31-35, 36*
T157N	R31W	Sec. 24-28*, 30*, 31, 32-33*, 34-36
T157N	R32W	Sec. 19-22*, 25-27*, 28-36
T157N	R33W	Sec. 21-24*, 25-28, 29-30*, 31-36
T157N	R34W	Sec. 25*, 34-36*

SIZE: (acres)

Total	CA	WPA
233,800	83,000	150,800

OWNERSHIP:

94% State - Beltrami Island & Pine Island SF & Red Lake WMA
(0% trust fund, 94% other)
4% Federal
(3% BIA - Red Lake Ind. Res.)
(1% BLM)
2% Private

SIGNIFICANCE:

This peatland contains the largest, most highly developed, and diverse patterned peatland in the United States. Features present include the largest and best developed water track in the the U.S. (except possibly Alaska), and includes every pattern fen feature including the best display of tear drop islands, circular islands (best developed of only two state locations) and ribbed fens. This peatland also contains one of the richest flora of rare plants, second only to the Lost River Peatland, with extensive populations of several of these species. Several rare animals are also found in this peatland. The transitions in surface patterns also provide value clues for the development of raised bog complexes and patterned water tracks with the tear drop islands, and for deciphering the vegetational-hydrological process that controls peatland succession. This peatland is ranked as the most significant peatland in the state and is considered to be of international significance. A portion of the area has already been designated a a National Natural Landmark.

ELEMENTS:Plant Species

Drosera linearis
Drosera anglica
Carex exilis
Cladium mariscoides
Juncus stygius
Rhychospora fusca
Xyris montana

Wildlife Species

short-eared owl
yellow rail
eastern timber wolf
Wilson's phalarope
greater sandhill crane

Landforms

Raised Bog Complex
 Raised Bogs
 Ovoid Island
 Incipient Ovoid Island
 Internal Water Tracks

Fen Complex

Ribbed Fen
Teardrop Islands
Circular Islands

OTHER ATTRIBUTES:

- last location of caribou in the state

DISTURBANCE:

Moderate - minimal for eastern and western most portions.
- drainage ditch network along section lines 1-2 miles apart for most of central sections.

- highway #72 bisects east-central watershed
- some logging near highway on bog islands and crested divide.
- fence line in west-central area (old elk farm)
- remains of cabin along north margin of western water tracks.
- some Christmas tree cutting.

FORESTRY POTENTIAL:

- data currently not available

PEAT DEVELOPMENT POTENTIAL:

Low - long distance to markets

MINERAL POTENTIAL:

B Rating - potential for silver, gold, iron, copper, nickel, lead, and zinc

Leases - past interest in the area, not offered for lease recently

MYRTLE LAKE PEATLAND (Agassiz National Natural Landmark)

Myrtle Lake Peatland is located near the eastern end of the large peatland area in the Agassiz Lowlands. This peatland marks the eastern most example of a highly developed patterned peatland complex. The peatland is characterized by a very large water track bifurcating around a massive raised bog and is classified as watershed type 4.

LOCATION: Approx. 13 mi. SE of Big Falls

Koochiching Co.

T63N	R24W	Sec. 2*, 3, 4-5*, 8-11*
T64N	R24W	Sec. 3-6*, 7, 8-10*, 15-17*, 18-20, 21-22*, 25-27*, 28-29, 30-32* 33-34, 35-36*
T65N	R24W	Sec. 29-30*, 31, 32-34*
T64N	R25W	Sec. 1-4, 5*, 7*, 8-15, 16-18*, 22-23*, 24, 25*, 26, 27*, 35-36*
T65N	R25W	Sec. 22-25*, 26, 27-28*, 33*, 34-36

SIZE: (acres)

Total	CA	WPA
36,300	23,000	13,300

(1% of the area is open water)

OWNERSHIP: 97% State - Koochiching State Forest
(97% trust fund, 0% other)
2% County
1% Private

SIGNIFICANCE:

This peatland exhibits very striking landforms that are virtually undisturbed. It includes the best developed raised bog in the state, extensive and highly developed ribbed fen patterns and is the best example of Watershed Type 4. It also contains numerous species of rare plants. This area has been valuable for scientific research since the 1960's and continues to be one of ongoing future interest. The significance of this peatland has been recognized by the U.S. Dept. of Interior, which has designated it as a National Natural Landmark, and the State, which has protected it as a Natural Area, as well as the Society of American Foresters. Myrtle Lake Peatland is ranked among the top ecologically significant peatlands in the state, second only to the Red Lake Peatland.

ELEMENTS:

Plant Species
Drosera anglica
Drosera linearis
Cladium mariscoides
Carex exilis
Juncus stygius

Wildlife Species

Eastern timber wolf
Bog copper butterfly

Landforms

Raised Bog Complex
Raised bog
Internal Water Tracks
Fen Complex
Patterned Water Track
Ribbed Fen

ADDITIONAL ATTRIBUTES:

Moose (occasional)
Peat water falls (3 ft drop)

DISTURBANCE:

Minimal - winter trails

FORESTRY POTENTIAL:

Minimal - 240 acres of commercial timber in CA

PEAT DEVELOPMENT POTENTIAL:

Low - long distance to markets

MINERAL POTENTIAL:

B Rating - potential for lead, zinc, copper, nickel,
gold, silver, and iron
Leases - requested but not offered

LOST RIVER PEATLAND

The Lost River Peatland is situated in the south central portion of the Agassiz Lowland peatland area in northern Minnesota. This loosely defined peatland covers a vast area that stretches from west of Upper Red Lake to the Big Fork River. This peatland covers a broad and nearly level lake plain that is interrupted only by low beach ridges and tributary streams. A variety of features are scattered across this peatland which is second in size only to the Red Lake Lake Peatland. This peatland is best characterized by its semi-circular shaped raised bogs abutted against a beach ridge (type 8) which occurs to varying degrees of development throughout the area. In addition, several spring fens including types 7 & 11 also occur here. Because of the wide spread nature of these peatlands and the relatively confined areal extent of the peatland landform, this peatland has been divided into several CA's and WPA's.

LOCATION: Approx. 15 mi. W of Big Falls.

Koochiching Co.

T152N	R29W	Sec. 3-4*
T153N	R27W	Sec. 16-18*, 19-20, 21*, 28-31*
T153N	R28W	Sec. 9-12*, 13-15, 16*, 21-22*, 23-25, 26-27*, 35-36*
T153N	R29W	Sec. 33-34*
T154N	R27W	Sec. 5*, 6-7, 8*, 17-19*, 21-22*, 26-28*, 33-34*
T154N	R28W	Sec. 1-18, 19-24*, 29*, 34-36*
T154N	R29W	Sec. 1-3, 4*, 9*, 10-15, 16-17*, 21-24*
T155N	R27W	Sec. 28-30*, 31, 32-33*
T155N	R28W	Sec. 5*, 6-7, 8*, 17*, 18-19, 20-21*, 25-28*, 29-36
T155N	R29W	Sec. 1, 2*, 11*, 12-13, 14*, 22-23*, 24-26, 27-28*, 33*, 34-36
T156N	R28W	Sec. 31-32*
T156N	R29W	Sec. 35-36*

SIZE: (acres)	<u>Total</u>	<u>CA</u>	<u>WPA</u>
	62,000	8,800	53,200

OWNERSHIP: 93% State - Pine Island and Red Lake SF
(75% trust fund, 18% other)
2% County
5% Private

SIGNIFICANCE:

This peatland contains a series of striking peatland landform patterns, some of which are either unique to this peatland (type 11) or best developed in this area (type 8). Some of the peatland water tracks contain the only patterned water tracks with well developed fields of tear drop islands outside the Red Lake Peatland. In addition, this peatland contains the largest number of rare plant species of any peatland in the state. These species include a species of moss that was previously thought to be extinct in North America. Because of the

unique features and the large areas broken only by beach ridges and streams it offers an excellent opportunity to study the role of regional ground water flow systems on peatlands.

ELEMENTS:

Plant Elements

Drosera anglica
Drosera linearis
Eleocharis rostellata
Rhynchospora capillacea
Tofieldia glutinosa
Triglochin palustris
Carex exilis
Cladium mariscoides
Tomenthypnum falcifolium

Landform Elements

Semi-circular Raised Bog Complex
Patterned Fen
Ribbed Fen
Teardrop Islands

OTHER ATTRIBUTES:

Archaeological site - Indian Portage between Tamarack & Sturgeon Rivers.

FORESTRY POTENTIAL:

- data not currently available

PEAT DEVELOPMENT POTENTIAL:

Low - long distance to markets

MINERAL POTENTIAL:

B Rating - potential for lead, zinc, copper, nickel, gold, silver, and iron

Leases - none

NORTH BLACK RIVER PEATLAND

The North Black River is located near the Canadian border, south of the Rainy River in north central Minnesota. It lies within the large peatland area of the Agassiz Lowlands. The major portion of this peatland contains a highly developed ovoid island, with an internal water track, that is bordered to the north by a large water track with ribbed fen pattern downslope.

LOCATION: Approx. 20 mi. W. of International Falls

Koochiching Co.

T159N	R25W	Sec. 7*, 17-18*, 19, 20-21*, 28, 30*
T158N	R25W	Sec. 6-11*, 14-15*, 16-17, 18-19*, 20-21, 23*, 27-30*
T159N	R26W	Sec. 13-14*, 17, 23, 24*, 25-30*, 31-34, 35-36*
T158N	R26W	Sec. 1*, 2-12, 13*, 14-18, 19-24*
T159N	R27W	Sec. 25*, 34-35*, 36
T158N	R27W	Sec. 1-3, 4-5*, 7-8*, 9-16, 17-18*, 20-24*

SIZE: (acres)	<u>Total</u>	<u>CA</u>	<u>WPA</u>
	41,000	8,700	32,300

OWNERSHIP: 33% State - Pine Island SF
(5% trust fund, 28% other)
51% Federal
(48% BLM, 3% BIA - Red Lake Ind. Res.)
10% County
7% Private

SIGNIFICANCE:

This peatland contains a broad range of landforms including a large water track and ovoid island with highly developed bog drains and internal water track. Also present is a large water track with ribbed fen patterns and pool development. Both the ribbed fen and internal water track contain rare plant species. This peatland also contains several peatland complex types including the best example of types 2 and 3 and an excellent example of type 4. Because of the close proximity of several good examples of peatland types situated this area offers an excellent location for comparative studies of the topographic controls in peatland pattern development, the development of internal water tracks, and the origin of surface patterns.

ELEMENTS:

Plant Species
Drosera linearis
Drosera anglica
Juncus stygius

Wildlife Species
- no data.

Landforms

Raised Bog Complex
Raised Bogs
Internal Water Tracks
Fen Complex
Featureless Water Track
Patterned Water Track
Ribbed Fen

OTHER ATTRIBUTES:

FORESTRY POTENTIAL:

- data not currently available

PEAT DEVELOPMENT POTENTIAL:

Medium - access to markets

MINERAL POTENTIAL:

B Rating - good potential for lead, zinc, copper,
nickel, gold, silver, and iron
Leases - heavy interest past and present including
exploration and drill holes

SAND LAKE PEATLAND

The Sand Lake Peatland is situated in a large outwash plain north of the Toimi Drumlin field in the northwestern part of the state. This peatland contains raised bog patterns with internal waters that are locally interrupted by lakes, eskers and mineral island outcrops. Several locations of ribbed fen patterns are found to the south. This peatland is predominately a type 3 but also contains small areas of type 6.

LOCATION: Approx. 12 mi. SW of Babbitt

Lake Co.

T59N R11W Sec. 1*, 7*, 9-13*, 14-15, 16-21*, 22,
23-24*, 26-28*, 32-33*, 34*, 35*
T58N R11W Sec. 2-4*, 8-10*, 15-17*, 20*

St. Louis Co.

T59N R12W Sec. 12-13*

SIZE: (acres)

Total	CA	WPA
12,000	600	11,800

(3% of area is Open Water)

OWNERSHIP:

- 77% State - Finland State Forest
(77% trust fund, 0% other)
- 15% Federal - Superior National Forest
- 1% County
- 6% Private

SIGNIFICANCE:

This peatland, which contains well developed raised bog and ribbed fen patterns, is geographically significant because it is the only large peatland complex in northeastern Minnesota. Its setting is also unique because it is located on an outwash plain instead of a lake plain. This setting provides an excellent example of the intricate relationship of lakes and mineral islands to peatland landform development. This peatland shows the interactions of the spread of ombrotrophic bog and topographic obstructions, displays the only example of how internal water tracks can originate by spread of a bog around mineral outcrops and lakes. The lobate margins, which are unique to this peatland suggest an advancing outward spread of ombrotrophic peat. This area presents a very interesting study area for peatland research for explaining why the bogs are so young and actively growing in comparison with other peatlands of the state that appear to be in equilibrium with the environment.

ELEMENTS:

Plant Species

Carex exilis

Juncus stygius

Wildlife Species

Eastern timber wolf

Landforms

Raised Bog Complex
 Raised Bog
 Internal Water Track
Fen Complex
 Featureless Water Track
 Patterned Fen
 Ribbed Fen

DISTURBANCE:

Minimal, with heavy impact in certain locations:
 Erie Mining railroad bisects southern portion of fen
 complex including the best developed patterned
 fens.
 A network of winter trails dissect the fen complex,
 but has not greatly altered the area.

FORESTRY POTENTIAL:

- data not currently available

PEAT DEVELOPMENT POTENTIAL:

Low - long distance to markets

MINERAL POTENTIAL:

B Rating - good potential for lead, copper, nickel, iron,
 gold and silver
Leases - past and present leasing in the area

MULLIGAN LAKE PEATLAND

Mulligan Lake is located in northwestern part of the state near the western edge of the large peatland area in the Agassiz Lowlands. This peatland is typical of patterned peatlands (type 6) near the western edge of their range and is characterized by the complete lack of bog development and is dominated by several water tracks exhibiting ribbed fen patterns.

LOCATION: Approx. 25 mi. SW of Baudette

Lake of the Woods

T159N R36W Sec. 24-29*, 32, 33-36
T159N R35W Sec. 19-20*, 29*, 30, 31-34*
T158N R35W Sec. 2-5*, 6, 7*, 8-9, 10-11*, 15*,
16, 17-18*, 20-24*

Beltrami Co.

T158N R36W Sec. 1-3, 4-5*, 10-12

SIZE: (acres)

<u>Total</u>	<u>CA</u>	<u>WPA</u>
19,100	4,400	14,700

(1% of area is Open Water)

OWNERSHIP: 84% State - Beltrami SF, Red Lake WMA
(0% trust fund, 84% other)
14% Federal
(10% BIA - Red Lake Indian Reservation, 4% LUP)
3% Private

SIGNIFICANCE:

This peatland has an excellent and complete display of all patterned fen features including ribbed fen, tear drop islands, and is one of two peatlands with the net-like reticulate flark pattern. Several rare plant species also occur there. This peatland is the finest example of peatland type 6 in Minnesota.

ELEMENTS:

Plant Species

Drosera anglica
Drosera linearis
Nymphaea tetragona

Wildlife Species

Greater Sandhill Crane
Wilson's Phalarope

Landforms

Fen Complex
 Patterned Fen
 Ribbed Fen
 Teardrop Island

OTHER ATTRIBUTES:

sharp-tailed grouse - one of the few strongholds in Beltrami
Island State Forest.
formerly prairie chicken inhabited area (1930's)

DISTURBANCE:

Minimal - winter trails only

FORESTRY POTENTIAL:

Low - 360 acres of commercial timber

PEAT DEVELOPMENT POTENTIAL

Low - long distance to markets
- completely in WMA

MINERAL POTENTIAL

B Rating - potential for lead, copper, nickel, iron,
gold, and silver
Leases - current and past, also drilling in area

LOST LAKE PEATLAND

The Lost Lake Peatland is a relatively small peatland located in north-eastern part of the state and situated between the large peatland area of the Agassiz Lowlands and the Sand Lake Peatland. This peatland contains both bog and ribbed fen patterns, including an incipient ovoid island. These patterns are interrupted by a large lake (Lost Lake) and mineral islands

LOCATION: Approx. 5 mi. W of Tower, S. of Lake Vermilion.

St. Louis Co.

T62N R16W Sec. 17-18*, 19-20, 21*, 28-29*,
30, 31-32*

T62N R17W Sec. 13*, 23-26*, 35-36*

T61N R16W Sec. 5-6*

SIZE: (acres)

Total	CA	WPA
<u>7,900</u>	<u>1,600</u>	<u>6,300</u>

(7% of area is Open Water)

OWNERSHIP: 28% State
(28% trust fund, 0% other)
57% County
15% Private

SIGNIFICANCE:

This peatland contains interesting landform patterns that are only minimally disturbed. These include raised bog patterns and water track patterns and provide the best example of a type 5 peatland. The ribbed fen contains several rare species. These patterns provide an important link in the geographical variation between the Agassiz Lowlands and the Sand Lake Peatland. This peatland also contains an incipient ribbed fen and ovoid island, which may provide an important example of a potentially early stage of patterned water track and ovoid island development.

ELEMENTS:

Plant Species

Carex exilis

Juncus stygius

Wildlife Species

- no data.

Landforms

Raised Bog Complex

Raised Bog

Ovoid Islands

Fen Complex

Featureless Water Track

Patterned Water Track

Ribbed Fen

DISTURBANCE:

Minimal - winter trails

FORESTRY POTENTIAL:

- data currently not available

PEAT DEVELOPMENT POTENTIAL:

Medium - proximity to potential markets

MINERAL POTENTIAL:

B Rating - good potential for copper, lead, zinc, iron,
silver, nickel, and gold

Leases - past and present interest heavy

PINE CREEK PEATLAND

The Pine Creek Peatland is located northwest of the major peatland area of the Agassiz Lowlands and along the Canadian border west of Lake of the Woods. A large portion of this peatland is located in Canada. This peatland is a type 7 and contains spring fen landforms that are bordered to the east by a water track with ribbed fen patterns.

LOCATION: Approx. 11 mi. NW of Roseau, on Canadian Border

Roseau Co.

T164N R41W Sec. 25-27*, 35-36*

T163N R41W Sec. 1-2*

T164N R40W Sec. 30-31*

SIZE: (acres)

<u>Total</u>	<u>CA</u>	<u>WPA</u>
2,200	800	1,400

OWNERSHIP: 96% State
(89% trust, 7% other)
4% Private

SIGNIFICANCE:

This peatland contains the best developed example in the state of a spring fen landform and type 7 peatland complex. This peatland is only minimally disturbed and contains several rare plants.

ELEMENTS:

Plant Species

Drosera anglica

Cladium mariscoides

Wildlife Species

- no data

Landform

Spring Fen

Ribbed Fen

DISTURBANCE:

None, except for international boundary right-of-way

FORESTRY POTENTIAL:

- data not currently available

PEAT DEVELOPMENT POTENTIAL:

Low - long distance to markets

MINERAL POTENTIAL:

B & E Rating

Leases - none

OTENEAGEN PEATLAND

The Oteneagen Peatland is located in north central Minnesota, south of the Agassiz Lowlands and west of glacial lakes Aitkin and Upham. This peatland is a basin filled raised bog (type 1) with three distinct raised bog crests.

LOCATION: Approx. 20 mi. NW of Grand Rapids

Itasca Co.

T58N R27W Sec. 15-16*, 22-23*, 26-27*, 34-35*

T57N R27W Sec. 3*, 10-11*, 15*

T146N R25W Sec. 1*, 11-12*, 13, 14*, 23-25*

T147N R25W Sec. 24-25*, 36*

SIZE: (acres)

<u>Total</u>	<u>CA</u>	<u>WPA</u>
9,300	3,800	5,500

(5% of the area is open water)

OWNERSHIP: 86% State - Bowstring State Forest
(86% trust fund, 0% other)
7% Federal - Chippewa National Forest
6% Private

SIGNIFICANCE:

This peatland has a large and relatively well developed raised bog patterns. It is a good example of a peatland complex type 1 and the only candidate peatland with this type. However, its significance within this type remains to be determined. It is also geographically isolated from the other candidate peatlands.

ELEMENTS:

Plant Species

- no rare species found

Wildlife Species

- no data.

Landform

Raised Bog Complex

DISTURBANCE:

Low - drainage ditch

FORESTRY POTENTIAL:

- data not currently available

PEAT DEVELOPMENT POTENTIAL:

Low - long distance to markets

MINERAL POTENTIAL:

B Rating - potential for lead, zinc, copper, nickel,
iron, gold, and silver

Leases - none

- leasing to the east of the peatland in the same
rock types

WAWINA PEATLAND

The Wawina Peatland is situated in the heart of the Glacial Lake Aitkin and Upham lake plain in northeastern part of the state. The peatland area is contains a large raised bog complex west and south of highway 2. However, the feature of interest in this peatland is the ovoid islands accompanied by a featureless water track.

LOCATION: Approx. 7 mi. NW of Floodwood

St. Louis Co.

