

REPORT

ON A PROPOSAL FOR THE
CLASSIFICATION OF MANITOBA'S
SURFACE WATER

Souris River Principal Watershed Division

February, 1980

File: 1882.0

MANIT^BBA
CLEAN ENVIRONMENT COMMISSION

Office of the Chairman
Box 4, 139 Tuxedo Avenue
Winnipeg, Manitoba
R3N 0H6

February 28, 1980

The Honourable Warner H. Jorgenson,
Minister of Consumer and Corporate
Affairs and Environment,
Room 357 Legislative Building,
WINNIPEG, Manitoba.
R3C 0V8


Dear Mr. Jorgenson:

In a letter dated December 19, 1978, the Minister then responsible for The Clean Environment Act, the Honourable A. Brian Ransom, requested The Clean Environment Commission to conduct public hearings respecting the application of surface water quality objectives to individual basins and watersheds in Manitoba.

In consultation with the Environmental Management Division of your Department, the Commission determined that the Souris River Principal Watershed Division would provide an appropriate area for the commencement of this program. The Commission carried out its investigation of the Souris River Basin and held public hearings on the basis of a proposal prepared by the Division in consultation with other Divisions and Departments of Government.

The investigation has now been completed and I take pleasure in submitting herewith the Commission report and recommendations.

Yours very truly,


Guy E. Moore,
Chairman.



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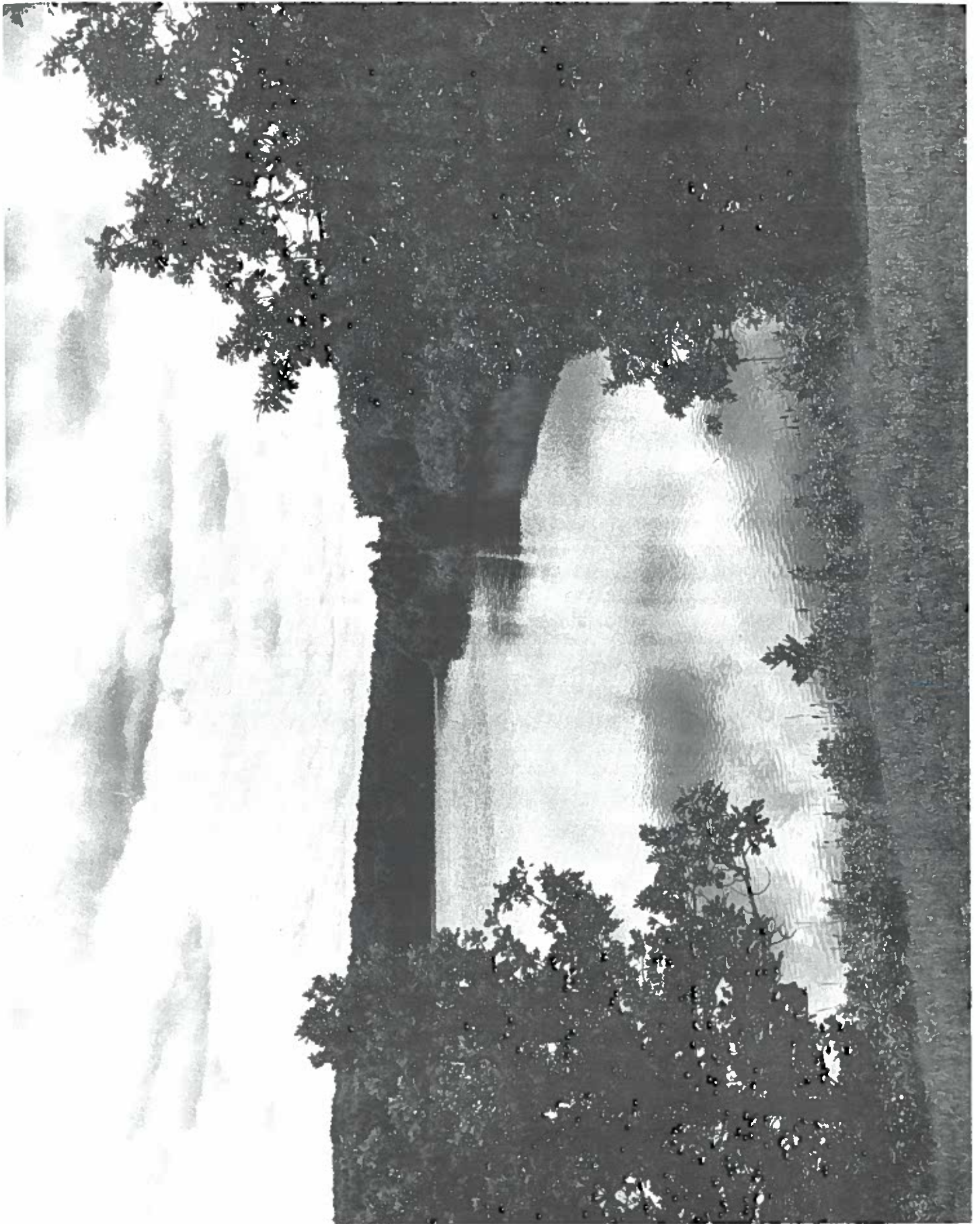


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REPORT ON A PROPOSAL FOR
THE CLASSIFICATION OF MANITOBA'S SURFACE WATER
SOURIS RIVER PRINCIPAL WATERSHED DIVISION



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Photos of the Souris River courtesy of the
Manitoba Government Information Services



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Conclusions

1. That the surface water classifications proposed for the Souris River Principal Watershed Division as described in Appendix "B" are soundly based and represent appropriate classifications for the waters in question.
2. That the omission of a proposed criterion for phosphorus represents the omission of a pollutant that is significant in terms of water quality in lakes and impoundments.
3. That the lack of an established minimum flow criteria during the winter months is significant in that it has been linked to declines in water quality resulting in depletion of fish stocks by winter fish kills.

Recommendations

1. That the *Proposed Classification of Manitoba's Surface Water Souris River Principal Watershed Division* of September, 1979, attached as Appendix "B" to this report, be adopted for the guidance of those who have a responsibility for water use planning and for water quality protection in the Souris River Principal Watershed Division.
2. That the classifications established in Appendix "B" to this report be subject to review not less frequently than once every three years and that any significant changes or updating of the classifications be subject to public hearing procedures.
3. That criteria be developed for phosphorus content levels in the waters of the Souris River Principal Watershed Division.
4. That efforts be made to have a reasonable minimum flow criterion established for the Souris River for the months of November to May, inclusive.

