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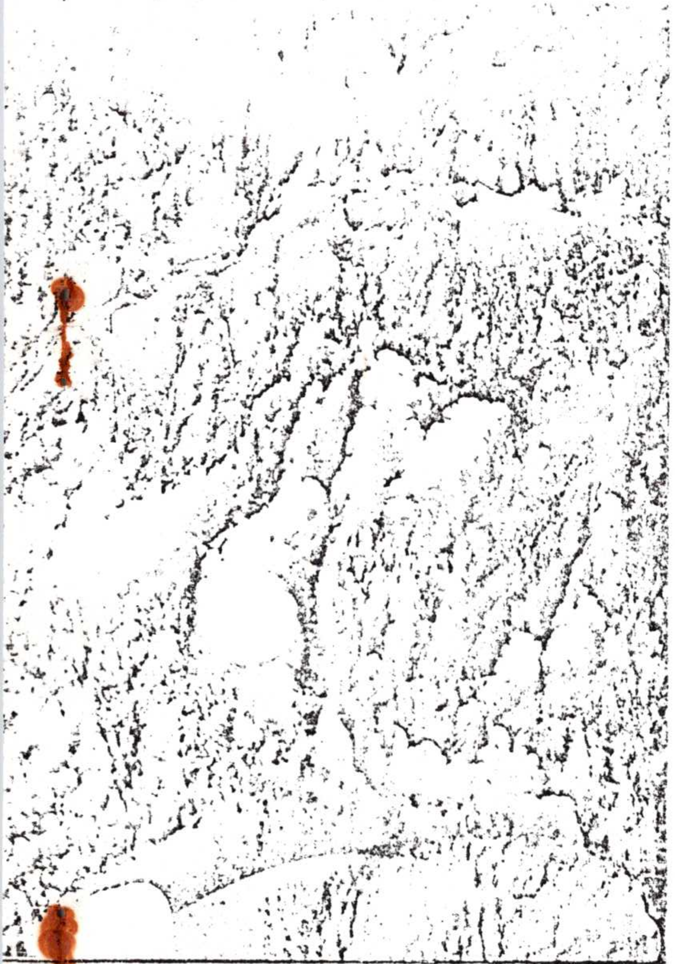

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LONG TERM ECOLOGICAL MONITORING OF THE LAKE WINNIPEG, CHURCHILL, NELSON RIVERS IMPACT AREAS.

A PROPOSAL BY

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Committee Members

Chairpersons:

J.F. Shay,	ecologist, University of Manitoba.
J. Thie,	ecologist and Remote sensing, Dept. of Mines, Resources and Environmental Management, Canada-Manitoba Soil Survey
C. Tarnocai,	pedologist, Winnipeg.
G. Mills,	pedologist, Canada-Manitoba Soil Survey, Winnipeg.
H. Ayles,	limnologist, Freshwater Institute, Winnipeg.
J. Stewart,	plant ecologist, University of Manitoba.

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Diversion of waters, engineering works and flooding, which are part of the important Lake Winnipeg, Churchill and Nelson Rivers, hydro-electric development scheme, will have a considerable impact on large parts of the Northern Manitoba environment.

Short term multi-disciplinary studies and surveys under direction of the Lake Winnipeg, Churchill and Nelson Rivers Study Board will be carried out over a period of three years to determine the effect of the Manitoba Hydro Project on water and related resources. On the basis of these somewhat qualitative and speculative assessments recommendations by which to minimize detrimental effects and maximize the beneficial efforts will be forwarded to federal and provincial ministers and Manitoba Hydro.

To evaluate the true influence of this development scheme on the environment, long term monitoring of the impacted areas is necessary. Only by such long term environmental studies (5-10 years or more) can we expect to assess and quantify changes. This will enable us to learn effectively from mistakes and successes. Knowledge gained would be of considerable importance in other developments projects in the north.

Dr. I.W. Dickson, Study Director, Lake Winnipeg, Churchill and Nelson Rivers Study requested Dr. J.M. Shay, Ecologist, University of Manitoba to organize and coordinate a multi-disciplinary group of environmental specialists to prepare a study proposal for a long-term monitoring program to determine environmental effects associated with the major power development in Northern Manitoba. Shortly after the formation of the committee Dr. Shay left on a sabbatical to England and Mr. J. Thie, Dept. of Mines, Resources and Environmental Management coordinated the work of the committee.