T53N R21W Sec. 26-30*, 31-33, 34-35*
T52N R21W Sec. 3*, 4-6, 7-10*

Aitkin Co.

T52N R22W Sec. 1*, 12*

Itasca Co.

T53N R22W Sec. 36*

SIZE: (acres)

Total	CA	WPA
8,600	3,600	5,000

OWNERSHIP:

- 1% State
(1% trust fund, 0% other)
- 81% County
- 17% Private

SIGNIFICANCE:

The peatland provide the best ovoid island patterns in the northeastern part of the state. This peatland complex is also important geographically because it is the most southern example of a large patterned peatland complex in Minnesota and is the only candidate peatland representing the glacial lakes Aitkin and Upham peatland area.

ELEMENTS:

Plant Species
- None found

Wildlife Species
- No data.

Landforms
Ovoid Island
Featureless Water Track
Ribbed Fen

OTHER ATTRIBUTES:

High sharp-tail grouse densities

FORESTRY POTENTIAL:

- data currently not available

PEAT DEVELOPMENT POTENTIAL:

High - proximity to potential markets

MINERAL POTENTIAL:

C Rating - fair potential for zinc, copper, lead, gold,
and silver
Leases - none

NETT LAKE PEATLAND

The Nett Lake Peatland is located on the eastern edge of the Agassiz Lowland peatland area in north central Minnesota. This peatland, which completely surrounds Nett Lake contains a spring fen whose channels originate near the headwaters at the western edge of the peatland and feed into a peat cutting stream.

LOCATION: Approx. 28 mi. S. of Little Fork

Koochiching Co.
T65N R22W Sec. 27-29*, 32-34*

SIZE: (acres)	<u>Total</u>	<u>CA</u>	<u>WPA</u>
	1,400	300	1,400

OWNERSHIP: 3% County
88% Federal - BIA - Nett Lake Indian Reservation
9% Private

SIGNIFICANCE:

The peatland contains a striking example of undisturbed spring fen patterns (peatland type 7) matched only by Pine Creek. This peatland is the eastern-most occurrence of spring fen in Minnesota. Several rare species are also found in this peatland.

ELEMENTS:

Plant Species
Eleocharis rostellata
Cladium mariscoides
Triglochin palustris

Wildlife Species
- no data.

Landform
Spring Fen

DISTURBANCE:

None

FORESTRY POTENTIAL:

- no data currently available

PEAT DEVELOPMENT POTENTIAL:

Low - long distance to markets

MINERAL POTENTIAL:

D Rating - potential for uranium
Leases - none

EAST RAT ROOT RIVER PEATLAND

The East Rat Root River Peatland is located in north central Minnesota near the Canadian Border and extends part way into Voyageurs National Park. This peatland contain minimally disturbed raised bog features bordered by a featuresless water track (peatland type 5) which are formed by channeled runoff from adjacent uplands.

LOCATION: Approx. 9 mi SE of International Falls

Koochiching Co.

T70N R22W Sec. 28-31*, 32, 33*
T69N R22W Sec. 2-4*, 5, 6-7*, 8, 9-11*, 17-18*
T70N R23W Sec. 8-17*, 20-22*, 24-26*, 34-36*
T69N R23W Sec. 1-3*

SIZE: (acres)

Total	CA	WPA
9,800	2,200	7,600

OWNERSHIP:

- 79% State
(0% trust fund, 79% other)
- 14% Federal - Voyageurs National Park
- 4% County
- 2% Private

SIGNIFICANCE:

This peatland represents a fine example of an minimally disturbed peatland type 5 matched only in the North Black River Peatland. The unusual shapes of some of the raised bogs are ideal for comparative studies of topographic controls on pattern development and the effects of surface runoff on peatland development.

ELEMENTS:

Plant Species
- no rare species found

Wildlife Species
- no data.

Landforms
Raised Bog Complex
 Raised bog
 Internal Water Tracks
Fen Complex
 Featureless Water Track

OTHER ATTRIBUTES:

eastern portion occurs in national park.

DISTURBANCE:

Minimal - winter roads

FORESTRY POTENTIAL:

- data currently not available

PEAT DEVELOPMENT POTENTIAL:

Uncertain - close proximity to a potential markets, but
may be restricted due to proximity of
national park

MINERAL POTENTIAL:

B Rating - potential for gold
Leases - none

SOUTH BLACK RIVER PEATLAND

The South Black River Peatland is located in the heart of the large peatland area of the Agassiz Lowlands in the north central part of the state. Although the features of this peatland occupy a relatively small area, the peatland is loosely defined and stretches for miles in either direction. This peatland is characterized by a water track bifurcating around a large semi-circular raised bog (type 8).

LOCATION: Approx. 16 mi. NW of Big Falls

Koochiching Co.

T157N	R26W	Sec. 17-18*, 19, 20-21*, 28-29*, 30, 31-32*
T157N	R27W	Sec. 10-13*, 14, 15*, 21-22*, 23-27, 28*, 33-34*, 35, 36*
T156N	R27W	Sec. 1*, 2, 3*, 10-12*, 14-15*
T156N	R26W	Sec. 6*

SIZE: (acres)	<u>Total</u>	<u>CA</u>	<u>WPA</u>
	15,600	5,700	9,900

OWNERSHIP: 96% State
(2% trust fund, 94% other)
1% County
3% Private

SIGNIFICANCE:

This peatland has the largest and one of the best examples of an undisturbed peatland complex type 8. This peatland type is found elsewhere only in the Lost River Peatland to the south. Although it lacks some of the extensive patterned fen features of the Lost River examples, this peatland has a much more extensively developed raised bog that contain internal water tracks. This peatland also contain several rare species.

ELEMENTS:

Plant Species

Drosera anglica
Drosera linearis

Wildlife Species

- no data

Landforms

Semi-circular Raised Bog Complex
Featureless Water Track
Ribbed Fen

OTHER ATTRIBUTES:

DISTURBANCE:

Minimal - drainage ditch along south west border.
- powerline cut through portions of the peatland.

- some Christmas tree cutter lanes through the area.

FORESTRY POTENTIAL:

- data not currently available

PEAT DEVELOPMENT POTENTIAL:

Low - inaccessible and long distance to markets

MINERAL POTENTIAL:

B Rating - potential for copper, lead, zinc, nickel, iron, gold, and silver

Leases - recent leasing activity in area, with drill holes and exploration data available

WINTER ROAD LAKE PEATLAND

Winter Road Lake Peatland is located in northwestern part of the state on the edge of the large peatland area of the Agassiz Lowlands. This peatland is typical of patterned peatlands near the western edge of their range (Watershed Type 6). It is characterized by the almost complete lack of bog development and is dominated by water tracks exhibiting ribbed fen patterns.

LOCATION: Approx 14 mi SW of Warroad

Lake of the Woods Co.

T160N R34W Sec. 5-6*, 7, 8-10*, 15*, 16-18,
19-22*

T160N R35W Sec. 1-12, 13, 14-15*, 18*,
23-24*

T160N R36W Sec. 1-3*, 10*, 11-12, 13-15*

Roseau Co.

T161N R35W Sec. 28*, 31-34*

T161N R36W Sec. 36*

SIZE: (acres)

<u>Total</u>	<u>CA</u>	<u>WPA</u>
18,000	2,700	15,300

(1% of area is Open Water)

OWNERSHIP: 69% State - Beltrami Island SF
(0% trust fund, 69% other)
25% Federal
(15% Red Lake Indian Reservation)
(10% LUP)
6% Private

SIGNIFICANCE:

This peatland contains a very well developed ribbed fen. Although moderately disturbed by ditches, the patterns are particularly striking due to tree and shrub growth occurring on the drier strings and their strongly arcuate shape in certain areas. It is one of 2 areas which contain a net-like reticulate flark patterns. A small raised bog, an uncommon feature this far northwest in the state is also present.

ELEMENTS:

Plant Species
- none found

Wildlife Species
- no data.

Landform
Patterned Water Track
Ribbed Fen

OTHER ATTRIBUTES:

sharp-tail grouse habitat

DISTURBANCE:

Moderate - drainage ditches and a road

FORESTRY POTENTIAL:

Low - 240 acres of commercial timber in CA

PEAT DEVELOPMENT POTENTIAL:

Low - distant from markets

MINERAL POTENTIAL:

B Rating (with some E) - potential for gold, silver,
iron, nickel, copper, lead, zinc

Leases - currently in peatland and surrounding area

SPRAGUE CREEK

The Sprague Creek Peatland is located northwest of the large peatland area of the Agassiz Lowlands, near the Canadian border and east of Pine Creek. This peatland contains spring form landforms (type 7) situated in a large swamp forest.

LOCATION: Approx. 7 mi. N. of Roseau

Roseau Co.

T164N R40W Sec. 25-28*, 33*, 34-36

T163N R40W Sec. 1-3, 4*, 9-13*

T164N R39W Sec. 27-31*, 32-33, 34*

T163N R39W Sec. 4-5*, 6, 7-8*, 18*

SIZE: (acres)

Total	CA	WPA
12,400	600	11,800

OWNERSHIP: 97% State
(6% trust fund, 91% other)
3% Private

SIGNIFICANCE:

This peatland contains a good example of one of only five spring fen landforms in the state. The presence of ditches in the southern portion of this peatland and the absence of rare plants make this area of less significance than the Pine Creek or Nett Lake peatlands. Several rare animal species occur in adjacent peatland areas.

ELEMENTS:

Plant species

- no rare species found

Wildlife species

- greater sandhill crane

Landforms

Spring Fen

OTHER ATTRIBUTES:

- a portion of this peatland is being managed for great gray owl

DISTURBANCE:

Moderate - downslope portion of spring fen channels are truncated by a ditch

FORESTRY POTENTIAL:

- data not currently available

PEAT DEVELOPMENT POTENTIAL:

Low - long distance to markets

MINERAL POTENTIAL:

B & E Rating
Leases - none

LUXEMBERG PEATLAND (MUD LAKE PEATLAND)

The Luxemberg Peatland is located in the northwestern part of Minnesota near the western edge of the large peatland area of the Agassiz Lowlands. This peatland is a relatively small peatland, typical of the patterned peatlands near the western edge of their range. It is characterized by the lack of bog patterns and is dominated by a water track with areas of ribbed fen patterns.

LOCATION: Approx. 15 mi S. of Warroad

Roseau Co.
T160N R37W Sec. 9-11*, 14*, 15, 16-17*, 20-22*

SIZE: (acres) Total CA WPA
 3,200 700 2,500
(2% of the area is open water)

OWNERSHIP: 73% State - Beltrami Island S.F.
 (0% trust, 73 % other)
26% Federal
 (23% BIA - Red Lake Indian Reservation)
 (3% LUP)
1% Private

SIGNIFICANCE:
This peatland is a good example of a ribbed fen peatland (type 6) and contains one rare species. Its significance is diminished somewhat by the presence of ditches and occurrence of other peatlands of this type in the adjacent areas.

ELEMENTS:
Plant Species
Drosera anglica

Wildlife Species
- no data.

Landform
Ribbed Fen

OTHER ATTRIBUTES:

DISTURBANCE: Moderate - drainage ditches

FORESTRY POTENTIAL:
- data not currently available

PEAT DEVELOPMENT POTENTIAL:
Low - long distance to markets

MINERAL POTENTIAL:
B Rating - potential for gold, silver, iron, nickel,
copper, lead, and zinc
Leases - curenly in adjacent uplands

WEST RAT ROOT RIVER PEATLAND

The West Rat Root River Peatland is located near the Canadian border in northcentral Minnesota near the eastern limits of the Agassiz Lowlands. This peatland is adjacent to the East Rat Root River and is separated only by the Rat Root River. This peatland contains bog patterns dissected by featureless water tracks feed by upland runoff.

LOCATION: Approx. 4 mi. SE of International Falls

Koochiching Co.

T70N R23W Sec. 8-17*, 20-22*, 24-26*, 34-36*
T69N R23W Sec. 1-3*

SIZE: (acres)	<u>Total</u>	<u>CA</u>	<u>WPA</u>
	3,600	1,000	2,600

OWNERSHIP: 100% State
(100% trust fund, 0% other)

SIGNIFICANCE:

This peatland contains well defined patterns typical of a type 3 peatland. Although the peatland is disturbed by both ditches and fires, this peatland provides a good example of a type 3 peatland that is at an earlier stage of development as the one in the North Black River Peatland. It thus provides a good standard of comparison for a comparative study of that type.

ELEMENTS:

Plant Species

- no rare species found

Wildlife Species

- no data.

Landforms

Raised Bog Complex
 Raised Bog
 Internal Water Tracks
Fen Complex
 Featureless Water Track

DISTURBANCE:

Moderate - ditches and railroad (except for eastern most portion).
- burned over in south.

FORESTRY POTENTIAL:

- no data currently available

PEAT DEVELOPMENT POTENTIAL:

Uncertain - close proximity to a potential market but may be restricted due to proximity to national park

MINERAL POTENTIAL:

B Rating - good potential for gold
Leases - none, but interest expected in the future

NORRIS CAMP PEATLAND

Norris Camp Peatland is located in northwestern part of the state near the western edge of the large peatland area in the Agassiz Lowlands. This peatland is typical of the patterned peatlands (type 6) near the western limits of their range and is characterized by the lack of bog patterns and is characterized by a water track exhibiting ribbed fen patterns.

LOCATION: Approx. 19 mi. SW of Warroad

Lake of the Woods Co.

T160N R36W Sec. 26-28*, 32*, 33-34, 35-36*

T160N R35W Sec. 31-32*

Beltrami Co.

T159N R36W Sec. 1-5*, 10-11*

T159N R35W Sec. 6*

SIZE: (acres)	<u>Total</u>	<u>CA</u>	<u>WPA</u>
	6,300	1,600	4,700

OWNERSHIP: 86% State (Beltrami State Forest)
(0% trust, 86% other)
3% Federal - LUP
12% Private

SIGNIFICANCE:

This peatland contains ribbed fen patterns with a relatively rich Ca⁺ concentrations. This peatland is situated in an area of several other peatlands of the same type, and because this peatland is moderately disturbed its significance is reduced. It does, however, provide a good example of the impact of ditches on peatland landforms.

ELEMENTS:

Plant Species

- no rare species found

Wildlife Species

- no data

Landform

Patterned Water Track
Ribbed Fen

OTHER ATTRIBUTES:

DISTURBANCE:

High - drainage ditches

FORESTRY POTENTIAL:

- data not currently available

PEAT DEVELOPMENT POTENTIAL:

Low - distance to potential markets

MINERAL POTENTIAL:

B Rating - potential for copper, lead, zinc, nickel,
iron, gold, and silver

Leases - current activity, including drillholes in area

APPENDIX F
Peatland Candidate Area Maps

Following are a complete set of maps for 3 of the 18 candidate peatland areas for which complete data is available. Each set includes the following maps:

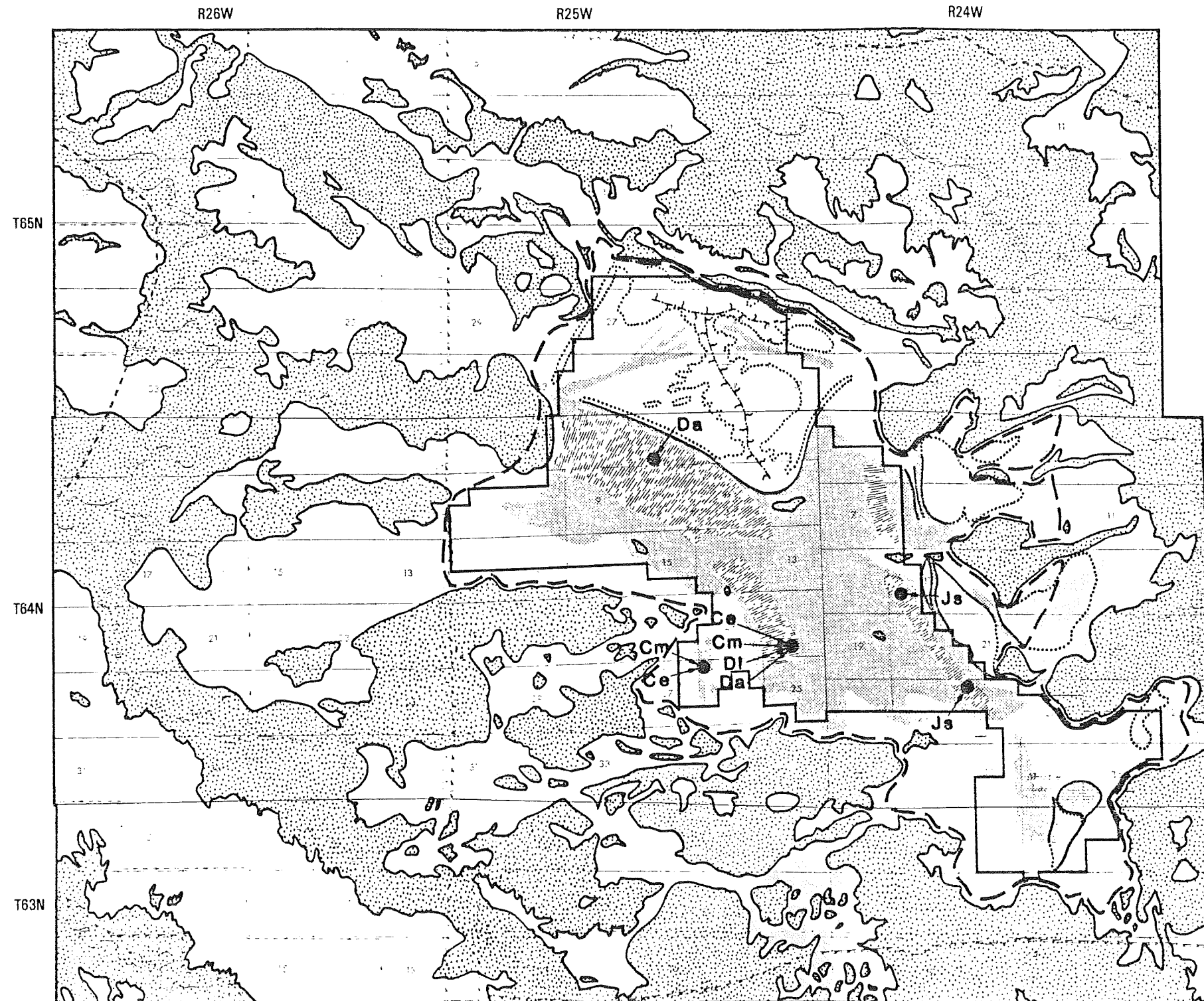
- A. Ecologically Significant Elements
- B. Surficial Water Flow
- C. Existing Disturbance
- D. Land Ownership
- E. Commercial Forestry Potential
- F. Mineral Potential and Areas Leased for Mineral Potential

Although these maps may be difficult to read, the quality should greatly improve in the final report. The final version of the maps will be printed in two colors instead of photocopied.

These maps are included in the report to provide an indication of the type of information being gathered and to show the scale at which the information will be provided. The large format has been adopted in order to accommodate the large range in peatland sizes while maintaining the same scale. These maps will be evaluated and revised as necessary.

Maps for the remaining 15 peatland candidate areas are being drafted at this time. For this report maps showing the current boundaries of the core and watershed protection areas of these 15 areas are provided.