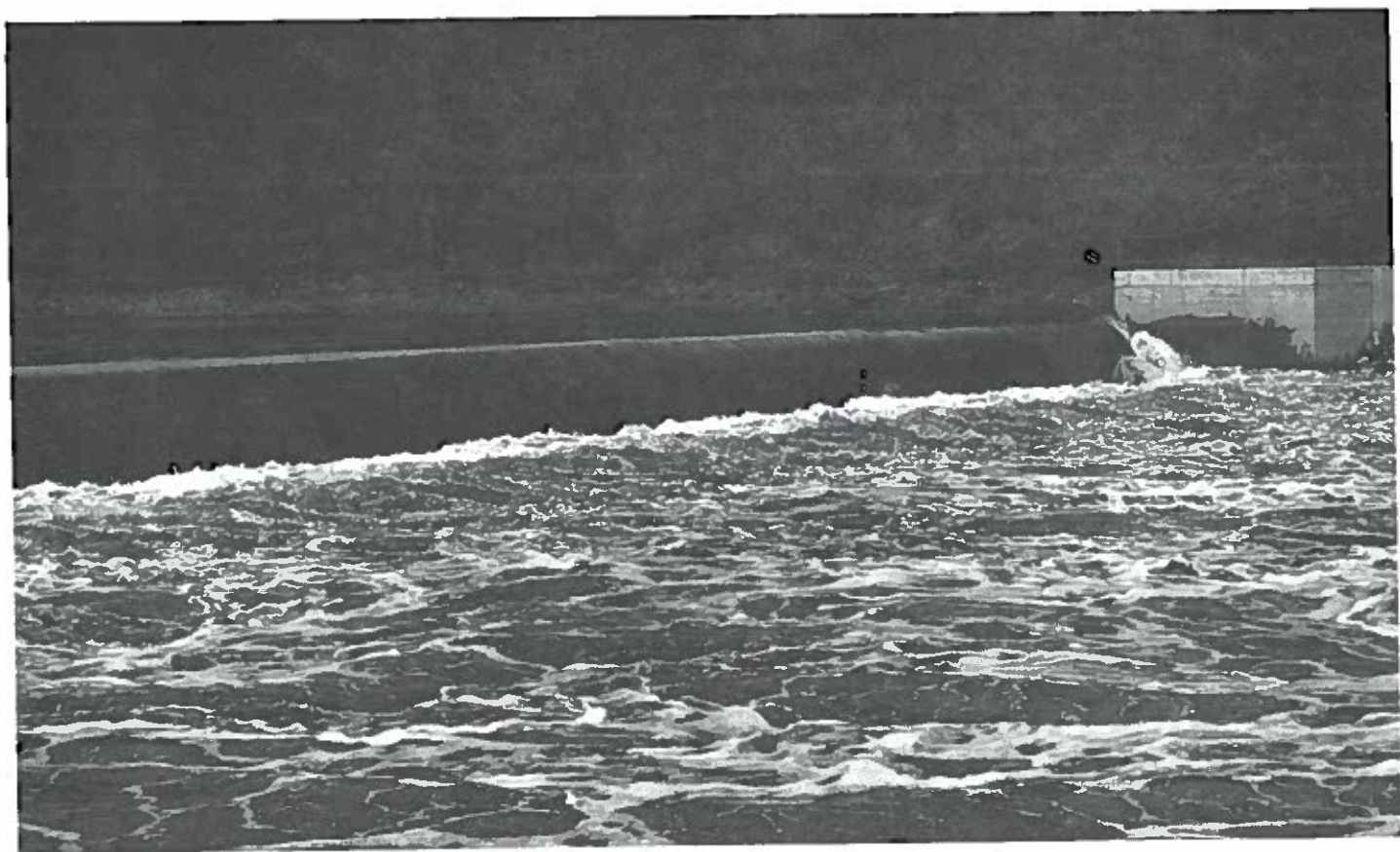
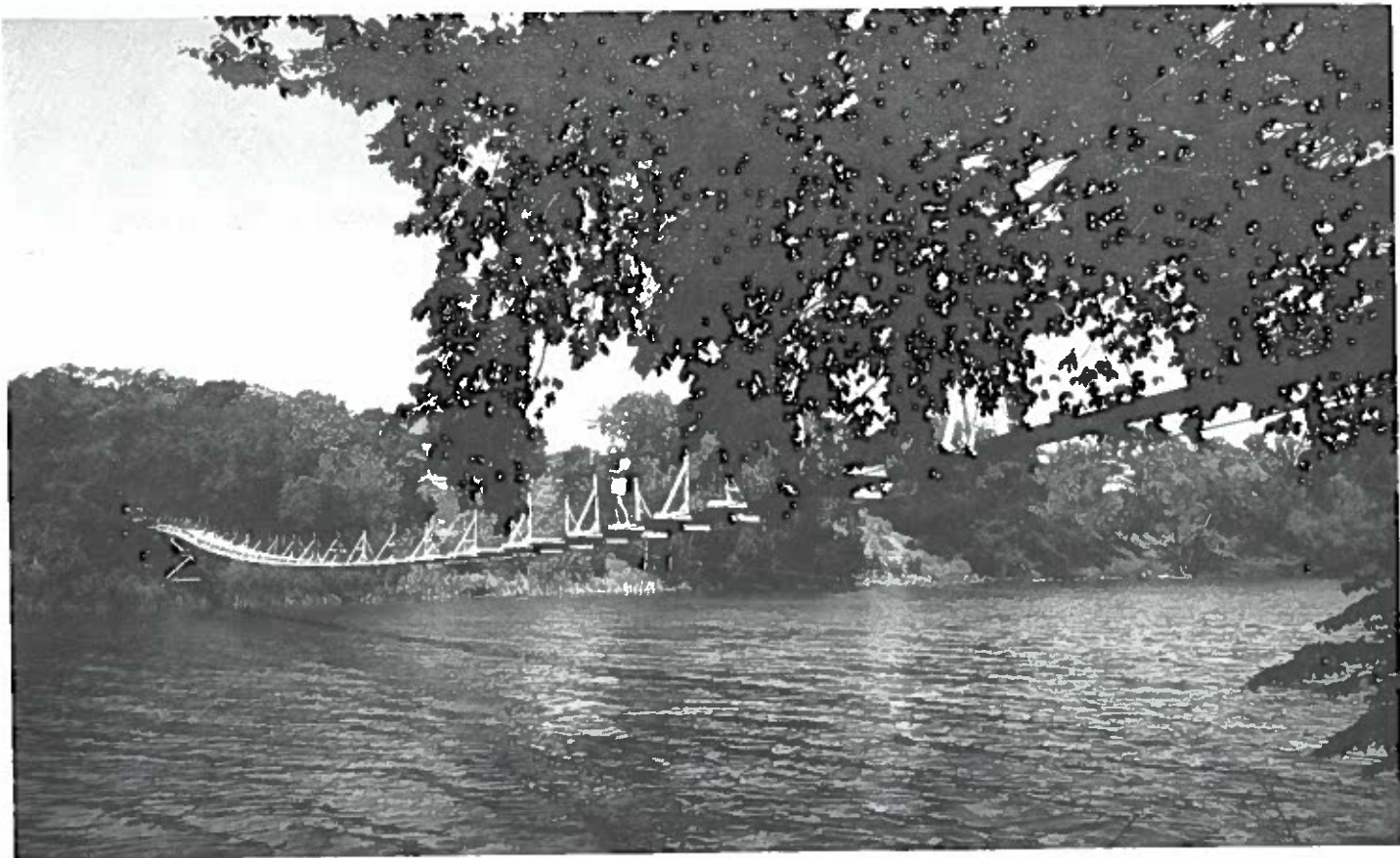
Background