To describe environmental impact is a difficult and complex undertaking. Environmental changes associated with resource management practises of mankind, in this case the hydro-electric development scheme, have to be assessed in relation to the natural changes as result of the normal dynamic behaviour of the environment.

To be able to adequately assess the changes in the environment caused by the scheme, it is essential to identify and study all critical parameters involved, their interrelationships; then evaluate the influence of the changing parameters, in this case usually flooding, changed water-tables, changes in heat budget, vegetation, etc.

In the proposed approach a number of representative ecosystems will be selected in the impact area, based on the Biological-Physiographical Survey carried out by the Soil Survey of Manitoba and based on the experiences of the disciplinary surveys. All elements of these ecosystems will be studied by a team of specialists. These elements can be grouped as:

soil related
vegetation related
water related
wildlife related

The following pages discussing methodology, cost estimates, objectives, operational aspects, etc., are based on discussion and special contributions in the form of detailed technical reports by Dr. G. Adams, Canadian Wildlife Service, Dr. J. Shay, Department of Botany, University of Manitoba and Mr. C. Tarnocai and G. Mills, Manitoba Soil Survey, Mrs. H. Ayles, Freshwater Institute, Mr. J. Thie, Department of Mines, Resources and Environmental Management.

To assess and monitor long term environmental changes attributed to artificial manipulation of water levels and flows.

A multi-disciplinary or multi-agency study team will evaluate the changes occurring in the vegetation, wildlife, soils and water elements of representative ecosystems in the impact areas. Monitoring intervals may vary from days to a number of years. Because of the use of airborne and satellite remote sensing techniques, in addition to conventional ground sampling, repetitive surveys can easily be accomplished, while findings in selected ecosystem can be extrapolated over the total impact area at an unusually low cost.

Phase I and II:	Selection and survey of sample ecosystem before development.
Phase III :	Monitoring of selected ecosystem using a combination of conventional and remote sensing techniques.
Phase IV :	Data interpretation and assessment of change;

Minimum of eight years from the start of phase one: minimum of five years from the start of flooding.

Monitoring of some parameters (selected by disciplines after the first 5 years) may have to continue for periods up to 30 years.

Per year:	vegetation.........	20,000	Total for project	
	soils..............	20,000		
	wildlife...........	20,000	8 years	- $880,000
	water..............	20,000		
	remote sensing.....	20,000		
	co-ordination......	10,000		
		$110,000		

Co-ordinator agency - similar to Lake Winnipeg, Churchill, Nelson Rivers Study Board or e.g. Manitoba Remote Sensing Centre, with sub-contracts from Federal Department, Provincial Department, and Universities.

To identify the present conditions and relationships of the selected ecosystems a survey of the conditions before flooding has to be carried out. This would provide the base line information for comparison and assessing impact. Because of the timetable for the development, this survey would have to be done before 1974. Parameters to be measured are identical to the ones for the monitoring phase and are described later.

Phase I - selection of representative ecosystems and sample areas by the Bio-physical group during 1972-73, based on results of studies in progress directed by the Study office.

Phase II- analysis and detailed description of selected ecosystems during the summer of 1973, winter 1973-74.

The characteristic ecosystem parameters will be measured on a repetitive basis. Intervals may be yearly, seasonally, weekly or daily, where required.

Phase III - repetitive surveys of selected ecosystems.

Phase IV - data interpretation and assessment of change; recommendations.

For the initial survey and subsequent monitoring after flooding extensive use of the most up to date Remote Sensing techniques will enable a team of specialists to describe areas and assess change at a relatively low cost. With the use of airborne and satellite imagery costly ground surveys can be reduced to the minimum. With remote sensing techniques extrapolation of the results to non-sampled areas becomes possible for only a relatively small investment. Facilities of the Manitoba Remote Sensing Centre, and sophisticated interpretation equipment are assumed to be available to the monitoring team.

The surveys in the different phases will be carried out by a team of specialists working in a closely co-ordinated manner and organized along the following elements of the ecosystem: Land, Vegetation, Water and Wildlife. Remote Sensing is added because of its special importance and capabilities to this study. Each of the elements is discussed in detail according to objectives and methods of approach. The following information is abstracted from the detailed reports submitted by C. Tarnocai and G. Mills (Land); G. Adams (Wildlife); J. Shay (Vegetation); J. Thie (Remote Sensing) and H. Ayles (Water).

Objective: To determine the impact of water level changes on the soil and permafrost systems.