Map 12A. Ecologically Significant Elements in the Myrtle Lake Peatland



LANDFORMS

FEN:



Featureless Water Track



Ribbed Fen, pattern oriented perpendicular to direction of water flow



Teardrop Islands

BOG:



Raised Bog,
dotted line indicates indistinct boundary
solid line indicates distinct boundary



Crest of Raised Bog
(water flow off each side of crest)



Ovoid Island,
solid line indicates distinct boundary
dotted line indicates indistinct boundary

SPECIES

PLANT OCCURRENCES:

- Reported, herbarium specimen collected
- Reported, no specimen collected

ANIMAL OCCURRENCES:

- Nesting location
- Siting location

Ce *Carex exilis*

Cm *Cladium mariscoides*

Da *Drosera anglica*

DI *Drosera linearis*

Js *Juncus stygius*

MANAGEMENT AREA BOUNDARY

— Core Area

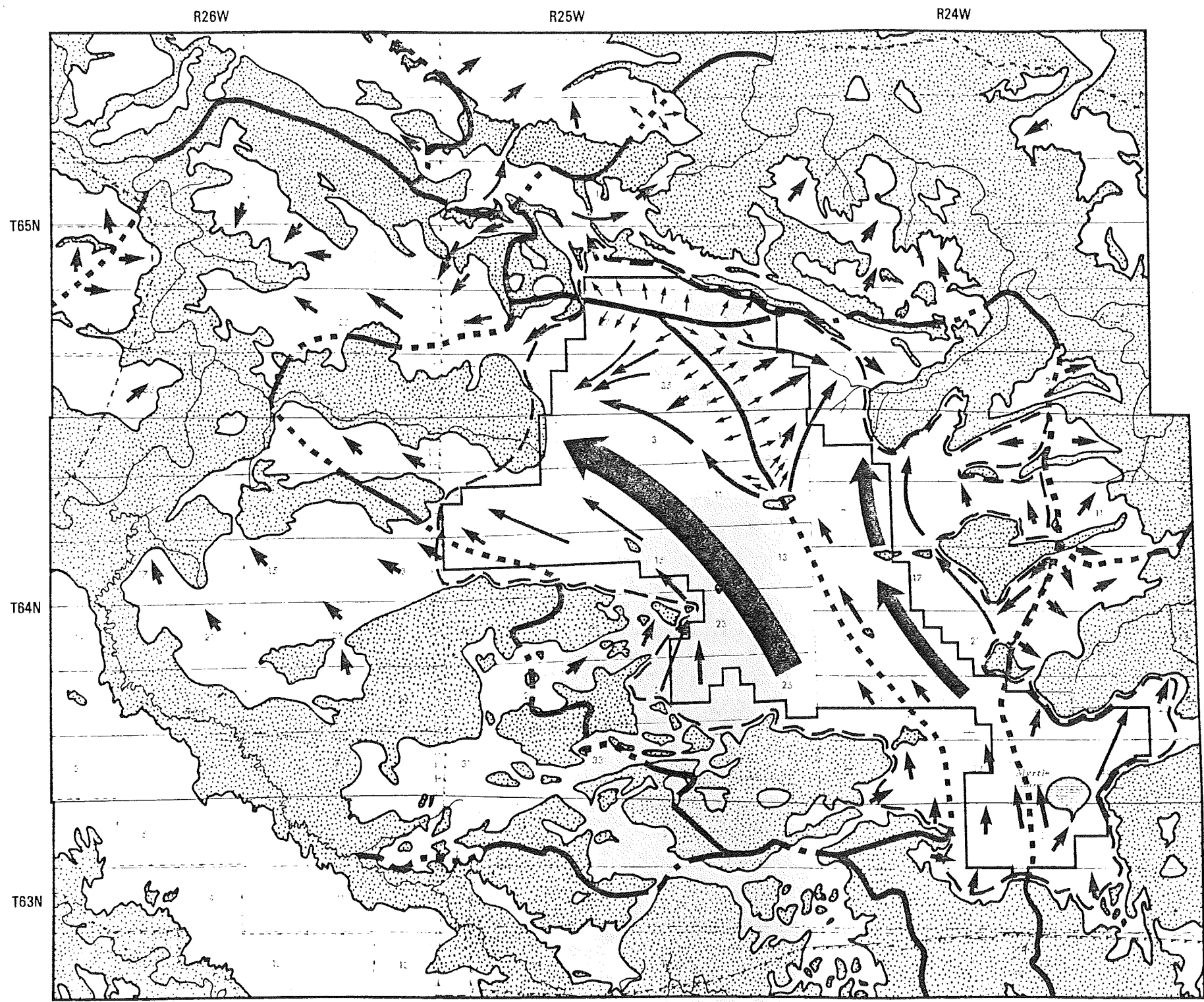
- - - Watershed Protection Area

SURFICIAL GEOLOGY

□ Peat

■ Mineral Soil

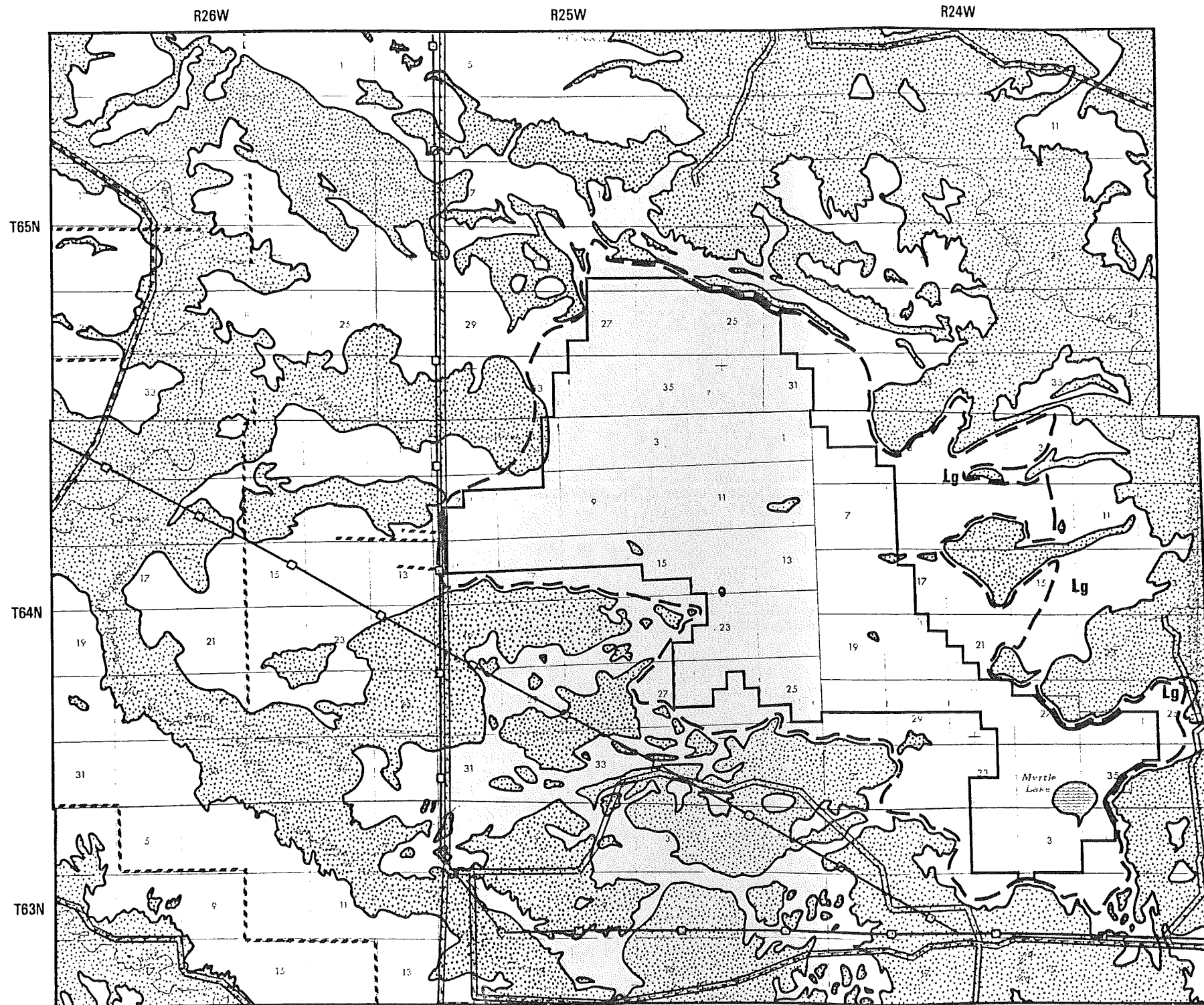
0 .5 1 2 3 Miles
One-half inch equals one mile



Map 12B. Surficial Water Flow in the Myrtle Lake Peatland

- SURFICIAL WATER FLOW**
- Generalized Watershed Boundary, dashed where indefinite
 - Direction of Flow, width of arrow indicates relative degree of flow
 - ⊕ Water Flow off Crest of Raised Bog
- MANAGEMENT AREA BOUNDARY**
- Core Area
 - - - Watershed Protection Area
- SURFICIAL GEOLOGY**
- Peat
 - ▒ Mineral Soil

0 .5 1 2 3 Miles
One-half inch equals one mile.



Map 12C. Existing Disturbance in the Myrtle Lake Peatland

DISTURBANCE FACTORS

- == Road
- Ditch
- + + + Railroad
- Utility Corridor (Powerline or Pipeline)
- Lg Logging Activity
- ▣ Agricultural Activity

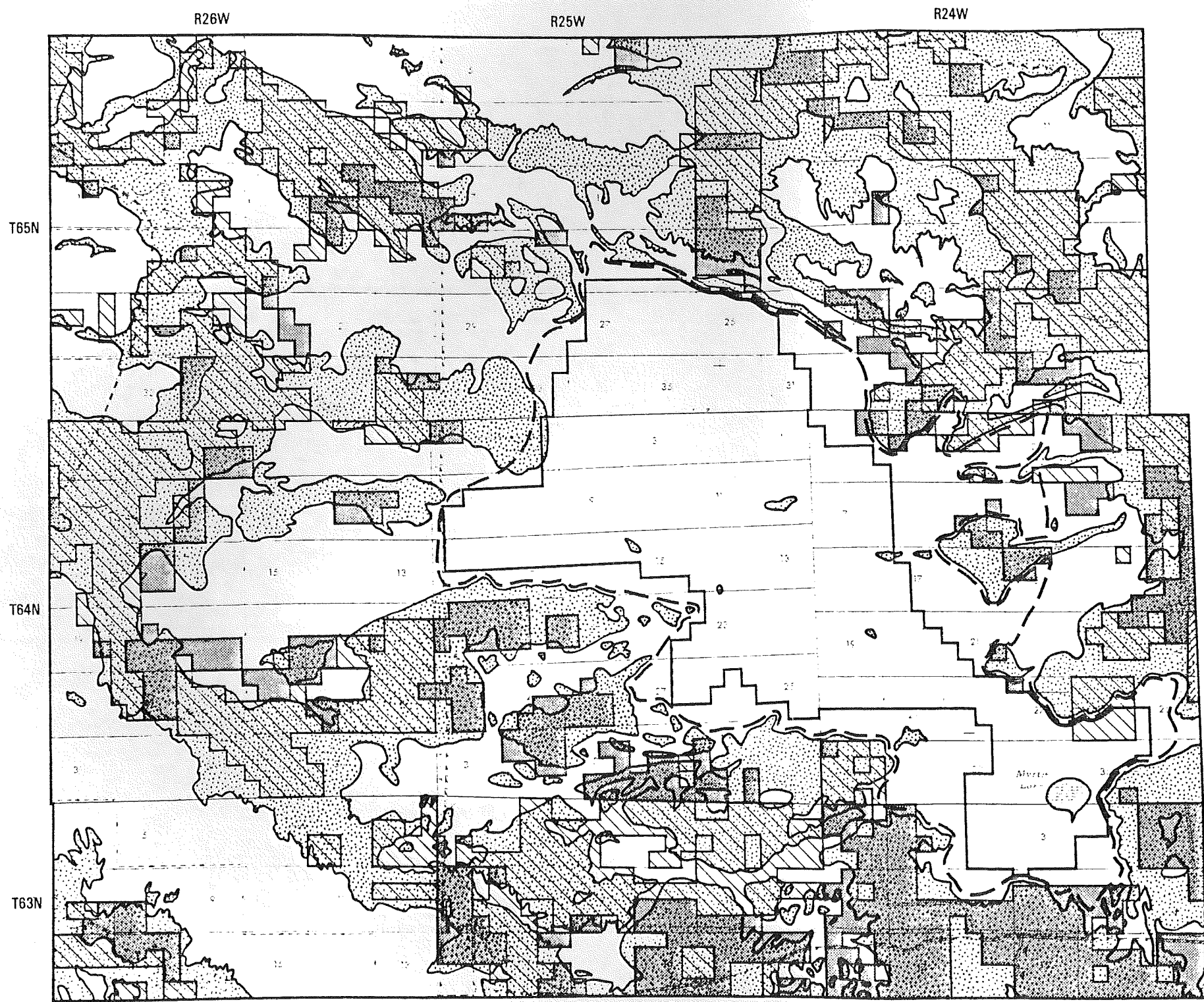
MANAGEMENT AREA BOUNDARY

- Core Area
- - - Watershed Protection Area

SURFICIAL GEOLOGY





- Peat
- ▣ Mineral Soil

0 .5 1 2 3 Miles
One-half inch equals one mile.





Map 12D. Land Ownership in the Myrtle Lake Peatland



LAND OWNERSHIP

-  State
-  County
-  Federal
-  Private

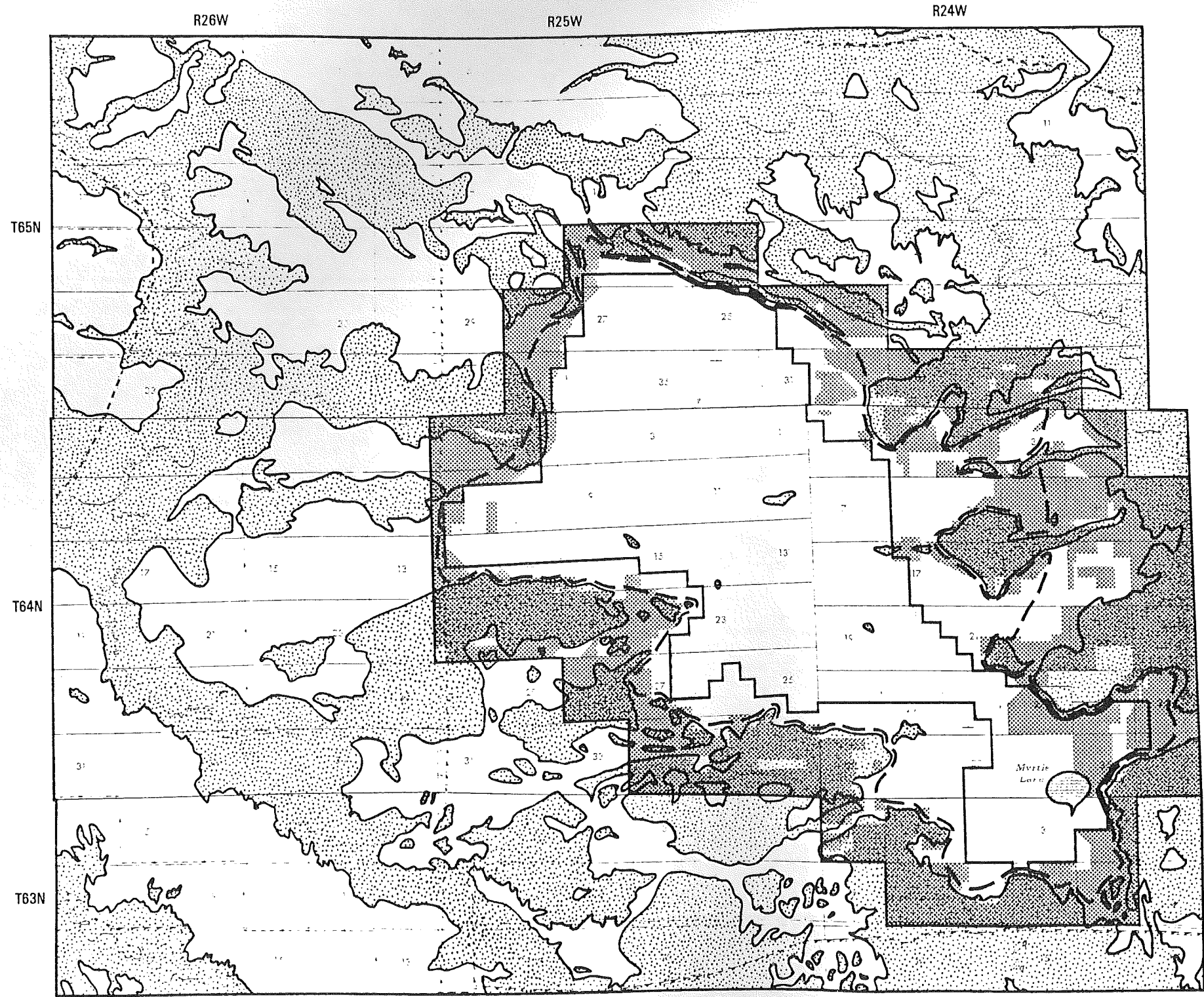
MANAGEMENT AREA BOUNDARY

-  Core Area
-  Watershed Protection Area

SURFICIAL GEOLOGY

-  Peat
-  Mineral Soil

0 .5 1 2 3 Miles
 One-half inch equals one mile.



Map 12E. Commercial Forestry Potential in the Myrtle Lake Peatland

FORESTRY POTENTIAL

- Data Collected Within this Boundary
- ▨ Commercial Timber
- No Commercial Timber
- ? No Data Available

MANAGEMENT AREA BOUNDARY

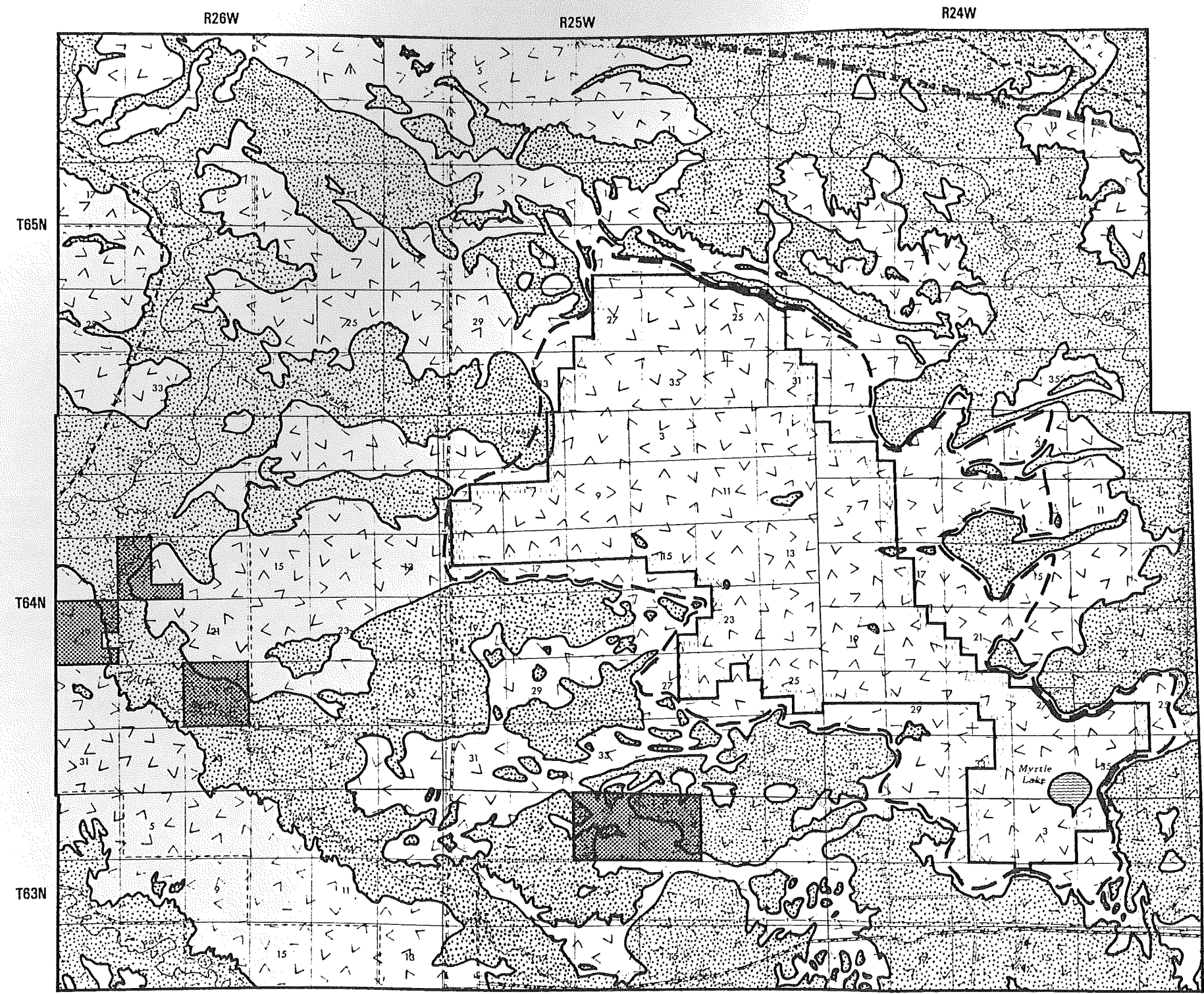
- Core Area
- - - Watershed Protection Area

SURFICIAL GEOLOGY

- Peat
- ▨ Mineral Soil

0 .5 1 2 3 Miles
One-half inch equals one mile.