In May, 1978, The Clean Environment Commission submitted its *Report on a Proposal Concerning Surface Water Quality Objectives and Stream Classification for the Province of Manitoba* to the Honourable A. Brian Ransom who was at that time the Minister responsible for The Clean Environment Act. In December, 1978, the Minister indicated in a letter to the Commission that the water quality objectives and stream classifications contained in the proposal prepared by the Environmental Management Division which formed the basis of the Commission's report were accepted in principle. In the letter, he also requested the Commission to conduct public hearings in order to apply the stream classifications to individual watersheds and to submit periodic progress reports. The Minister's letter is attached as Appendix "A" to this report.

To commence the program of stream classification, it was necessary to select which of the nineteen principal watershed divisions in Manitoba would be dealt with first. After consultation with the Environmental Management Division, it was agreed to begin with the Souris River Basin. The Souris River was chosen because of the availability of a large amount of data. This had been accumulated in connection with ongoing monitoring programs and a number of studies conducted by other organizations and agencies. A further reason for choosing the Souris River Principal Watershed Division was the recommendation of the Canada-Manitoba-Saskatchewan Souris River Basin Study Board in its report of June, 1978, that "Surface water quality objectives specific to the Souris River should be prepared." Also, the Souris River Basin was relatively straightforward when compared with the complexity of some of the other important principal watershed divisions in the Province. The Commission's interest was confined to that portion of the Souris River Principal Watershed Division located within Manitoba.

Preparation

The Environmental Management Division then proceeded with the preparation of a proposal for stream classification within the Souris River Watershed. This entailed a comprehensive comparison of the data on the present



state of the water quality with the water quality objectives already established. It also involved an investigation to establish what are the present uses of the water of the River and its tributaries, lakes and wetlands. Also, it involved an exercise of judgement in an effort to anticipate future needs and developments on the part of residents of the Watershed Division as they may affect or be affected by the quality of the surface water. In September, 1979, the Environmental Management Division, in collaboration with the Parks, Water Resources and Fish and Wildlife Divisions and the Agriculture, Health and Community Services, Municipal and Urban Affairs Departments of the Manitoba Government filed with the Commission its *Proposed Classification of Manitoba's Surface Waters Souris River Principal Watershed Division*, September, 1979. This proposal, which is the principal document in this investigation, was tabled as evidence at the public hearings and distributed widely by the Commission. It is attached as Appendix "B" to this report.

In preparation for holding public hearings, the Commission Chairman sent out letters to all municipalities, media outlets and organizations in the Souris River Watershed explaining the form and extent of the present investigation. The first of these letters was sent out September 14, 1979, and the second, accompanying a distribution of copies of the above proposal, was sent out October 25, 1979. Copies of these letters are attached as Appendix "C" to this report. Advertisements of the hearings were published by the Commission in the daily and weekly newspapers in Winnipeg, in the area affected by the Souris River Watershed and in the region nearby where residents take advantage of recreational and business opportunities in the area. These advertisements appeared October 3, 4 and 9, 1979, and advance copies were mailed to the municipalities and organizations considered likely to have an interest in the development of stream classifications for the Souris. These advertisements invited municipalities, individuals and organizations to submit representations or briefs to identify the needs and concerns of residents, regional and provincial organizations and of government departments. A copy of the advertisement is attached as Appendix "D" to this report.

Conduct of Hearings

Public hearings were held by the Commission November 5, 1979, in the Legion Hall at Melita and November 12, 1979, in the Town Council Chambers at Souris. These hearings were attended by representatives of federal, provincial, state, and local governments and interested organizations as well as private citizens and media journalists. A list of the representations received is attached as Appendix "E" to this report. The Commission considered it significant that only one objection was received in connection with the surface water classification proposal under review. The objection, which was specific and touched on a matter of some importance, is dealt with in some detail below. However, the proposal gained general acceptance by those who attended the hearings.

Review of Evidence Received

In introducing the proposal in evidence, Mr. W. M. Ward noted that the criteria being used are based on the available scientific data for the constituents that make up water quality. He indicated there is broad agreement among experts in the field and that the criteria being proposed do not differ in any important respects from those in use in North Dakota or other neighbouring jurisdictions. He pointed out the classification criteria being proposed do not represent any significant changes from the present characteristics or water uses prevailing in the Souris River Basin. Bearing in mind natural limitations on the water quality levels, it is not the purpose of the proposal to advocate any changes or improvements. Rather, the purpose is to place in the hands of the decision-makers a set of classifications which will bring a semblance of order into measures for water use and related land use planning and for the control of pollution and contamination in future.

Mr. Ward noted the purpose of the present proposal is to arrive at a list of water uses with the intention that these uses will be protected in future. This list of uses being proposed is based on a review of the current water uses and on an extensive study to determine future trends and requirements. The results of this study indicate present water use patterns are unlikely to

change appreciably in the foreseeable future. For this reason, the water uses being proposed for protection are basically the same uses that prevail at present.