In order to determine the effect of changes of water level on the soil and permafrost systems the following data should be collected and monitored both prior to and subsequent to water level changes:

1. Initial characterization of chemical and physical properties of soils of representative ecosystems.

2. Installation of observation wells on representative ecosystems to determine the water table levels before and after flooding and to sample the ground water periodically in order to determine the changes of ground water quality.

3. Installation of thermocouples on each subject to determine the alteration of thermal regime due to water level changes.

4. Periodic resampling of the soil system to determine the changes in its physical and chemical properties.
   Continuity: Monitoring to be maintained for at least 3 years prior to and 5 years after the water level changes take place.

5. Periodic resampling of the perennially frozen soils to determine the alteration of permafrost properties (i.e. changes of moisture and ice content of the active and permafrost layers).

Objective: To monitor the vegetation and associated environmental factors before flooding and the changes after flooding.

Phase I. 1972/73 The proposed biophysical survey will locate major ecosystems from which study sites will be selected.

Phase II. 1973

(1) Compiling an inventory of the components of the vegetation. Each stratum will be examined - moss, herb, shrub and tree in order to determine the plant community structure. A reference collection of plants will be made.

(2) Quantitative data will be obtained from the principal plant communities to provide a baseline against which changes can be measured after flooding.

(3) Each site selected for study will be characterized by vegetation and the associated physiochemical components in order to record the key ecosystemic parameters prior to any water level change.

Phase III. 1973/78 Using the data from Phase I and II a representative selection of major plant communities will be selected for intensive monitoring. The monitoring program has to be continued for at least 5 years after flooding.

Permanent transects and quadrats will be set up. Water quality pH, conductivity, organic matter content of the soil. Soil texture will be analysed and compaction measured. Close cooperation between the vegetation program and the land program should avoid duplication of effort in relation to soil and water data gathering.

Objective: To record any changes in water quality and fauna that would result from the water diversions and flooding.

Because this study is to monitor changes and not to research all affected aspects of the water environment, it has been organized to include only those data that may act as indicators for many other features.

It is visualized that after an initial intensive study of water quality, subsequent observation can be made from simpler, less intensive field techniques. The remote sensing provided for this program will be used to supplement the water data with information on changes in flow patterns and ice patterns as well as the possibility of information on changing turbidity values.

The fish populations are slower in their response to environmental changes so that the first intensive fish study need not occur until several years following the diversion.

Phase I 1973

Selection of those areas that will typify changes occurring throughout the water system.

Phase II 1973-74

Compilation of available information on the selected areas. Collection of any remaining data required.

Phase III

Monitoring of subsequent changes, the program to take this form:

1. For the year following the flooding and for at least one year more, a relatively intensive study of water quality to be conducted. This part of Phase III should sample the study areas throughout the year.

2. Thereafter the water quality to be monitored using secchi disc readings to indicate change in turbidity.

3. During the first five years following flooding fish populations to be monitored through commercial fish catch statistics.

4. Approximately five years following flooding a relatively intensive study be made to monitor changes in fish populations and food available.

5. The intensive fish study to be repeated again at a later date.

Objective: To monitor impact of changes in water regime (large scale impoundments, manipulations of flow and water diversions) upon the wildlife habitats and associated wildlife populations and wildlife use and recommend management or mitigation measures.

An inventory of species and an assessment of their responses to environmental changes should involve the determination of the following ecological and population parameters.
Measurements of most of these parameters may require considerably

more than one year of inventory, and others require a research input. For convenience, the species concerned should be grouped according to taxonomic relationships and habitat affinities into the following categories: migratory birds, resident game birds, waterfowl, big game, furbearers, and other non-game mamals. Where possible the study should attempt to monitor the following parameters: species diversity, interactions and trophic relationships; distribution of populations, density and spatial distribution of individuals; temporal distribution patterns, productivity, migratory patterns, consumptive and non-consumptive use.

Phase I - 1973-74. On the basis of work completed by the Bio-physical and wildlife teams of the diversion study, ecosystems or combinations of ecosystems will be selected for detailed description and monitoring.

Phase II - 1974

Compilation of available information on areas selected for monitoring. Collection of any remaining data required to form an accurate basis. Monitoring of selected ecosystems by means of ground, aerial and remote sensing surveys.

Phase III

Isolate the important environmental factors governing wildlife population distributions and interpret how they are influenced by changed water regimes. Relate population levels and indexes of wildlife use to changes in habitats such as plant succession as influenced by altered water regimes. Relate impacts on wildlife to known effects of existing water diversions and impoundments located elsewhere. Develop a predictive model that correlates changes in ecosystems with habitat affinities and population dynamics of key wildlife species.