Map 12F. Mineral Potential and Areas Leased for Mineral Exploration in the Myrtle Lake Peatland



MINERAL POTENTIAL

Mineral Potential Rating:

- A High
- B
- C to
- D
- E Low

Boundary Zone

AREA LEASED FOR MINERAL EXPLORATION

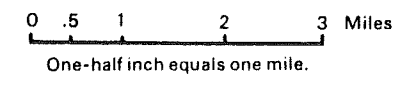
- Existing Leases
- Past Leases
- Drilling Activity

MANAGEMENT AREA BOUNDARY

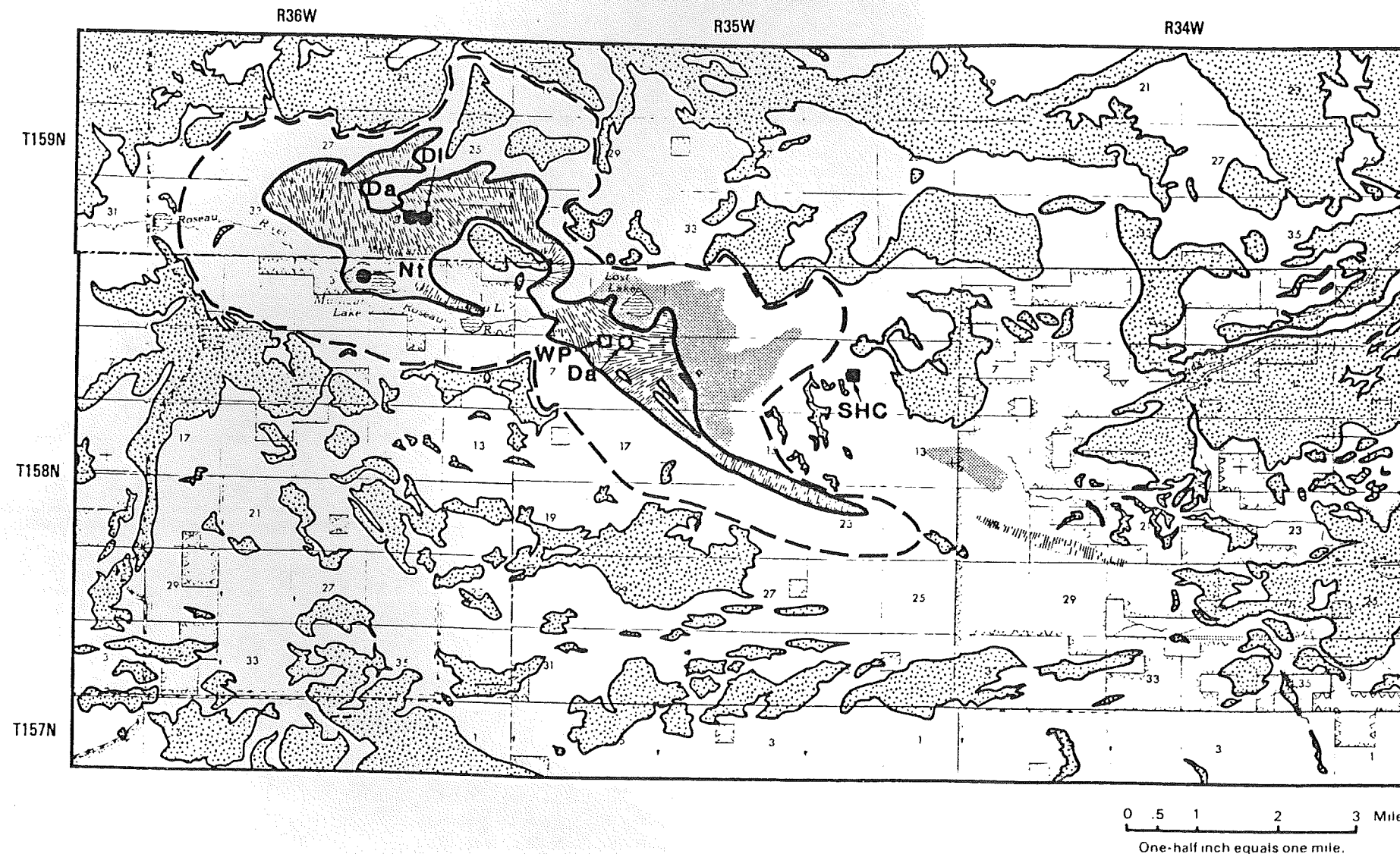
- Core Area
- Watershed Protection Area

SURFICIAL GEOLOGY

- Peat
- Mineral Soil






Map 13A. Ecologically Significant Elements
in the Mulligan Lake Peatland






LANDFORMS

FEN:

-  Featureless Water Track
-  Ribbed Fen, pattern oriented perpendicular to direction of water flow
-  Teardrop Islands

BOG:

-  Raised Bog,
dotted line indicates indistinct boundary
solid line indicates distinct boundary
-  Crest of Raised Bog
(water flow off each side of crest)
-  Ovoid Island,
solid line indicates distinct boundary
dotted line indicates indistinct boundary

SPECIES

PLANT OCCURRENCES:

- Reported, herbarium specimen collected
- Reported, no specimen collected

ANIMAL OCCURRENCES:

- Nesting location
- Siting location

Da *Drosera anglica*

DI *Drosera linearis*

Nt *Nymphaea tetragona*


SHC Greater Sandhill Crane

WP Wilson's Phalarope

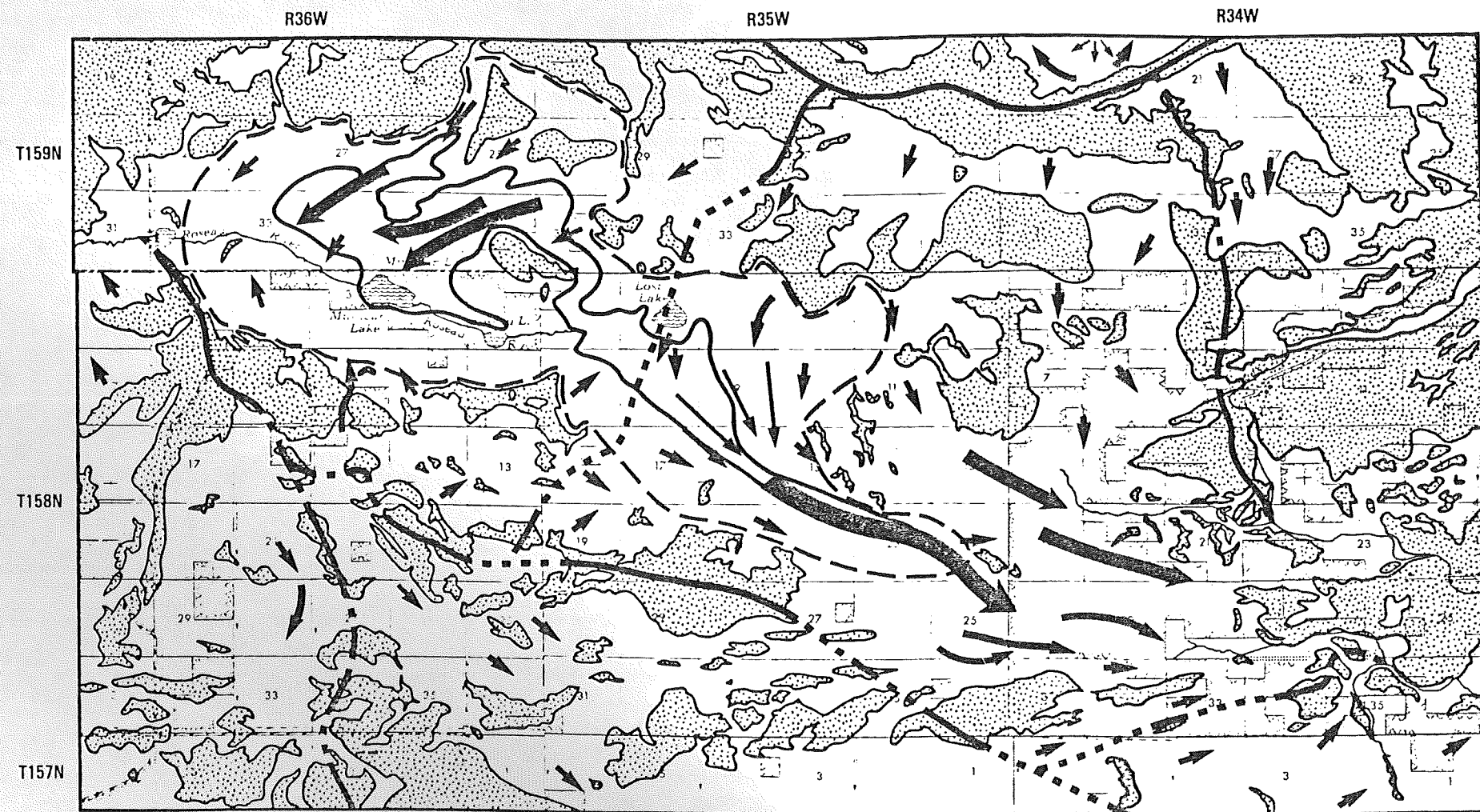
MANAGEMENT AREA BOUNDARY

- Core Area
- - - Watershed Protection Area

SURFICIAL GEOLOGY

-  Peat
-  Mineral Soil

Map 13B. Surficial Water Flow in the Mulligan Lake Peatland



SURFICIAL WATER FLOW

- Generalized Watershed Boundary, dashed where indefinite
- Direction of Flow, width of arrow indicates relative degree of flow
- Water Flow off Crest of Raised Bog

MANAGEMENT AREA BOUNDARY

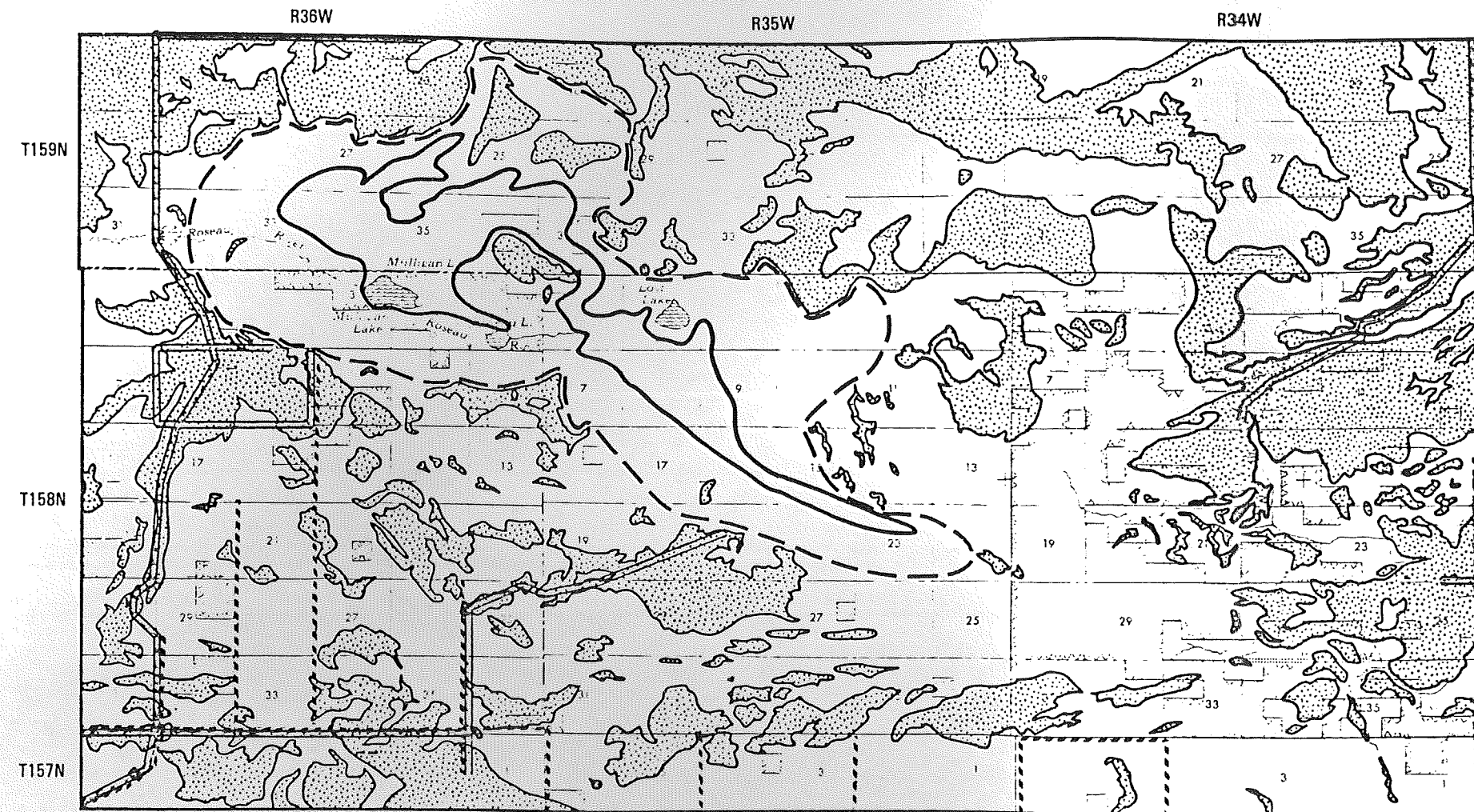
- Core Area
- Watershed Protection Area

SURFICIAL GEOLOGY

- Peat
- Mineral Soil

0 5 1 2 3 Miles
One-half inch equals one mile.

Map 13C. Existing Disturbance in the Mulligan Lake Peatland



DISTURBANCE FACTORS

- == Road
- Ditch
- + + + Railroad
- □ - Utility Corridor (Powerline or Pipeline)
- Lg Logging Activity
- ▣ Agricultural Activity

MANAGEMENT AREA BOUNDARY

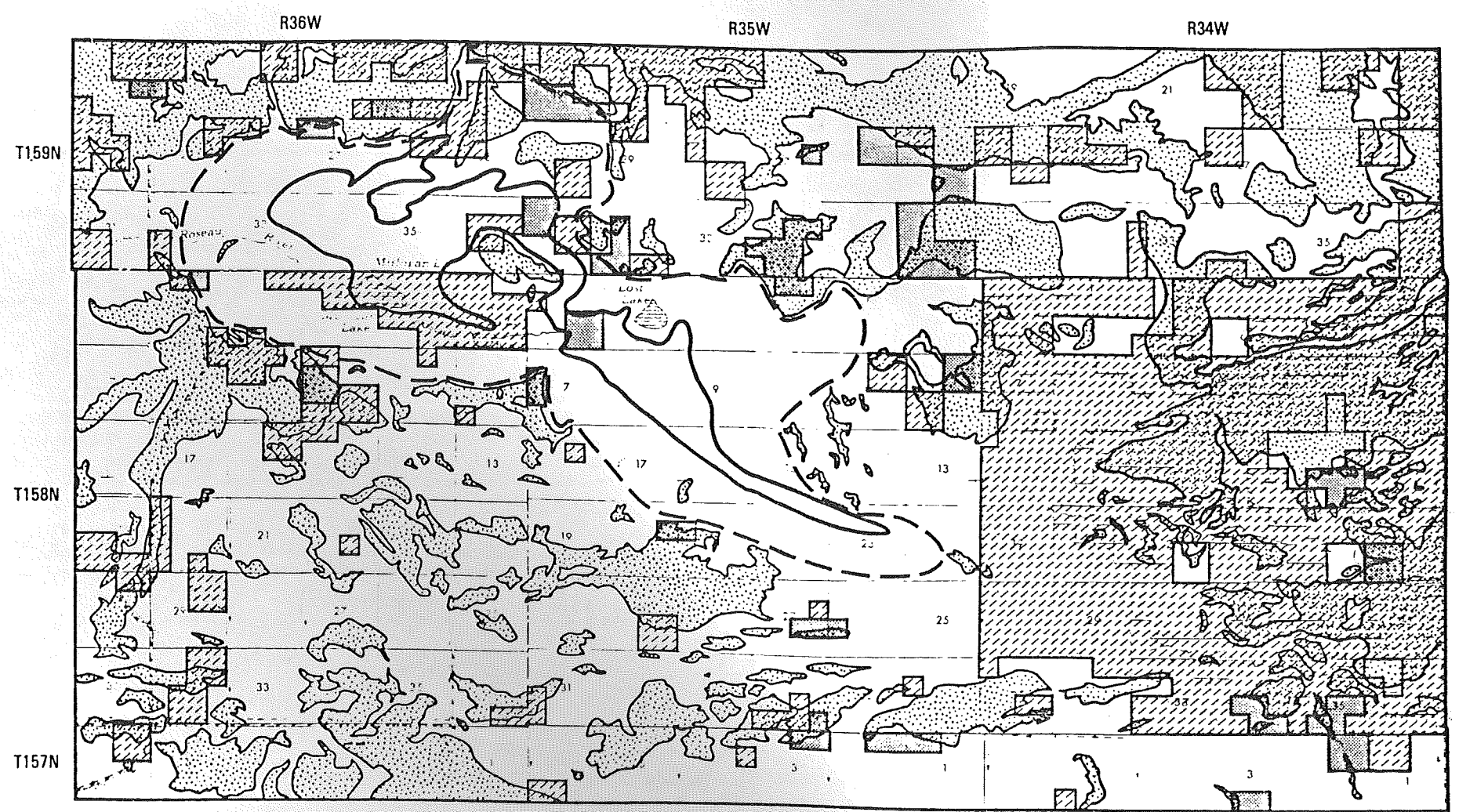
- Core Area
- - - Watershed Protection Area

SURFICIAL GEOLOGY





- Peat
- ▣ Mineral Soil

0 .5 1 2 3 Miles
One-half inch equals one mile.



Map 13D. Land Ownership in the Mulligan Lake Peatland





LAND OWNERSHIP

-  State
-  County
-  Federal
-  Private

MANAGEMENT AREA BOUNDARY

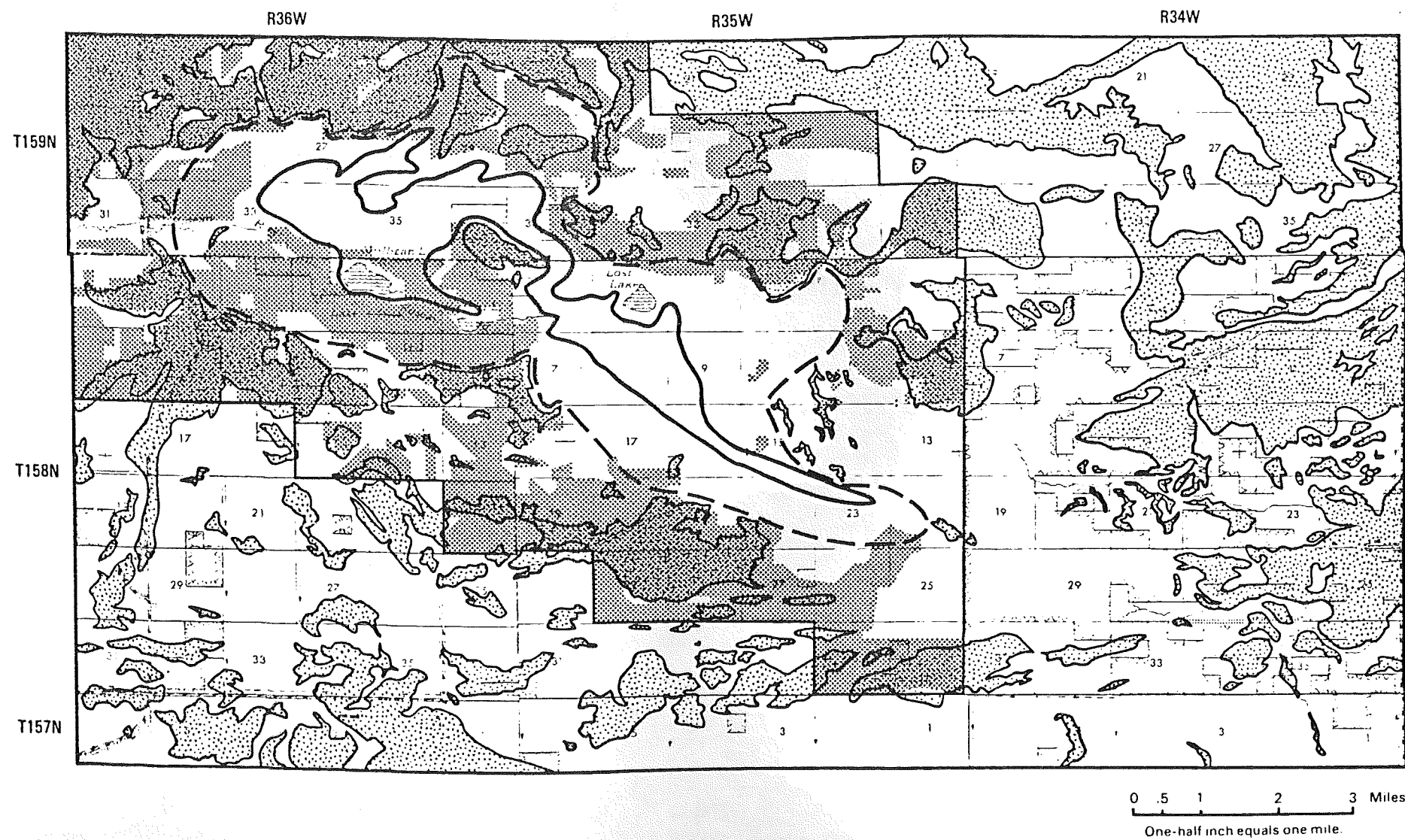
-  Core Area
-  Watershed Protection Area

SURFICIAL GEOLOGY

-  Peat
-  Mineral Soil

0 .5 1 2 3 Miles
One-half inch equals one mile.