The selection of water uses forms the basis of the stream classifications being proposed. The stream classifications, in turn, give rise to a series of water quality objective numbers - a separate set of numbers for each classification (note Appendix "F" and Tables 9 and 10 in Appendix "B"). One of these numbers, representing a specific constituent or quality, will thus be isolated as the critical level for that quality factor and a single set of critical factors will thus emerge as the water quality objective for the entire Principal Watershed Division. Mr. Ward noted the desirability of reviewing the water quality objective numbers from time to time as progress is made in the understanding of these matters by the scientific community.

The interjurisdictional aspects of assigning stream classifications were noted by Mr. Ward in his presentation. As the Souris River flows through Saskatchewan and North Dakota, as well as Manitoba, five governments have responsibility for aspects of water quality management. Responsibility is shared in the various reaches by a long list of boards, commissions, councils, committees, and departments of local, state, provincial and federal governments in the two nations. In international negotiations in the past, a set of assumed water quality objectives was used to represent the Manitoba position. Further waiting to establish a set of provincially recognized water quality objectives would be counterproductive from the point of view of planning in Manitoba. These objectives can be expected to provide a basis for a position to be taken into account when matters relating to these bodies of water are under discussion with neighbouring jurisdictions. It was also noted that, where assimilative capacity is seen to exist in the Souris River Watershed, the future apportionment or use of this capacity will be subject to negotiation by decision-makers responsible for the overall direction of this important resource.

Mr. Ward noted that the hearings and other activities relating to the present Commission investigation provide an opportunity for the discussion of any particular water quality problems in the Souris Watershed. One of these

problems was raised in a representation by Ms. Nancy Cornish, Western Region Chairman of the Manitoba Environmental Council. Ms. Cornish objected to the absence from the proposal of water quality objectives for phosphorus or radioactive materials. She noted the importance of these constituents. In reply, it was pointed out that radioactivity has never been a problem in the Souris. However, it was indicated the presence of phosphorus is a matter of some concern. As a plant nutrient, phosphorus encourages the growth of aquatic plants and algae, especially in lakes and impoundments. It also contributes to eutrophication in lakes. Speaking for the interdepartmental committee which participated in the preparation of the proposal, Mr. James N. Warrener of the Environmental Management Division explained that no objective was included in the proposal as no agreement has been reached on an appropriate phosphorus level. This is a very complex problem and it is felt that further study is required. He noted that, while a limiting standard has been adopted in North Dakota, there is particular complexity in assigning limiting numbers to streams or running water. Phosphorus is identified as one of the principal contaminants entering the surface waters from so-called non-point pollution sources. It was pointed out that phosphorus is a constituent of run-off water from a wide variety of land uses, and not solely or even primarily from agricultural activities. It is also feared as an anticipated contaminant in connection with the possible introduction of irrigation return flows from Garrison Diversion Unit to the Souris River Basin. Mr. Warrener suggested that, until a limiting number is determined, it may be appropriate to control phosphorus pollution in the Souris River Watershed by prescribing limits on a case-by-case basis.

Mr. W. E. Griffin of the Manitoba Department of Agriculture spoke as a representative of his Department and member of the interdepartmental committee responsible for drafting the water classification proposal. He indicated that the classifications assigned to the surface waters must be attainable, consistent with the desires of the residents of the area, and relevant to the best economic use of the Basin. Residents of the area should be given complete access to full and understandable information on the present water quality status and on the technology and the costs and benefits of any proposed water quality changes. It is important to remember that the stream classifications will not be a law to be enforced, but an objective that may or



may not be attainable. The objectives should be based on optimum social and economic benefits to residents, keeping economic realities in mind. The greatest single benefit of the Souris River Watershed lies in the removal of run-off water from improved lands, particularly those used for agriculture. He noted that properly run agricultural operations are unlikely to cause water quality problems. He stated that most of the nutrient pollution in the Manitoba portion of the Souris River is caused by wildfowl refuges along the River between Lake Darling and Westhope in North Dakota.

The Commission was disappointed that, of the twenty-four municipalities lying entirely or partly within the Souris River Watershed, representatives of only seven were present at the Commission hearings and only two made representations. Moreover, it was noted there was no response to the offer from the Environmental Management Division to make speakers available for talks or informal briefing sessions with municipal councils, service clubs and organizations, in spite of the fact that the Commission circulated this offer widely in the Chairman's letters. While disappointing, the lack of interest is understandable when it is remembered various study boards and committees have held hearings and meetings throughout the area during the last few years. Due to the public input recorded by previous recent studies, the lack of widespread citizen participation did not impede the work of the present investigation.

As a result of the lack of widespread response by local governments, the trouble taken by the municipal representatives who attended the hearings and the representations made by them were of considerable value and were very much appreciated by the Commission.

Speaking as Reeve of the Rural Municipality of Arthur and as Chairman of a task force which worked with the Souris River Basin Study Board, Mr. Ron Renwick stated the municipality is opposed to deterioration of the present water quality of the Souris River. He also expressed confidence that appropriate pollution controls will limit the possibility of contamination from agricultural and industrial practices in future. He said the Council supports the statement that the water quality criteria must recognize and be compatible with the continuation of a viable agricultural industry in the Souris River Watershed.

Speaking on behalf of the Town of Melita, Deputy Mayor Ken Carels stated that the quality of the Town water supply might be affected by the quality of the water in the River as it is drawn from groundwater adjacent to the River. Water quality of the River is also of great importance as a potential source of water for domestic and industrial use and to serve as a basis for recreational activities. For these reasons, no deterioration of the water quality should be permitted. Potential for such deterioration exists from plans for the Garrison Diversion Project, from the effects of agricultural chemicals and from the discharge of municipal wastes. The Town of Melita requested that any decision in connection with the classification of waters for the Souris River Basin not have an adverse effect on the Town water supply.

Mr. Wayne Drummond spoke at the hearing on behalf of the Souris River Water Commission. He cautioned that while agriculture plays the major role, thirty percent of the land in the Souris Basin is not suitable for crops and is, therefore, devoted to the raising of livestock and to the support of both summer and winter recreation. These activities include fishing, hunting, camping, canoeing, swimming, skiing, tobogganing, and orienteering. The Canadian Orienteering Championships were held recently in the Lauder Sand Hills. The water quality of the surface waters in the Souris Basin is important to all of these activities as it is to the raising of livestock and the welfare of wildlife and these uses should be protected.

Water Quality Problems

The Water Quality Supplement of the Souris River Basin Report states "prairie streams such as those in the Souris River Basin generally contain poor quality water." This is attributed by the report to the precipitation deficit with the result that all of the tributaries of the Souris River in Manitoba are intermittent in nature. They have low flows or they run dry except during the spring run-off period. This results in the flow being sustained in part by the infiltration of groundwater which brings about an increase in the hardness and dissolved mineral content of the streams.