Phase IV - Recommendations:

1. Designate important natural ecosystems that would support

a diversity of species, or that would contain endangered species such as the colonial birds, or that serve as key production or staging areas. Recommend procedures for safeguarding some of these areas.

2. Delineate and describe areas that may function as replacement habitat for wildlife species, given proper management inputs.

3. Assess the current use and demand for the existing wildlife resources in the affected area and project estimates of wildlife gains or losses.

Objective:

To provide airborne and satellite remote sensing data essential to the efficient and low cost monitoring of ecosystems by the land, water, wildlife and vegetation study team.

To provide special instrumentation expertise and equipment to the study team and to assist in the extrapolation of information to non-sampled impact areas.

Method:

As a part of the Canadian and Manitoba Remote Sensing programs the selected representative ecosystem will be surveyed by airborne platforms from different altitudes according to specifications by the study team (altitudes 3,000, 10,000, 35,000ft. A.S.L.) at day and night times; where necessary at particular times during the year, as to enable to study the dynamic aspects of ecosystems. Infrared scanners, multispectral scanners, radar and microwave equipment may be used in combination with multiband photographic sensors. These sensors can be applied to study such parameters as soil texture, soil surface temperature, perma-frost, goundwater discharge, erosion, vegetation stress (moisture), disease, phenology related to water fluctuations, vegetation temperature, evapotranspiration, micro climate, regional climate, wildlife trails, possible movements, habitat, water turbulence, sedimentation load, shoreline erosion, water temperature, organic debris, etc.

Special instrumentation like Bausch and Lomb zoom stereoscopes, double scanning stereoscopes, color density slicers, scanning densitometers, color additive viewers, computers, etc. will be available to the study teams to analyse the Remote Sensing Data. Also special remote sensing expertise will be able to provide assistance in the interpretation of data and the design of goundtruth studies.

The ERTS satellite is presently already providing good quality imagery of the study area in 4 bands of which two are in the visible part (4,5) and two are in the infrared part of the spectrum (6,7). Satellites have already shown their ability to assist in monitoring turbidity in water, water level change, forest fires, plant succession and waterflow in Northern rivers in a general way.

Co-ordination of efforts will be important in this type of study. It is suggested that a special co-ordinator will be required to melt data gathering of the different disciplines and the evaluation in the later stages. This person could be an employee of the University of Manitoba, Province of Manitoba, or any other agency which may play a major contributing role to the monitoring aspects.

The monitoring of the selected ecosystem could be carried out via contractual arrangements with the University and its departments. However, from logistics, interest and efficiency point of view it may be more desirable to compose a study team of representatives from the major interested agencies: Province of Manitoba (Dept. of Mines, Resources and Environmental Management), Manitoba Hydro, Federal Departments, Universities of Manitoba and Winnipeg and present contractors of the Lake Winnipeg, Churchill and Nelson Rivers Study Board. In this way we will be able to draw on all existing expertise, facilities and instrumentation, and include in the evaluation process all interested parties.

As all disciplines will lean heavily on Remote Sensing techniques and special instrumentation it is suggested that the Manitoba Remote Sensing Centre could act as the co-ordinating agency. Expertise of the Centre or seconded to the Centre could do part of the contract work or work in association with contracting agencies.

On the basis of the detailed reports submitted by Dr. G. Adams, Dr. J. Shay, Mr. C. Tarnocai, G. Mills, Mrs. H. Ayles and J. Thie, the total man-year involvement, field expenses, etc. were estimated. These estimates are approximate and only identify the magnitude of cost associated with the proposal. For some years the cost may be lower, for some years higher than anticipated. Summarized as follows:

Phase I - 1973	All disciplines (Total)	$ 10,000	
Phase II - 1973-74	Vegetation	20,000	
	Soils	20,000	
	Water	20,000	
	Wildlife	20,000	
	Remote Sensing	20,000	
		$100,000	
	Coordination	10,000	
		$110,000	per year
1975	All disciplines (Total)	110,000	
1976	All disciplines (Total)	110,000	
Phase III 1977	All disciplines (Total)	140,000	
and IV 1978	All disciplines (Total)	110,000	
1978	All disciplines (Total)	110,000	
1979	All disciplines (Total)	160,000	
	Total	$740,000	

Total cost of Phases I, II, III, IV $860,000