Map 13E. Commercial Forestry Potential
in the Mulligan Lake Peatland



FORESTRY POTENTIAL

- Data Collected Within this Boundary
- ▨ Commerical Timber
- No Commercial Timber
- ? No Data Available

MANAGEMENT AREA BOUNDARY

- Core Area
- - - Watershed Protection Area







SURFICIAL GEOLOGY

- Peat
- ▨ Mineral Soil




Map 13F. Mineral Potential and Areas Leased for Mineral Exploration in the Mulligan Lake Peatland

MINERAL POTENTIAL



Mineral Potential Rating:

-  A High
-  B
-  C to
-  D ↓
-  E Low
-  Boundary Zone



AREA LEASED FOR MINERAL EXPLORATION

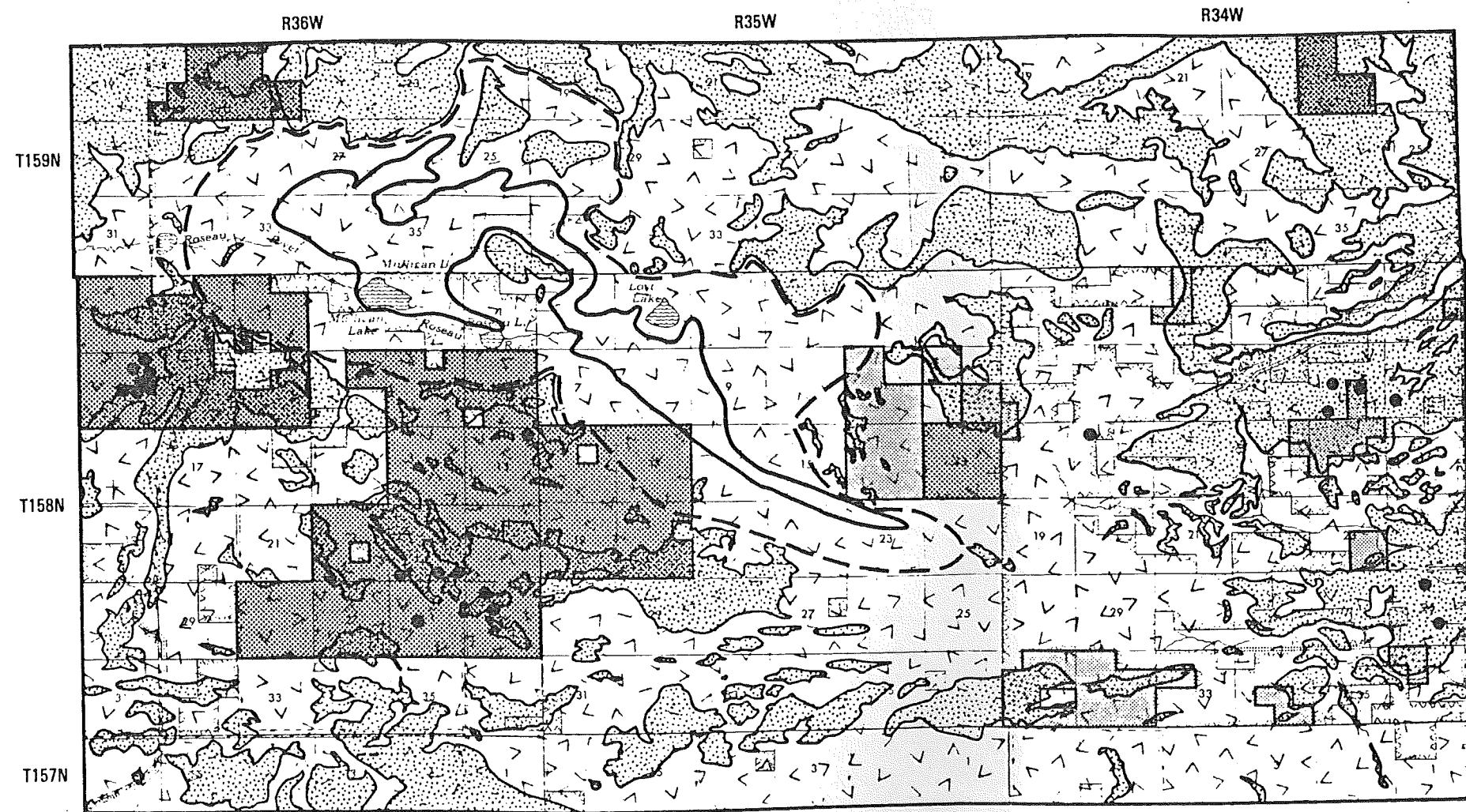
-  Existing Leases
-  Past Leases
-  Drilling Activity

MANAGEMENT AREA BOUNDARY

-  Core Area
-  Watershed Protection Area

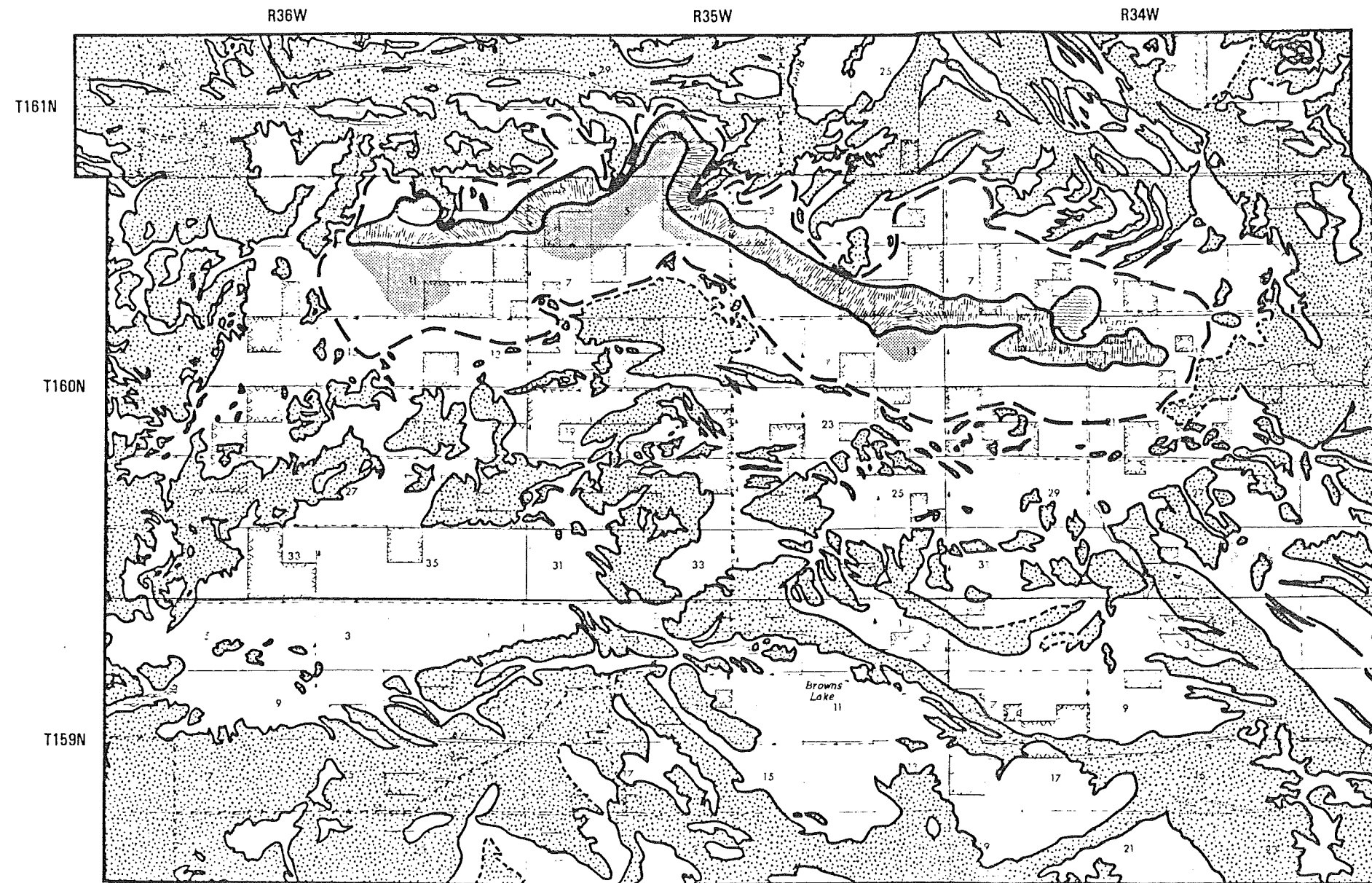
SURFICIAL GEOLOGY

-  Peat
-  Mineral Soil






0 .5 1 2 3 Miles
One-half inch equals one mile.

Map 14A. Ecologically Significant Elements
in the Winter Road Lake Peatland






LANDFORMS

FEN:



-  Featureless Water Track
-  Ribbed Fen, pattern oriented perpendicular to direction of water flow
-  Teardrop Islands

BOG:



-  Raised Bog,
dotted line indicates indistinct boundary
solid line indicates distinct boundary
-  Crest of Raised Bog
(water flow off each side of crest)
-  Ovoid Island,
solid line indicates distinct boundary
dotted line indicates indistinct boundary

SPECIES



PLANT OCCURRENCES:

-  Reported, herbarium specimen collected
-  Reported, no specimen collected



ANIMAL OCCURRENCES:

-  Nesting location
-  Siting location

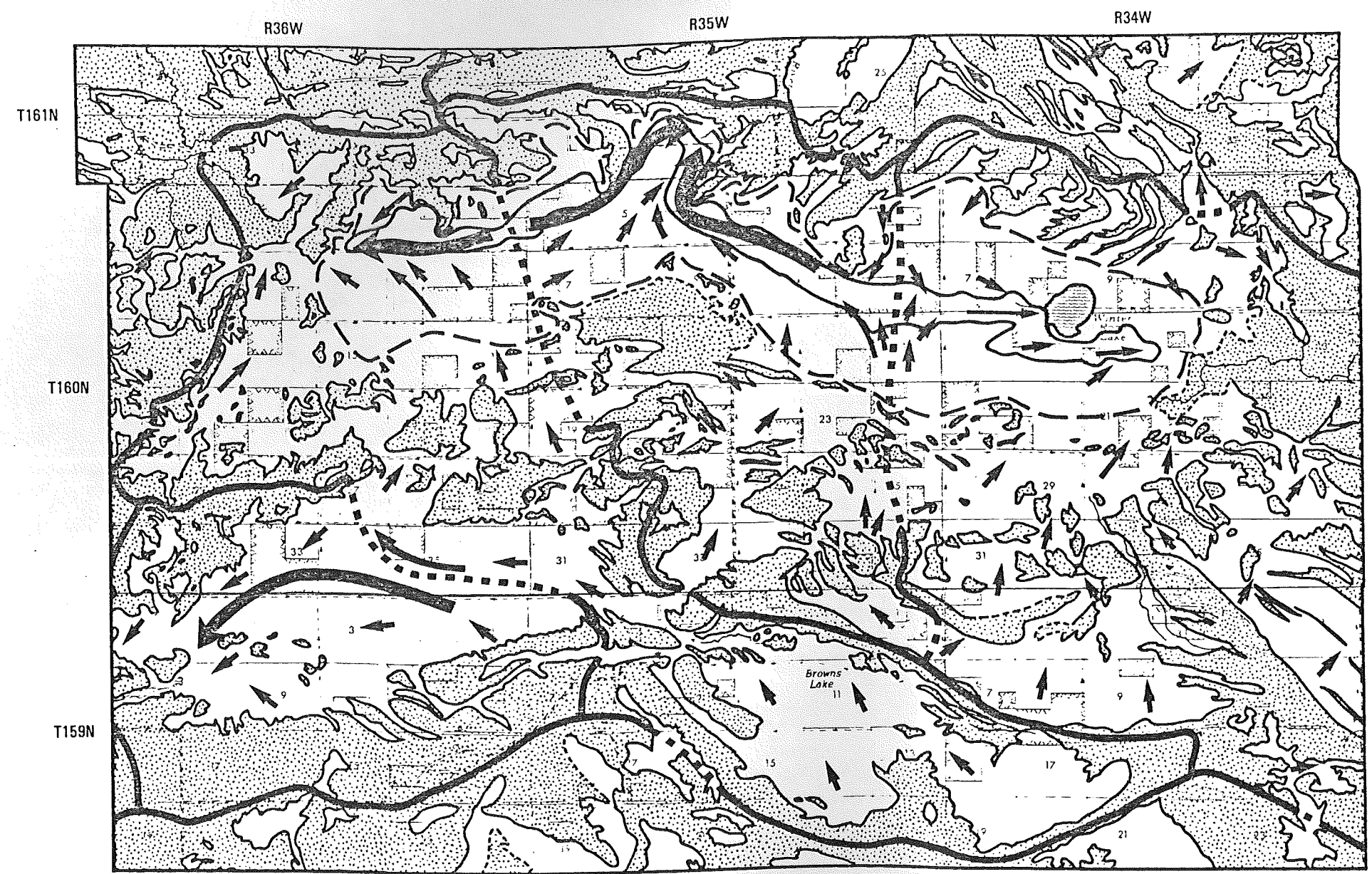
MANAGEMENT AREA BOUNDARY

-  Core Area
-  Watershed Protection Area

SURFICIAL GEOLOGY

-  Peat
-  Mineral Soil

Map 14B. Surficial Water Flow in the Winter Road Lake Peatland



SURFICIAL WATER FLOW

- Generalized Watershed Boundary, dashed where indefinite
- Direction of Flow, width of arrow indicates relative degree of flow
- ⊕ Water Flow off Crest of Raised Bog

MANAGEMENT AREA BOUNDARY

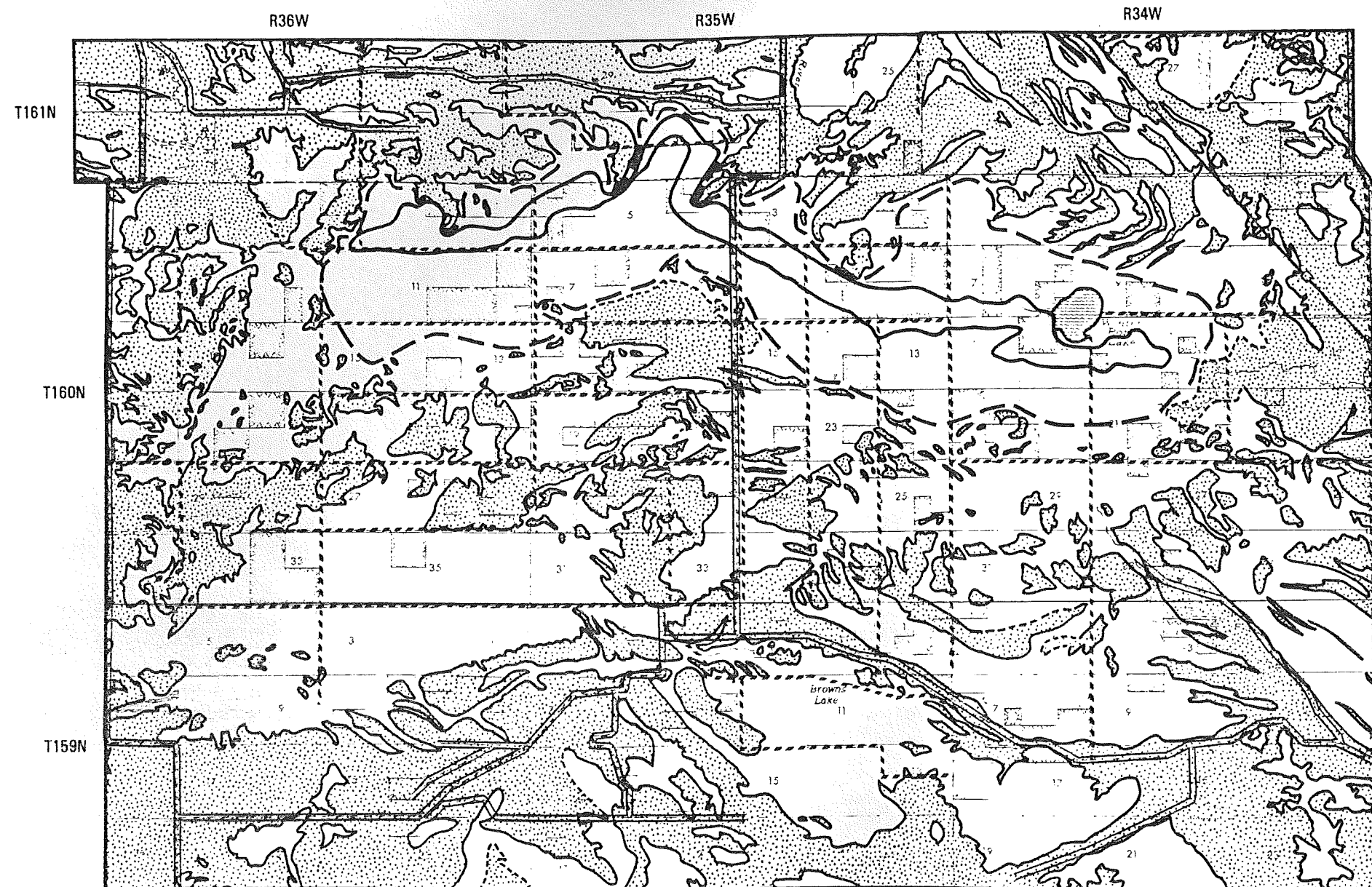
- Core Area
- - - Watershed Protection Area

SURFICIAL GEOLOGY

- Peat
- ▣ Mineral Soil

0 .5 1 2 3 Miles
One-half inch equals one mile.

Map 14C. Existing Disturbance in the Winter Road Lake Peatland



DISTURBANCE FACTORS

- == Road
- Ditch
- + + + Railroad
- Utility Corridor
(Powerline or Pipeline)
- Lg Logging Activity
- ▣ Agricultural Activity

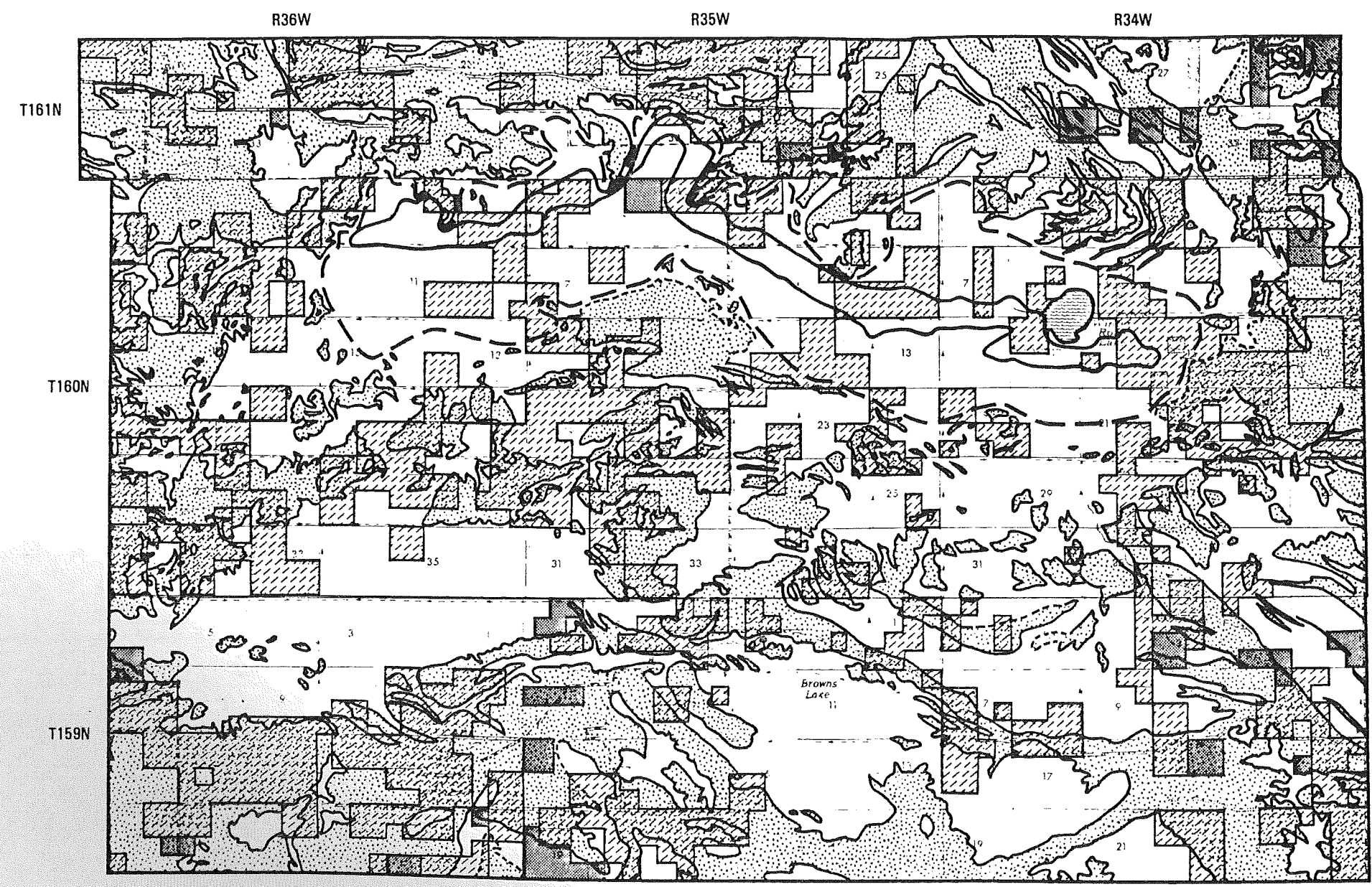
MANAGEMENT AREA BOUNDARY

- Core Area
- - - Watershed Protection Area

SURFICIAL GEOLOGY





- Peat
- ▣ Mineral Soil

0 0.5 1 2 3 Miles
One-half inch equals one mile.