A second reason for the poor water quality is the richness of the

the prairie soil. The spring floods cause soil erosion. The attendant nutrient problems are prevented during the run-off by the high dilution factor. However, these silts add to the nutrient contamination in the impoundments in the River contributing to the growth of algae and aquatic plants.

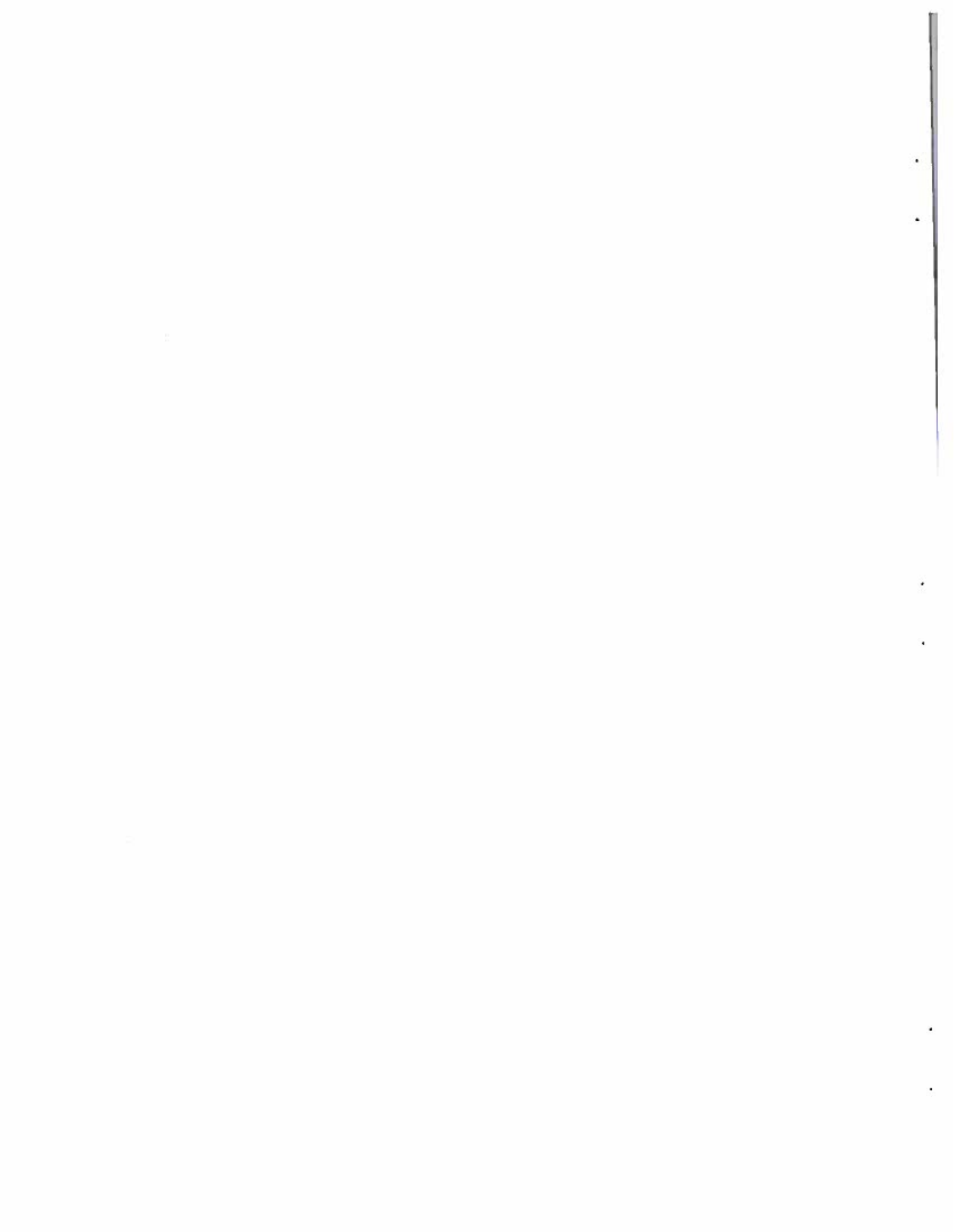
A third factor contributing to water quality problems is the length and coldness of the winters. The streams become frozen when water levels are low. As a result, some streams freeze right to the bottom while, in others, oxygen levels are depleted without the opportunity for replenishment. Similar conditions prevail in the lakes in the Souris Basin with depleted oxygen levels resulting from decaying organic material. One result of these conditions has been a series of fish kills in the lakes and streams during the winter. As is noted in Appendix "B", this is "particularly devastating" above the Wawanesa dam, as "natural repopulation from the Assiniboine River is not possible except in flood situations."

The Commission noted that there exists a formally agreed minimum flow of $0.57 \text{ m}^3/\text{sec}$. from June to October, inclusive, in the main stem of the Souris River under the International Souris River Board of Control. However, this limit does not apply in the Winter or Spring and, as has been mentioned, water quality problems originating from low flows are most damaging at those times of year. It would appear to be most desirable from the point of view of the quality of the surface water and the viability of the sports fishery to secure agreement on a reasonable flow criterion for those critical months.

A fourth cause of poor water quality is the advanced eutrophic state of the lakes in the Souris River Basin. This results from a number of natural factors already alluded to. However, the report at Appendix "B" suggests that better management of non-point nutrient sources, reduced organic loading and improved regulation of stream flows might bring about some improvement. Such an improvement would give promise of enhanced recreational opportunities in an area where facilities for water-based recreation are greatly in demand.

It is important to note, in the words of the Souris River Basin Study Board Report, "Water quality in streams in the basin is relatively poor as a

result of natural conditions rather than human activity. Thus, a significant improvement in water quality cannot be expected. It is essential that man's work not cause a worsening of water quality."



LETTER FROM THE HONOURABLE A. BRIAN RANSOM



MANITOBA

MINISTER

MINES, RESOURCES AND ENVIRONMENTAL MANAGEMENT

WINNIPEG
R3C 0V8

December 19, 1978.

Mr. Guy E. Moore,
Chairman,
Clean Environment Commission,
Box 4, 139 Tuxedo Avenue,
WINNIPEG, Manitoba.
R3C 0V8

Dear Mr. Moore:

The Report on a Proposal Concerning Surface Water Quality Objectives and Stream Classification for the Province of Manitoba has been received and reviewed by the Department.