Map 14D. Land Ownership in the Winter Road Lake Peatland



LAND OWNERSHIP

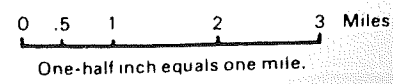
-  State
-  County
-  Federal
-  Private

MANAGEMENT AREA BOUNDARY

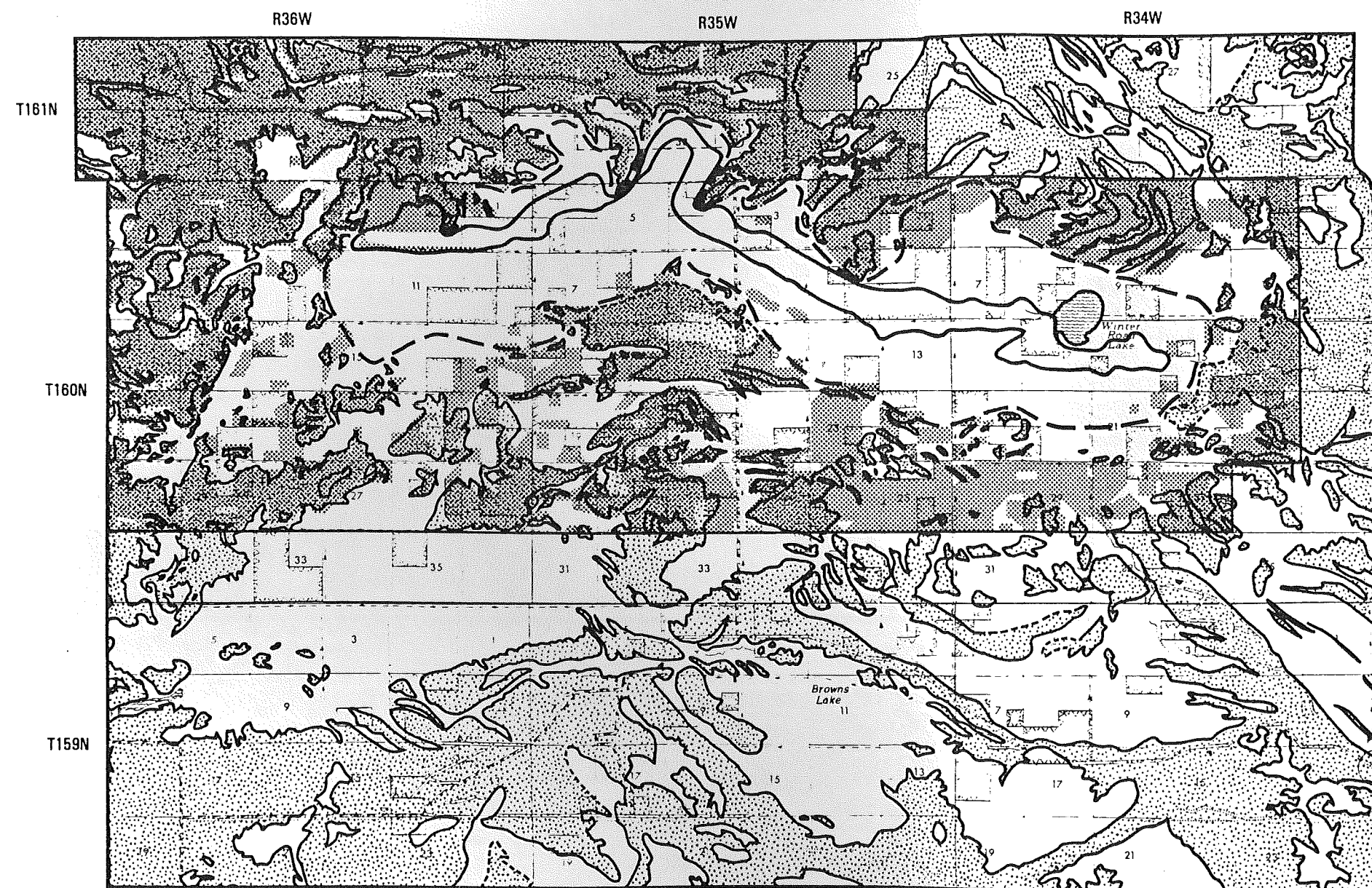
-  Core Area
-  Watershed Protection Area

SURFICIAL GEOLOGY

-  Peat
-  Mineral Soil



Map 14E. Commercial Forestry Potential in the Winter Road Lake Peatland



FORESTRY POTENTIAL

- Data Collected Within this Boundary
- ▣ Commercial Timber
- No Commercial Timber
- ? No Data Available

MANAGEMENT AREA BOUNDARY

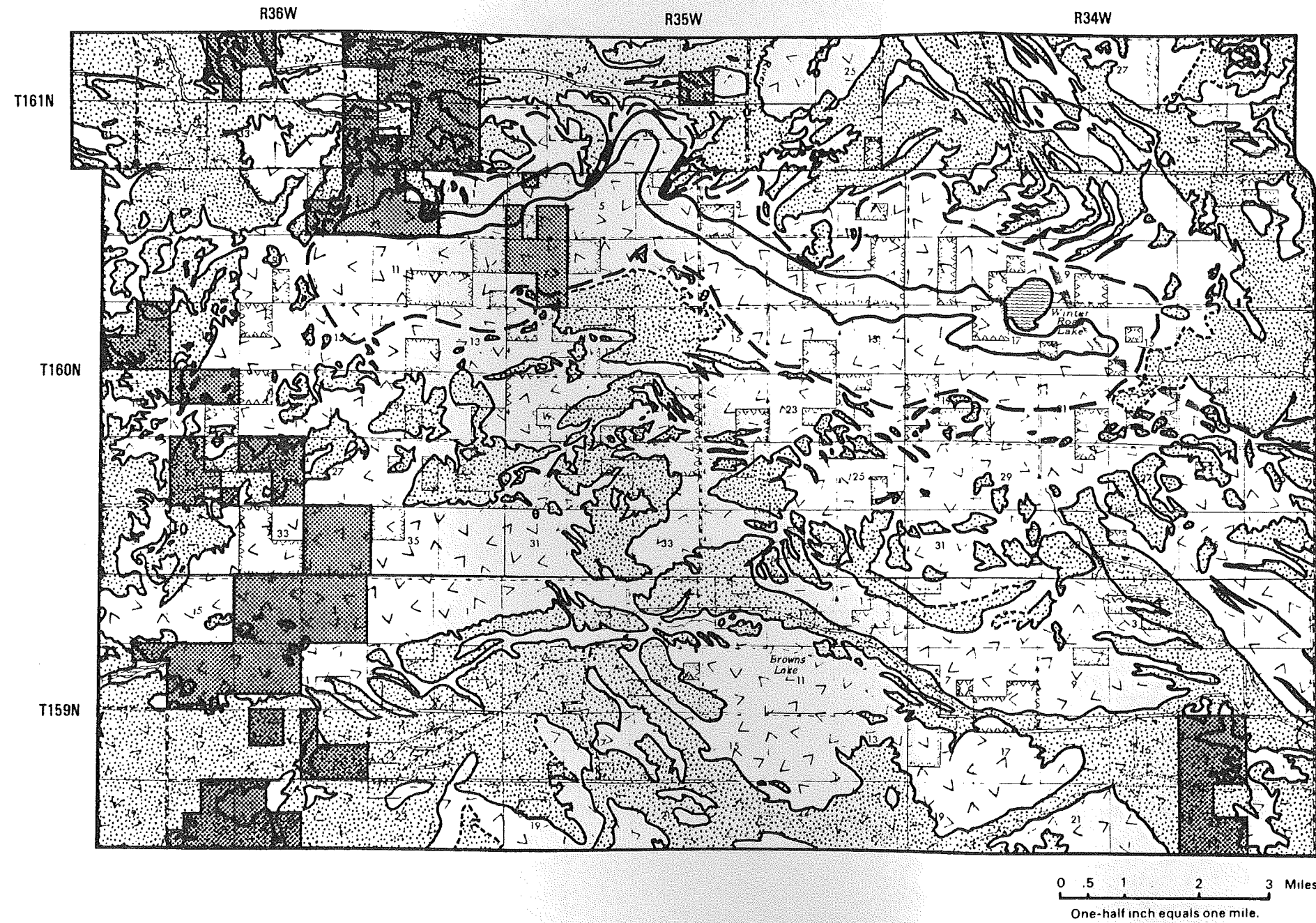
- Core Area
- - - Watershed Protection Area

SURFICIAL GEOLOGY

- Peat
- ▣ Mineral Soil

0 .5 1 2 3 Miles
One-half inch equals one mile.

Map 14F. Mineral Potential and Areas Leased for Mineral Exploration in the Winter Road Lake Peatland



MINERAL POTENTIAL

Mineral Potential Rating:

- A High
- B
- C to
- D ↓
- E Low

Boundary Zone

AREA LEASED FOR MINERAL EXPLORATION

- Existing Leases
- Past Leases
- Drilling Activity

MANAGEMENT AREA BOUNDARY

- Core Area
- Watershed Protection Area

SURFICIAL GEOLOGY

- Peat
- Mineral Soil

T157N

T156N

T155N

T154N

R36W

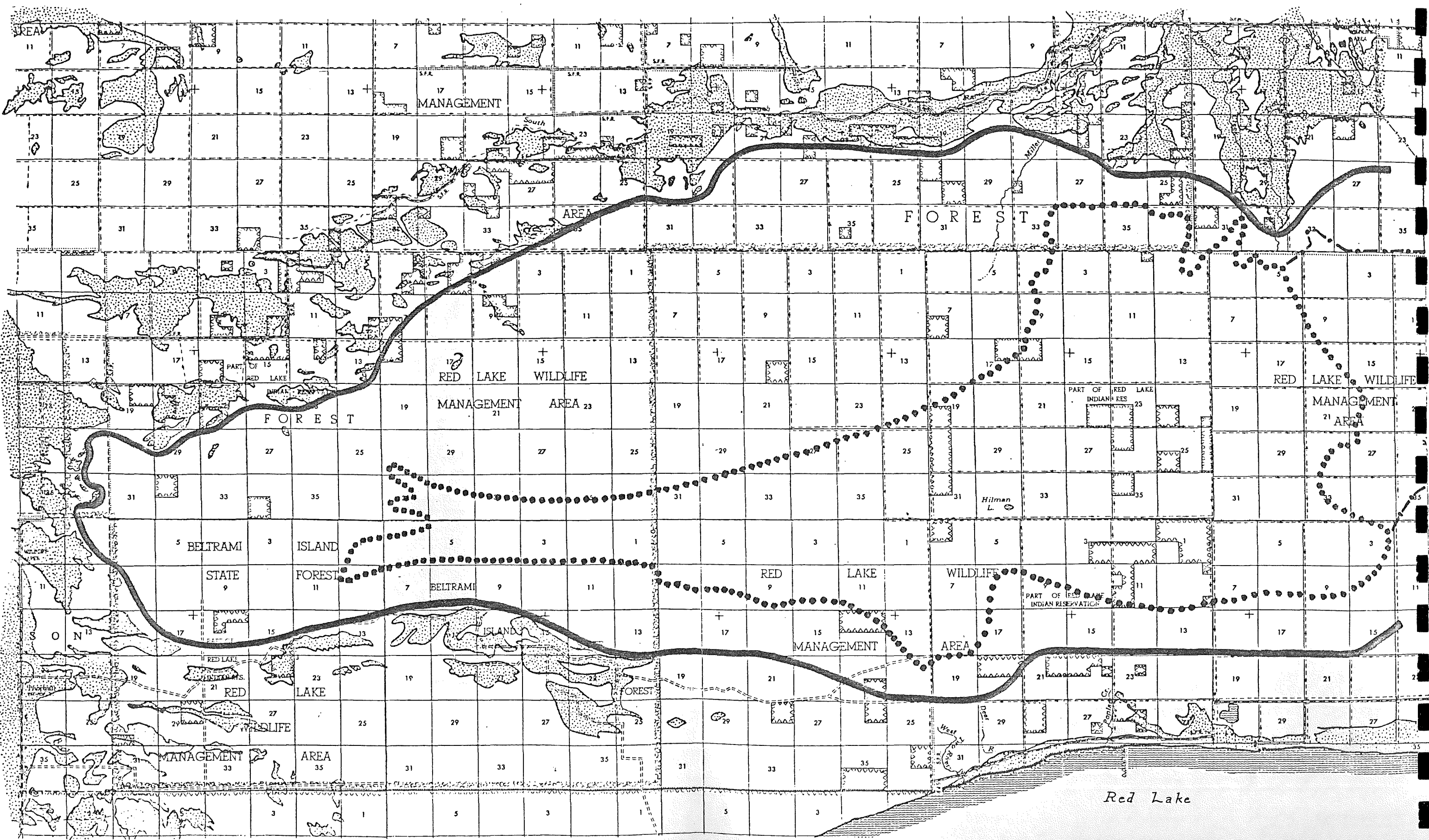
R35W

R34W

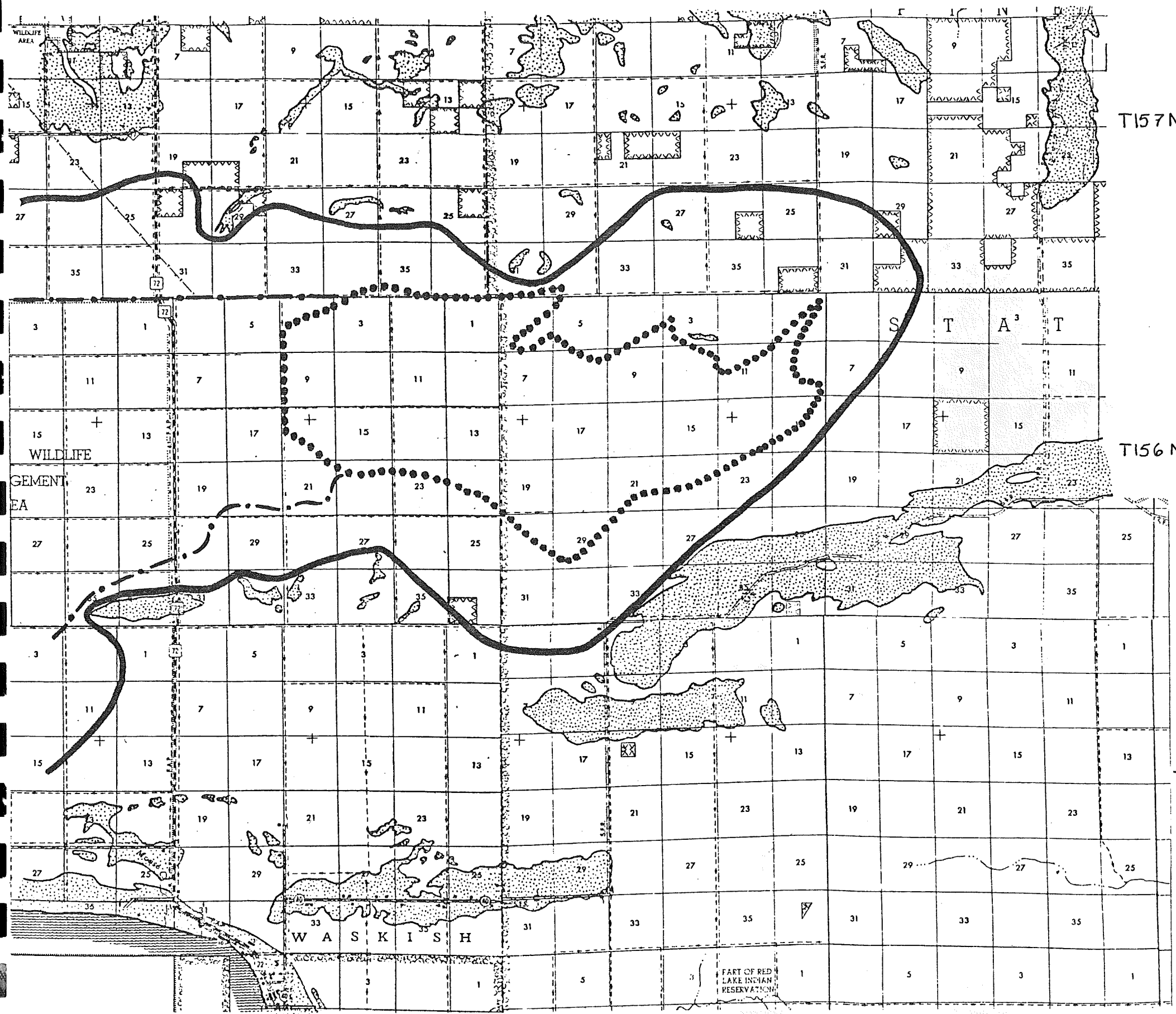
R33W

R32W

R31W



Red Lake (West half)



T157 N

T156 N

T155 N

T154 N

R31W

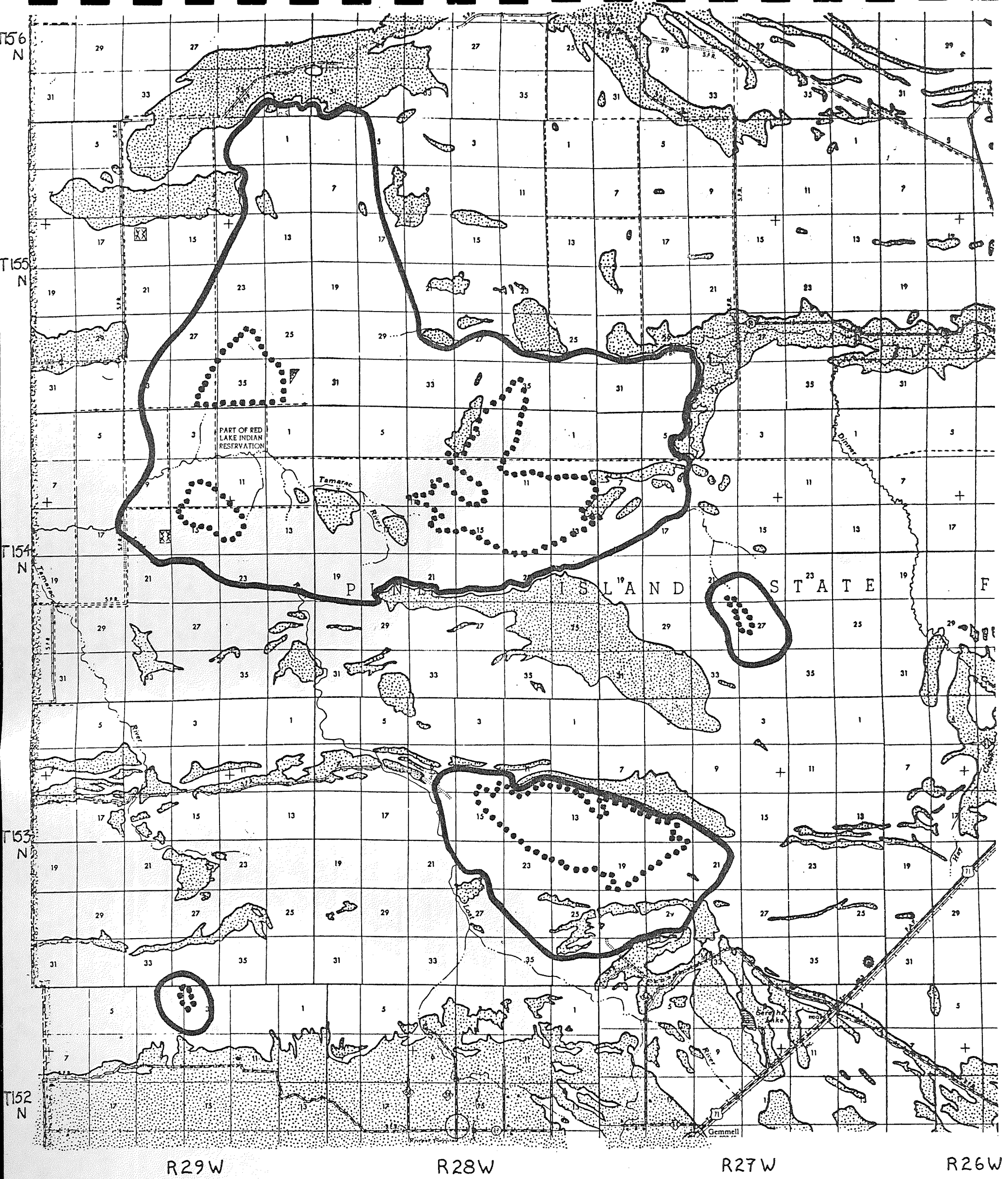
R30W

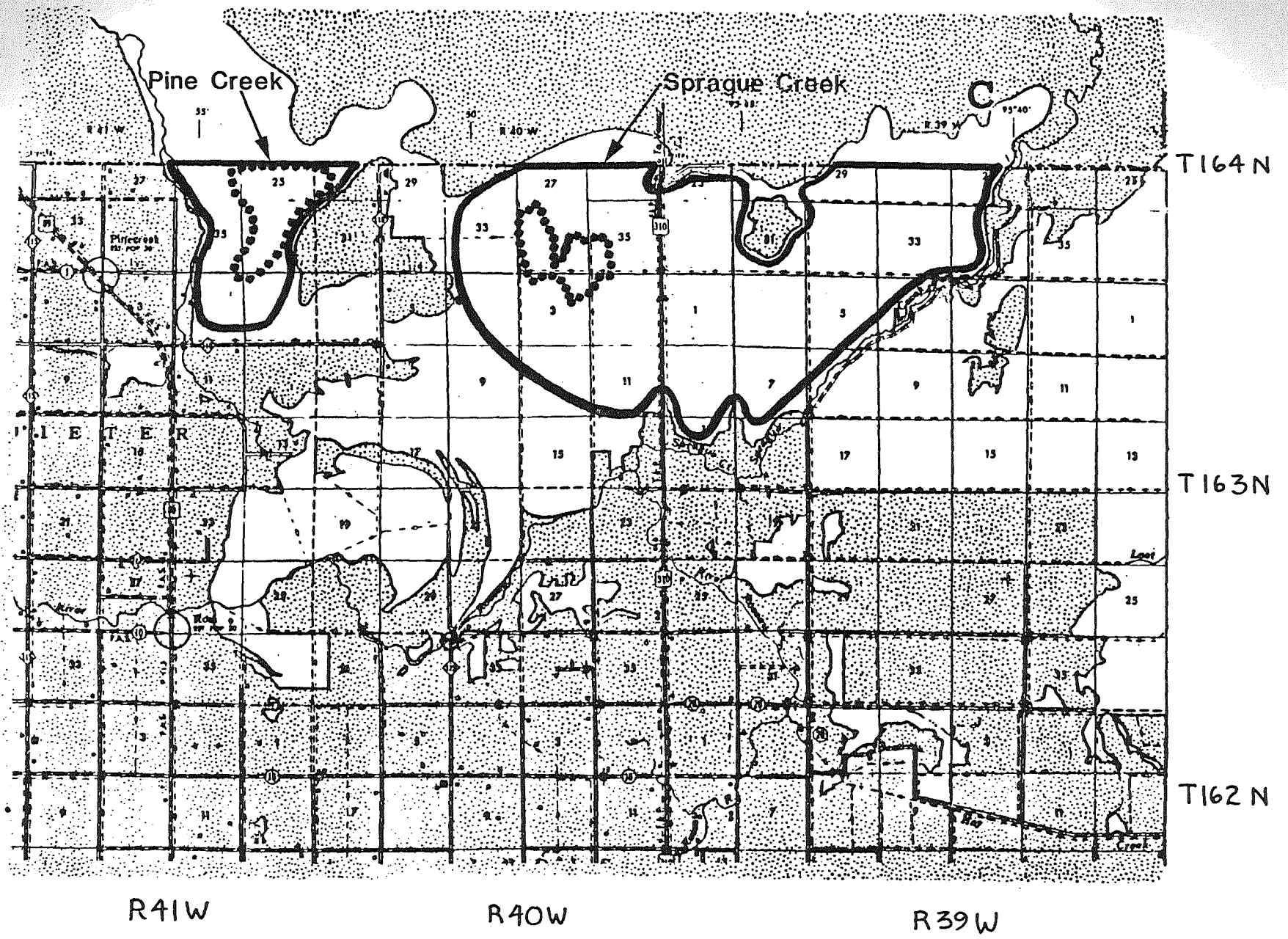
R29W

R28W

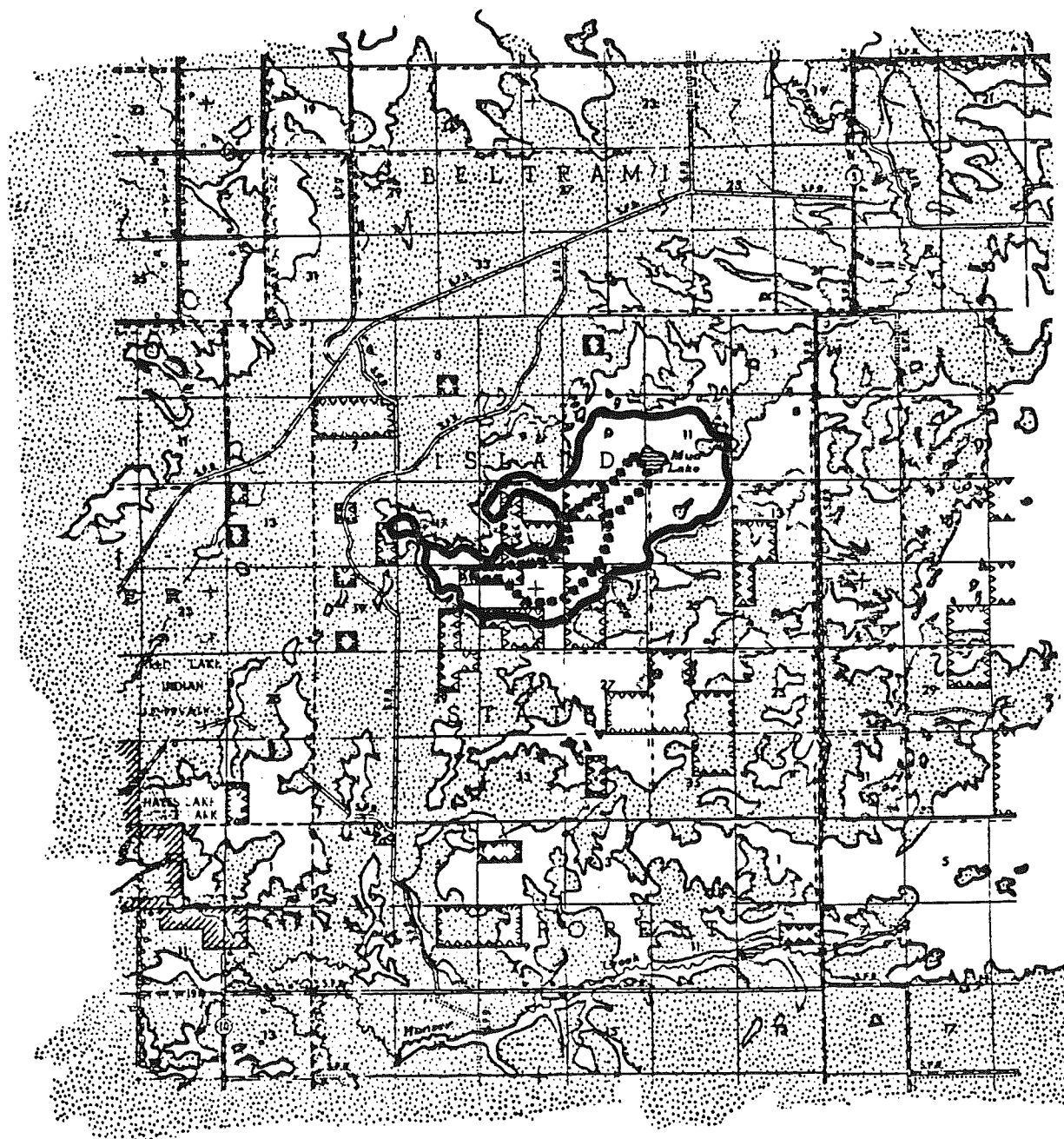
Legend

- Water Protection Area
- Core Area





Pine Creek and Sprague Creek



T161 N

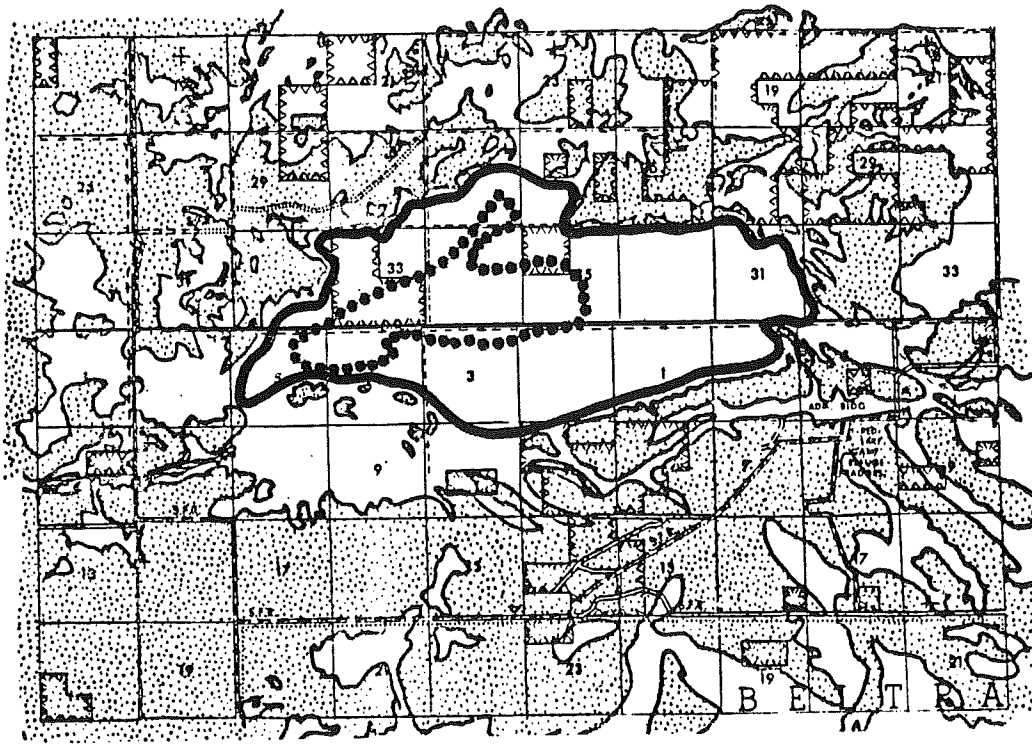
T160 N

T159 N

R38 W

R37 W

R36 W



R37W

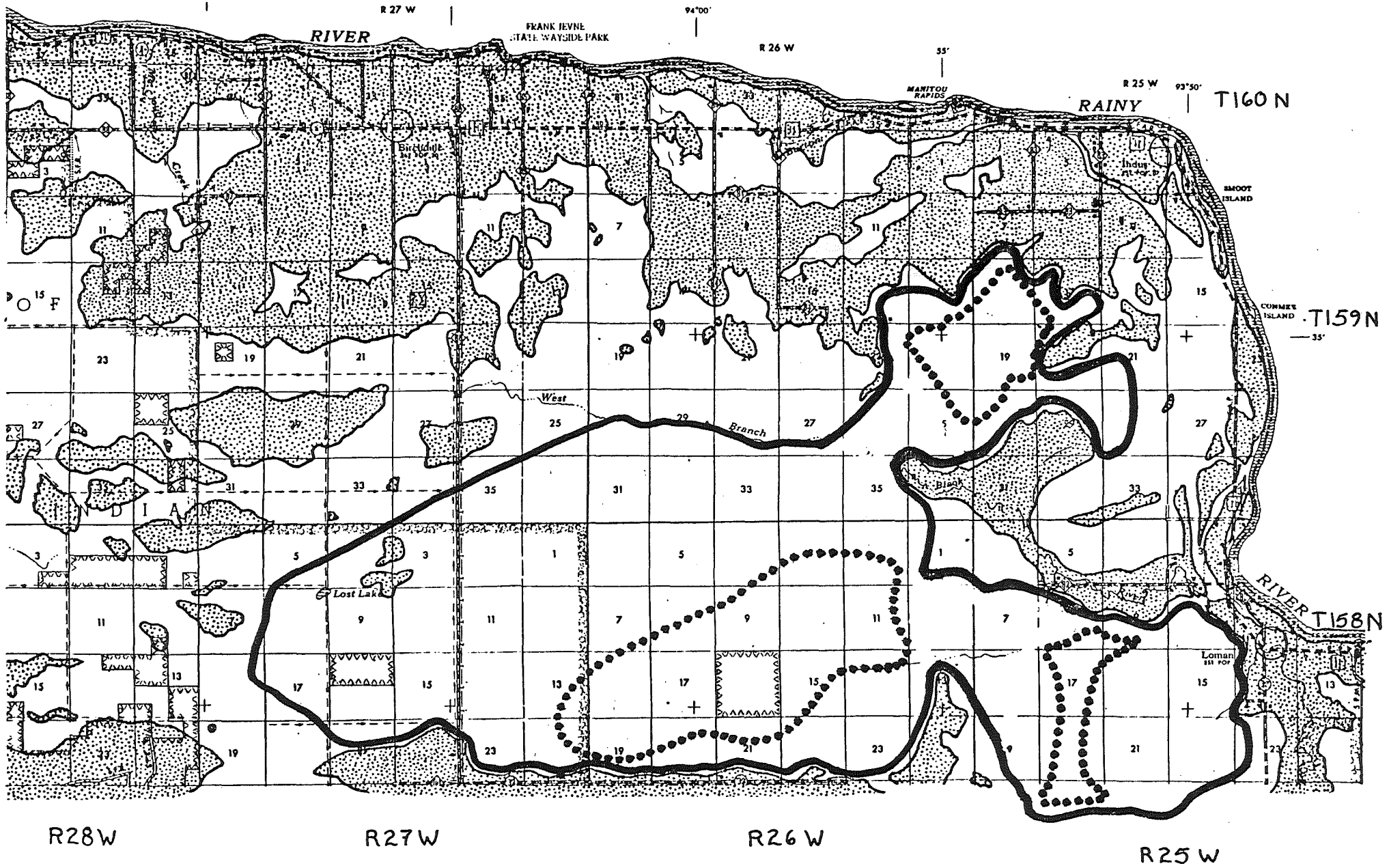
R36W

R35W

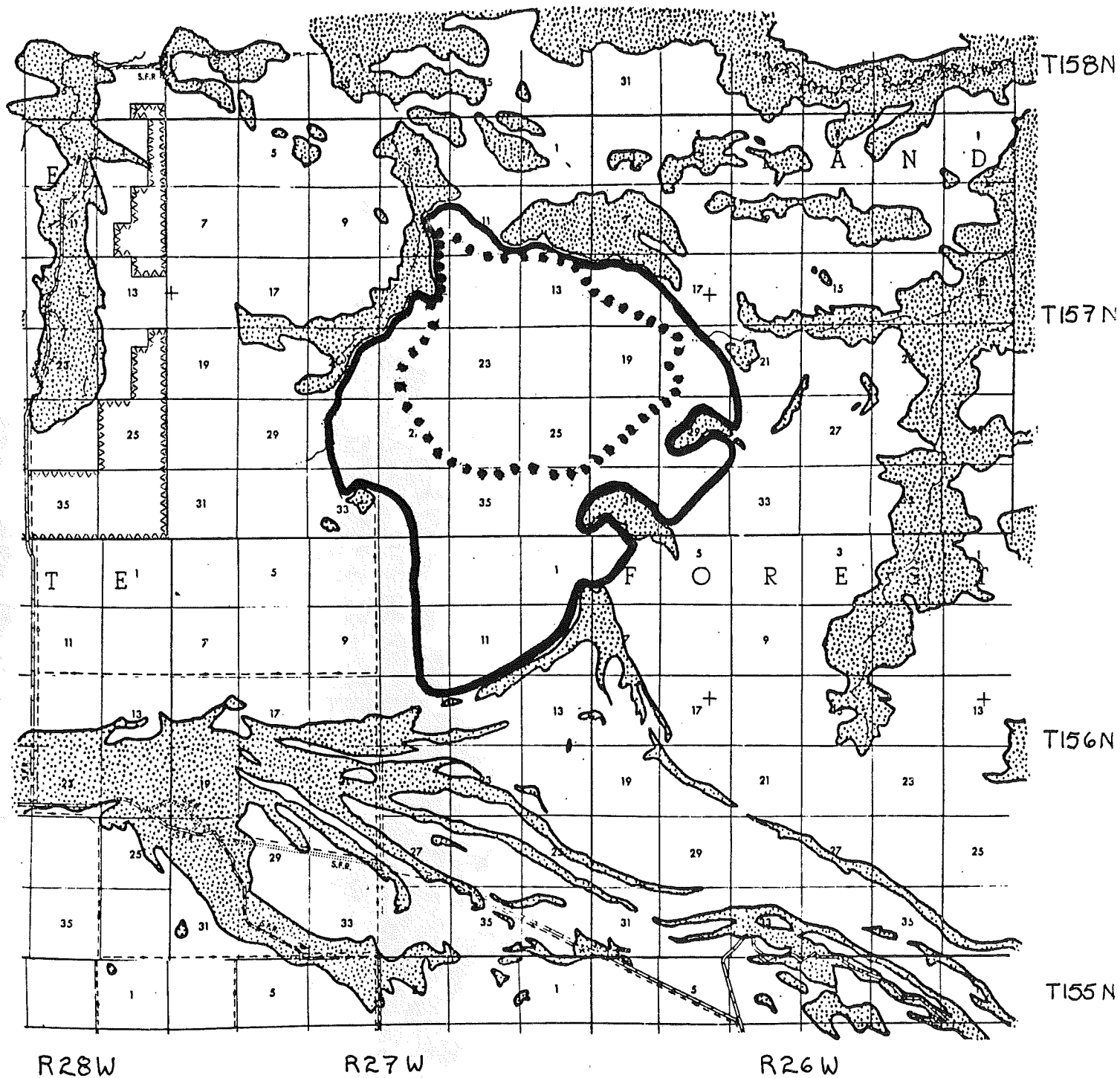
TIGON

T159N

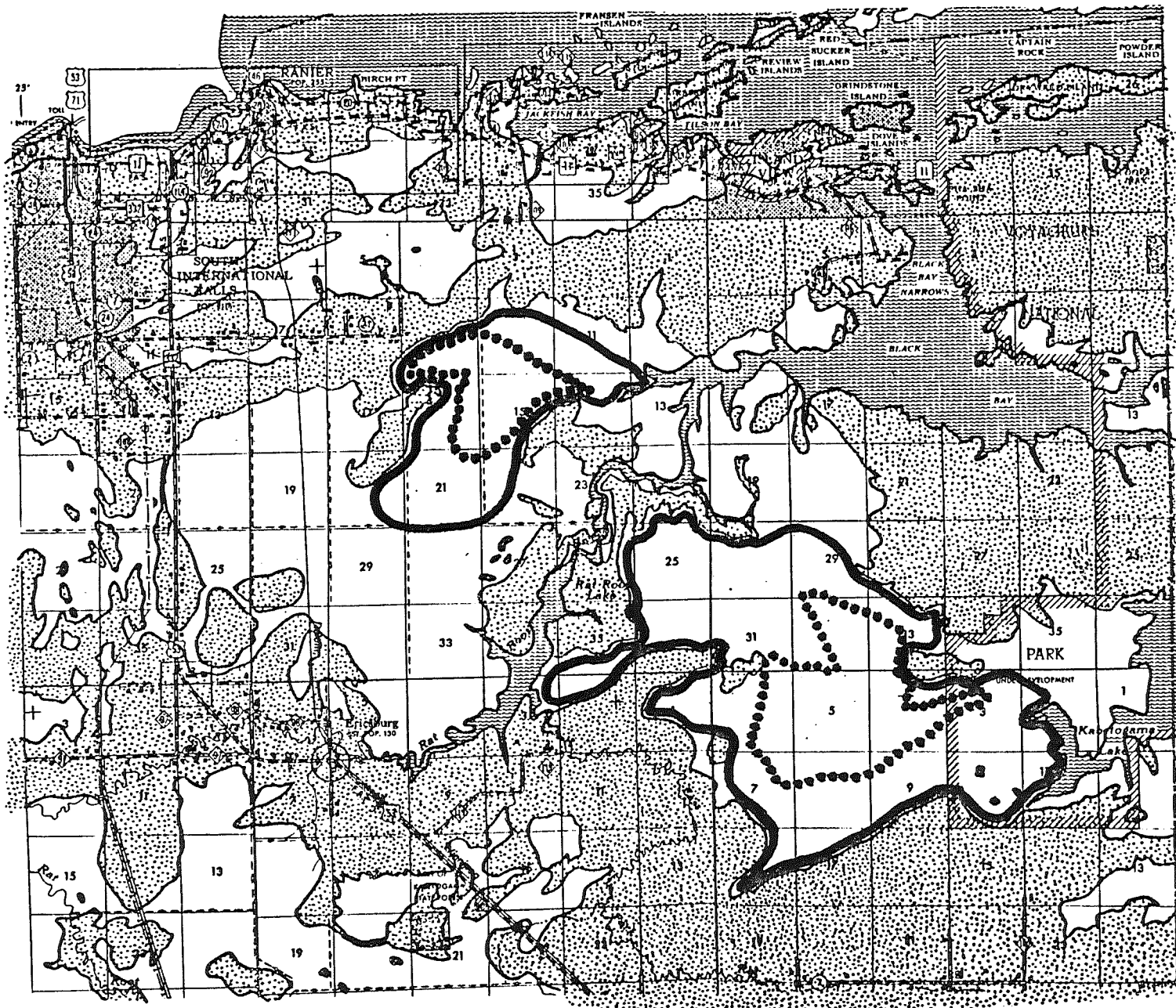
BEATA



North Black River