It is now considered important that the Commission proceed with public hearings respecting the application of these water quality objectives to individual basins and watersheds in various parts of the Province.

Accordingly, this letter will provide approval in principle to the water quality objectives and stream classifications as recommended in the report and I would request the Commission proceed to conduct such public hearings as may be required for individual watersheds and provide me with periodic progress reports as well as a final report.

The Environmental Management Division will continue to assist the Commission in this project.

Yours sincerely,

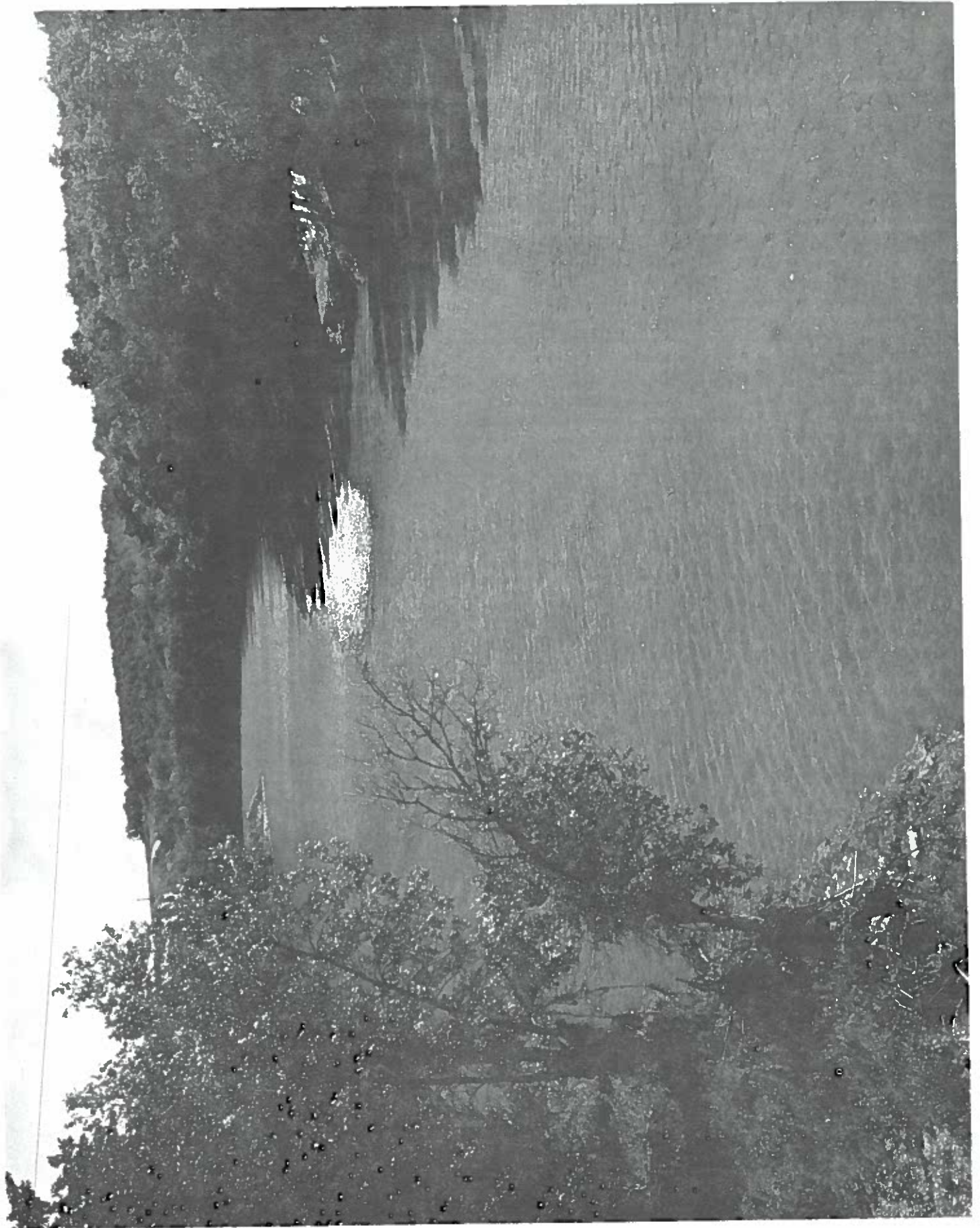
A handwritten signature in black ink, appearing to read 'A. Brian Ransom'.

A. Brian Ransom,
Minister.

PROPOSED CLASSIFICATION OF MANITOBA'S SURFACE WATER
SOURIS RIVER PRINCIPAL WATERSHED DIVISION

Prepared by Environmental Management Division,
Department of Mines, Natural Resources and Environment,
in collaboration with
Water Resources, Parks, Fish & Wildlife Divisions;
and Departments of Agriculture, Health & Community Services,
Municipal & Urban Affairs, Tourism & Cultural Affairs.

September 1979



PROPOSED CLASSIFICATION OF MANITOBA'S SURFACE WATER
SOURIS RIVER PRINCIPAL WATERSHED DIVISION

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PROPOSED CLASSIFICATION OF MANITOBA'S SURFACE WATER

SOURIS RIVER PRINCIPAL WATERSHED DIVISION

1.0 INTRODUCTION

This proposal is prepared for presentation to the Clean Environment Commission as a follow-up of the Commission's "Report on a Proposal Concerning Surface Water Quality Objectives and Stream Classification for the Province of Manitoba, May 4, 1978", which was approved by the Minister of Mines, Natural Resources and Environment on December 19, 1978. In the application of the report to the Souris River Basin the following background information has been compiled by an interdepartmental committee. Finally a recommendation for specific water quality objectives is proposed as a basis for discussion at the public hearings and for consideration by the Clean Environment Commission.

It should be noted that one of the recommendations of the Souris River Basin Study recently concluded was:

"31. IT IS RECOMMENDED THAT SURFACE WATER QUALITY OBJECTIVES SPECIFIC TO THE SOURIS RIVER BE PREPARED."(1)

It was stated that such objectives would provide the basis for establishing wastewater treatment and effluent disposal requirements.

Apart from considerations for Manitoba, streams in the Souris River Watershed and especially the main stem of the Souris River flow across international and provincial boundaries. This fact makes the setting of Objectives an important exercise in coordination since several jurisdictions, each having distinct but interdependent responsibilities, are concerned. Since the same water is involved as it crosses the border there must be recognition by downstream jurisdictions of the decisions of those upstream and vice versa. The hearings to which this is addressed and subsequent decisions by the Commission must reconcile views of the Province of Saskatchewan, the Prairie Provinces Water Board, the Canadian Government, the State of North Dakota and the Government of the U.S.A.

Unless there are major basic philosophical differences in the approach to this matter by one or more parties, the problems for reconciliation will be minor. In this respect those interested are referred to I.J.C. Report to the Governments of Canada and the United States - Transboundary Implications of the Garrison Diversion Unit, 1977, especially Chapters VIII and IX and the Separate Opinion of Commissioner, Bernard Beaupre.

1.1 General Description

The Souris River Principal Watershed Division extends into Saskatchewan, North Dakota and Manitoba. The portion of the watershed considered here is that in Manitoba covering an area of approximately 10,000 Km² (3,870 sq. mi.). The various regions in the study area are listed in Table 1 and shown in Figure 1.

Six physiographic regions are found in the Manitoba portion of this watershed. They are the Oxbow Till Plain on the west and at the border with Saskatchewan, the Souris Plain in the centre, the Waskada Till Plain in the south centre, the Turtle Mountain in the southeast corner, the Tiger Hills in the northeast and the Upper Assiniboine Delta in the uppermost north eastern corner of the watershed.

The land surface, basically flat to gently rolling, has an elevation of approximately 366 m (1200 ft.).

The Manitoba portion of the Principal Watershed Division has a continental climate, with a water deficit ranging from 64 mm (2.5 in.) to 127 mm (5.0 in.). The average annual precipitation ranges from 432 mm (17 in.) to 483 mm (19 in.) in a general west to east direction. Precipitation varies considerably from year to year. The growing season, number of days with an average temperature above 6⁰C, averages 175 days extending from late April to mid-October. On the average the frost-free period extends from the end of May to the first week in September, approximately 100 days.

The study area contains two major soil types: the black Chernozemic (dark coloured grassland) and the Podzolic (light coloured forest soils). The Podzolic soils are found in the Turtle Mountain physiographic region, while the remainder of the watershed is made of black Chernozemic soils. The natural vegetation, typical of subhumid areas, is made of widely spaced trees (parkland) and aspen forest. Although there are still areas of native vegetation, primarily located in less suitable agricultural areas, much of the original vegetation has been altered through the influence of man. Cultivation, drainage and suppression of prairie grass fires have had the greatest influence. Dense stands of broadleaved and coniferous trees are found in the Turtle Mountain area.

The Souris River is the main watercourse. It rises in southeastern Saskatchewan and flows in a southeasterly direction for 225 Km (140 mi.) to the International Boundary. The river continues southeasterly in the state of North Dakota to about 50 Km (30 mi.) southeast of Minot where it turns north. It crosses the International Boundary into southwestern Manitoba, about 520 valley Km (325 mi.) from its source. The river then flows northeasterly in Manitoba for about 274 Km (170 mi.) to its confluence with the Assiniboine River some 40 Km (25 mi.) southeast of Brandon. The Souris River Valley is a glacial spillway averaging less than 30.5 m (100 feet) in depth; the river channel varies from 1.5 m (5 feet) to 7.6 m (25 feet) in depth.

The Souris River and its tributaries, being typical prairie streams, derive most of their annual flow from snowmelt and early spring rains. Among the natural lakes in the study area Whitewater Lake and the Oak Lake-Plum Lakes complex are important as waterfowl nesting and staging areas. The Turtle Mountain lakes are mainly used for recreation. In addition, a number of lakes and reservoirs have been developed in the basin for water supply purposes. Information on these projects is reported in Table 2.

2.0 HYDROLOGY OF THE SOURIS RIVER PRINCIPAL WATERSHED DIVISION

The annual flow of the watercourses in the Souris River Principal Watershed Division derives mostly from snowmelt and early spring rains. For example, for the Souris River over the period of record (1914 to 1976) the April, May and June combined flow, as measured at the Wawanesa gauging station, has accounted for approximately 78 percent of the mean annual runoff of $423 \times 10^6 \text{ m}^3$ (343,000 acre-feet). The annual volume of flow has ranged from $4.194 \times 10^6 \text{ m}^3$ (3400 acre-feet) in 1937 to $2.59 \times 10^9 \text{ m}^3$ (2.1×10^6 acre-feet) in 1976. At Westhope, near the International Border, the mean annual volume of flow of the Souris River for the period of record (1931 to 1976) is $236 \times 10^6 \text{ m}^3$ (191,000 acre-feet) with the extremes being $136,000 \text{ m}^3$ (110 acre-feet) for the minimum and $1.455 \times 10^9 \text{ m}^3$ (1.18×10^6 acre-feet) for the maximum.

The highest daily discharge for Westhope has been recorded at $350 \text{ m}^3/\text{s}$ (12,400 cfs) in 1976. Numerous times the flow has dropped to zero, usually during the winter. At Wawanesa, the extremes recorded are $740 \text{ m}^3/\text{s}$ (26,200 cfs) in 1976 and zero on several occasions.

Six dams have been built on the main stem of the Souris River in Manitoba. Four are located at the Towns of Melita, Hartney, Souris and Wawanesa. Another dam is situated about seven kilometers (four miles) north of Napinka. The sixth is located about 11 kilometers (6.8 miles) north of the Town of Melita. The storage capacities behind these dams range from $271,000 \text{ m}^3$ (220 acre-feet) to $1.23 \times 10^6 \text{ m}^3$ (1000 acre-feet) and are used basically for stock-watering purposes. Most of the water for domestic use is taken from the groundwater aquifers in the basin.

Groundwater accounted for approximately $2.90 \times 10^6 \text{ m}^3$ (2350 acre-feet) or 73 percent of the $3.95 \times 10^6 \text{ m}^3$ (3200 acre-feet) of water used in 1974 for all purposes in the Manitoba portion of the Principal Watershed. It is estimated that 80 percent of the people in this area depend on groundwater for domestic use. The estimated sustained yield of all the aquifers in the Manitoba watershed is $33.3 \times 10^6 \text{ m}^3$ (27,000 acre-feet) per year. Thus, less than 10 percent of the potential groundwater supply is used. The groundwater resources, however, are not evenly distributed throughout the watershed in Manitoba. In some parts supply is abundant; in others, it is very limited or non-existent.

Seventy-five water rights have been issued in the Souris Basin with 2024 acre-feet being allocated to agriculture, 2029 acre-feet to conservation (including waterfowl), and 712 acre-feet to municipal and industrial purposes.