South Black River



R24 W

R23 W

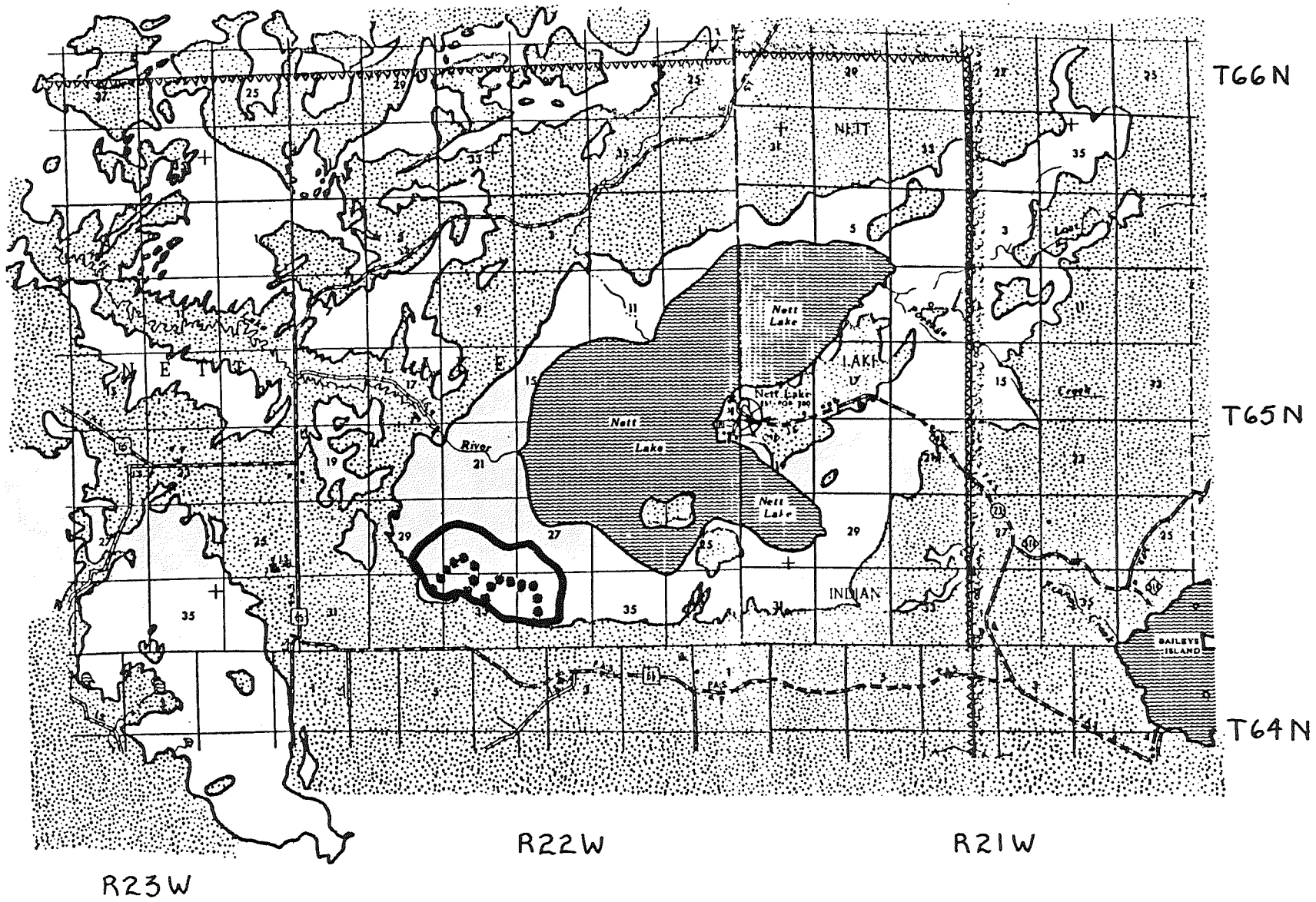
R22 W

T71 N

T70 N

T69 N

West and East Rat Root River



Nett Lake

T148N

T147N

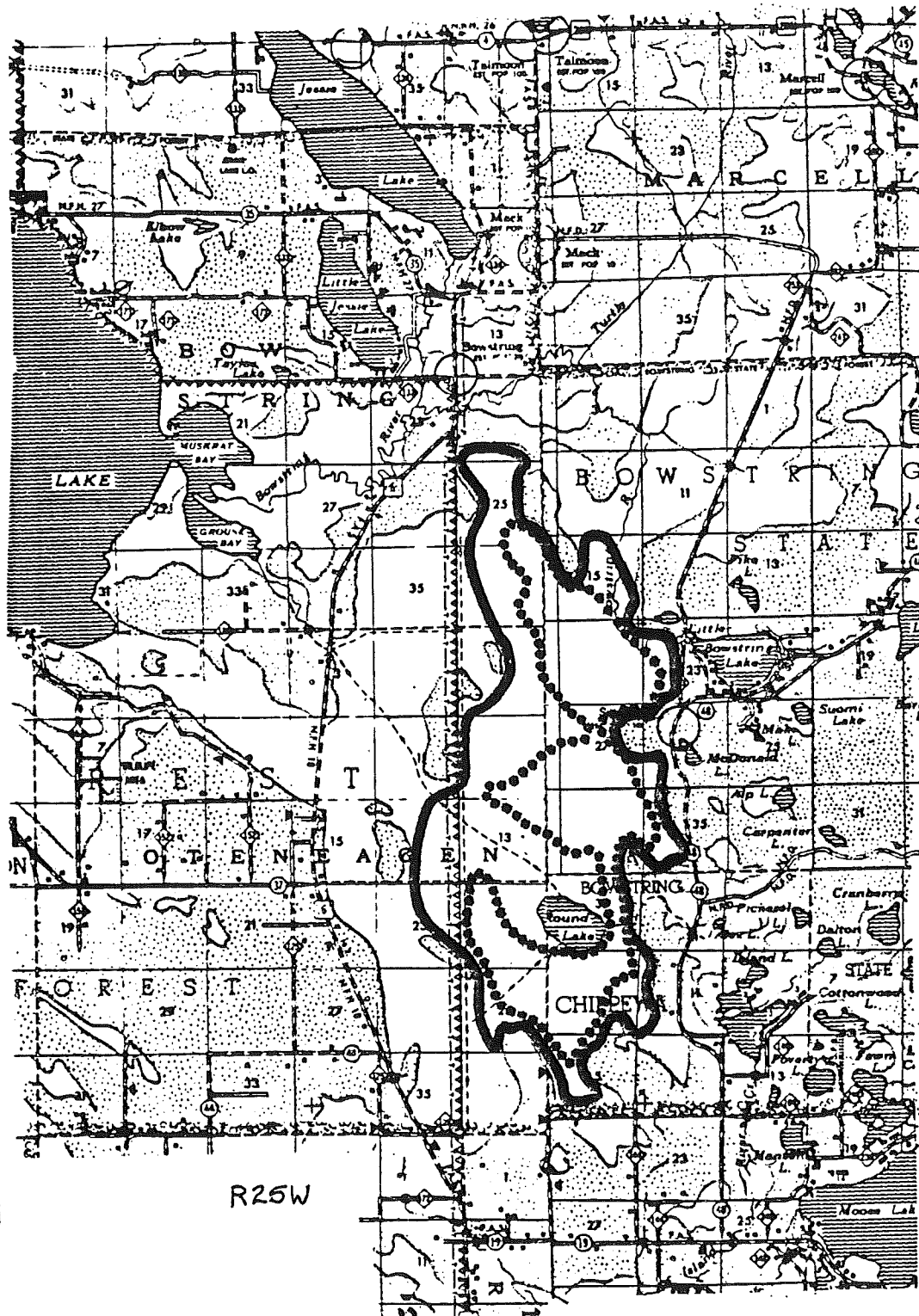
T146N

T145N

T59N

T58N

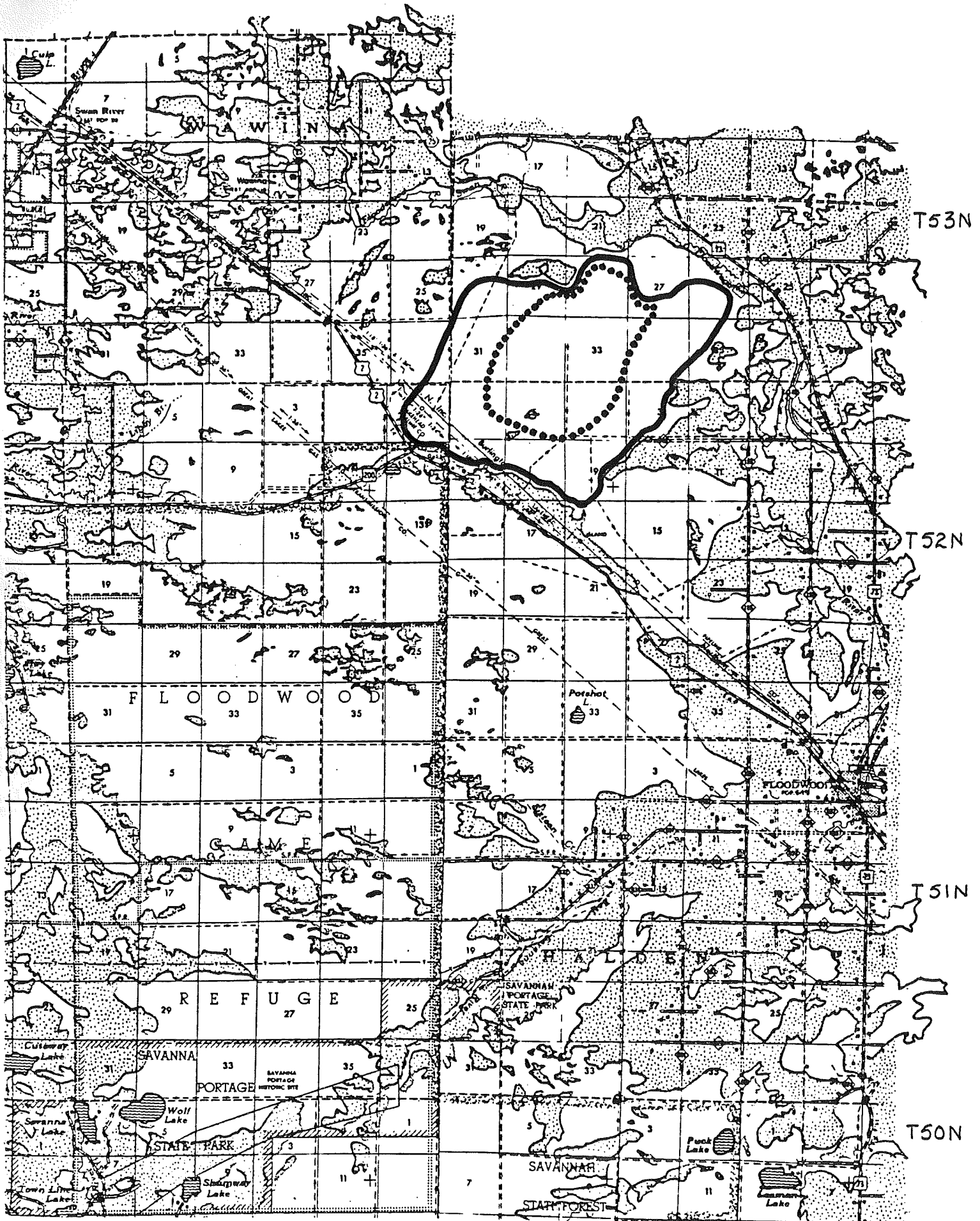
T57N



R25W

R27W

Oteneagen



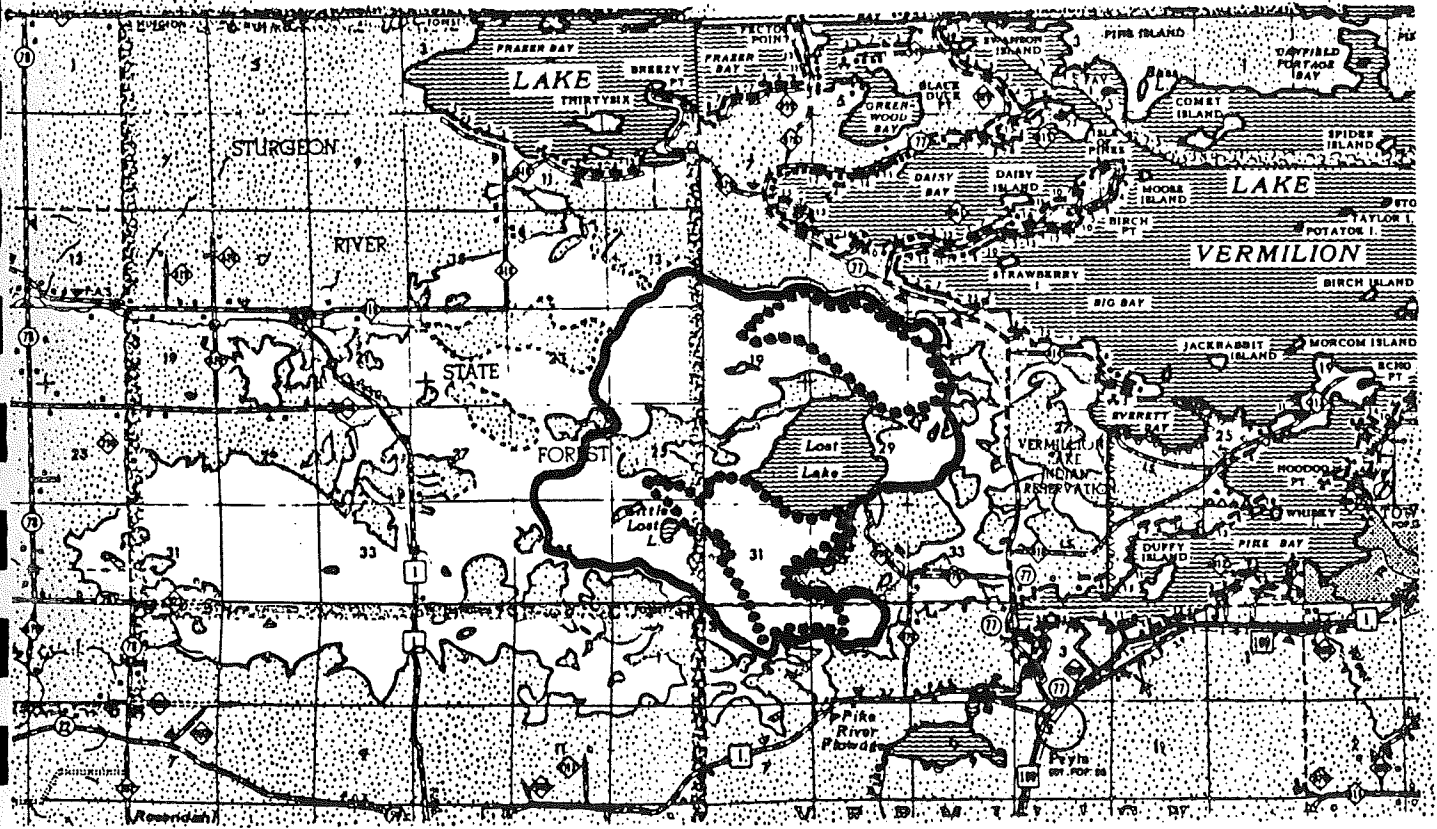
R23W

R22W

R21W

R20W

Wawina



T 62 N

T 61 N

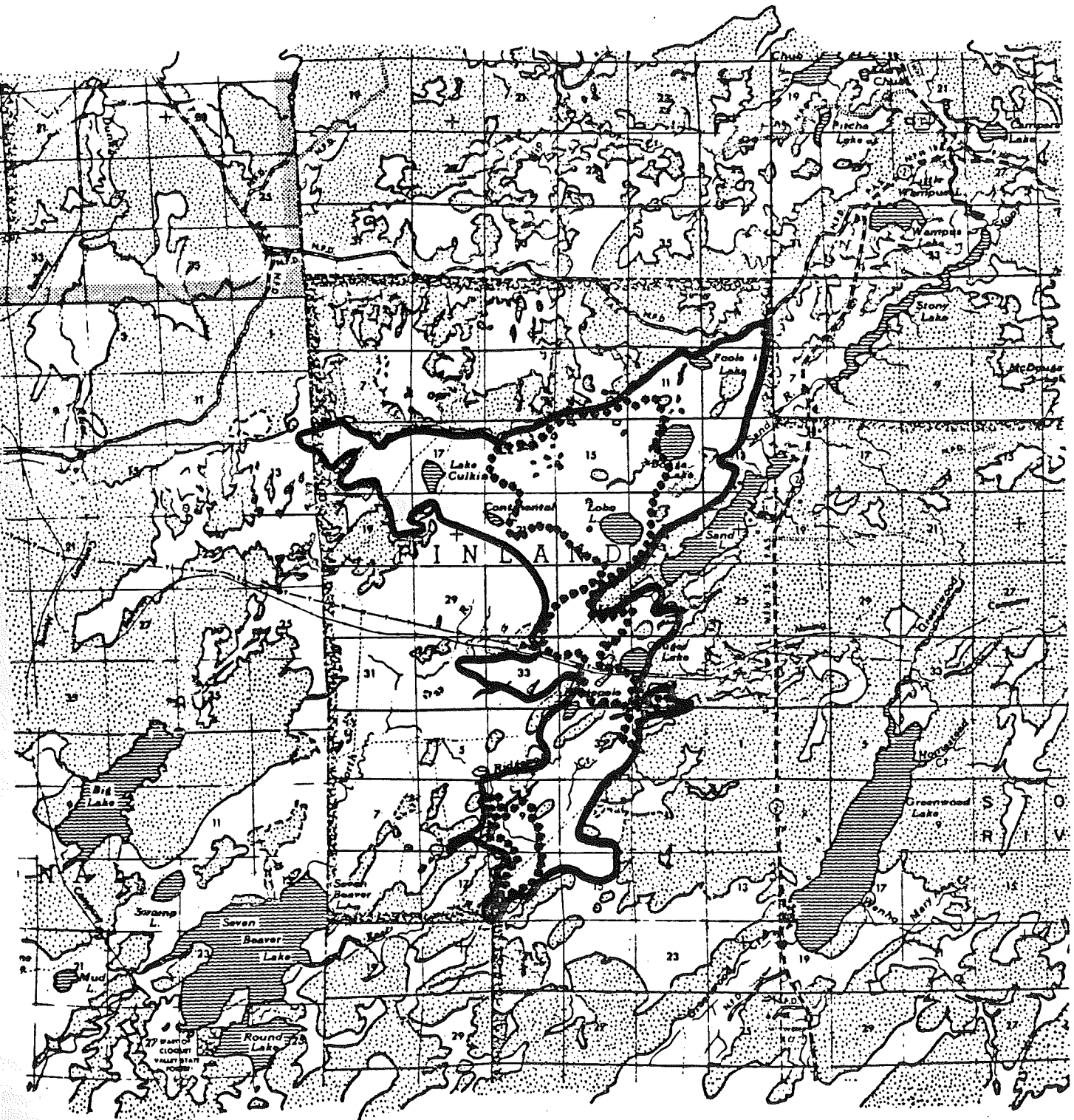
R18W

R17W

R16W

R15W

Lost Lake



T60N

T59N

T58N

R12W

R11W

R10W

Sand Lake