3.0 DEMOGRAPHIC ANALYSIS

The Souris River Basin in Manitoba had a resident population of 17,917 or 1.8% of the provincial total of 1,021,506 in 1976.

As shown in Table 3, the population of Manitoba Souris Basin had declined by 21.2% during the 1951-1976 period while the comparable figures for both Brandon and Manitoba had increased by as much as 69.4% and 31.5% respectively.

The Manitoba Souris Basin contains no cities. Melita and Souris are the two major urban centres having 16% of the 1976 Basin population. While the population of Melita had increased by 50%, the population of Souris had remained relatively stable during the 25-year period.

Table 4 shows 70% of the 1976 Manitoba Souris Basin residents as rural population. The number of rural population had decreased during the same period both in absolute numbers and percentage points.

The population figures for the existing level of development and immediate and long-term development levels are presented in Table 5.

4.0 ECONOMIC CONDITIONS

The labour force in the Manitoba Souris Basin increased by 2.8 percent during the 1961-1971 decade. In the same period labour force for the economic region* and the province grew by 22.1 percent and 18 percent respectively.

More people were unemployed in 1971 than in 1961 in the Manitoba Souris Basin, the economic region and the province as a whole; however, the size of unemployed expressed in percentage was lowest in the Manitoba Souris Basin as compared to its economic region and the province. More information on labour force and employment is presented in Table 6.

As to the labour force distribution, 41.5% of the Manitoba Souris Basin's labour force was employed by the primary agricultural sector as compared to 11.4% for the entire province.

*Since the Souris Basin as defined by census divisions 4 and 8 in Manitoba was not appropriate for purposes of analyzing economic conditions, census division 7, where Brandon is located, was added to delineate an economic region.

The overall labour force distribution trends had been such that secondary and tertiary sectors accounted for greater percentages of total labour force in the Souris Basin, economic region and the province, but the trend had been more prominent at the regional and provincial levels indicating a relatively more developed and balanced economy at these levels than at the Basin level.

The location quotient, based upon labour force statistics, is a convenient device for summarizing linkages and dependencies between different regional economies. A location quotient greater than unity indicates an industrial group in the Basin with a greater share of the labour force than the regional or the provincial proportion in that group and, therefore, that industrial group is considered basic or export oriented. Correspondingly, the Basin is considered to be specialized in and more dependent upon that industry than the region or the province as a source of employment and, hence, of income.

A study carried out recently by the Souris River Basin Study Board using the location quotient method confirmed that the Manitoba Souris Basin economy is distinctly specialized in agriculture and is becoming increasingly more dependent on it over time relative to the economic region and especially relative to the province. The location quotients in the remaining industrial divisions of the primary sector and also the secondary and tertiary sectors were less than unity.

The Basin's labour force in the tertiary sector grew at slower rate than that in the economic region implying that the importance of the City of Brandon as a service centre to the Basin economy is increasing. Within the Basin itself, Melita and Souris are the principal urban centres function as local market centres. The high percentage of older and retired persons in Melita, Souris, Deloraine, Hartney, Reston and Wawanesa suggests that they are serving as retirement settlements, absorbing a significant portion of the 55 years and over rural population.

5.0 AGRICULTURE

The land defined by the Souris River Watershed in Manitoba, Figure 2, represents an area of approximately 1,093,000 hectares (2,700,000 acres) of which approximately 931,000 hectares (2,300,000 acres) is farmland. Within the watershed approximately 688,000 hectares (1,700,000 acres) or 63% of the total land area is improved agricultural land. Agriculture is decidedly the predominant land use within the watershed. Employment in the area is heavily dependent upon agriculture with approximately 40% of the labour force engaged in agriculture .(1)

A summary of agricultural production within the watershed is presented in Table 7. The gross value of sales from farms in the area was \$87.6 million in 1976, or 12% of the sales from all Manitoba farms.

Though the area produces a full range of agricultural produce, cereal grain production predominates. Flaxseed production is also significant with 46,100 hectares (114,000 acres) seeded to flax in 1976 or 20% of the total flaxseed acreage in Manitoba. Livestock in the area is primarily beef cattle production; however, there are significant populations of dairy cattle, swine and poultry.

Water supply within the area is predominantly groundwater. It has been estimated that 73% of the water used for all purposes comes from groundwater sources. Approximately 80% of the people within the area depend upon groundwater for domestic use.(1)

Many of the soils of the area are very well suited to irrigation. Should surface supplies be augmented with suitable quantities and quality of water, irrigation would become a high priority use with some 40,500 hectares (100,000 acres) of good quality irrigable soils.(1)

Agricultural use requirements consist of irrigation and livestock watering and are estimated at 286,000 m³/year (232 acre feet per year) for the year 1975. It is estimated that this will increase to 432,000 m³/year (350 acre feet per year) by 1985 and possibly reach 7,650,000 m³/year (6200 acre feet per year) by the year 2,000.(2)

Summer flooding is a significant agricultural problem in the Westhope to Lauder region.

The activities of the Manitoba Department of Agriculture are providing direction to the agricultural industry in the areas of 1) increased crop and livestock production, 2) increased processing of agricultural products, 3) improved provincial and national transportation systems, and 4) increased exports both nationally and internationally.

As the world and domestic demand for food increases it is expected that the Souris basin will respond by increasing the yield of crops as well as some changes in cropping patterns. This will lead to an increased demand for water for irrigation, livestock and industrial purposes. The lack of a dependable flow of water in the Souris Watershed presents a constraint to unrestricted development of agriculture in the basin. As irrigation farming increases the need for an adequate level of agricultural land drainage also increases.

Some specific trends in agricultural production are already becoming evident in the basin and are expected to continue. The continued reduction in summer fallow will result in an increased acreage of crops. There will be a gradual increase in specialty crops and yields per hectare of traditional crops will increase partially as a result of increased and/or better usage of fertilizers, herbicides and pesticides. Improvements in surface and sub-surface drainage on agricultural lands will result in an increased crop acreages. The trend will be toward larger hog and beef feedlot operations.

It is anticipated that the demand for agricultural export products will more than double by the turn of the century. The implications for land and water use are significant. Agriculture is and will continue in the future to be the main economic generator in the Souris River basin. It is necessary to consider the economic importance and the welfare of this industry when discussing the development of guidelines for water use and quality.

6.0 FISHERIES

Southwestern Manitoba is a relatively dry area characterized by streams that are largely intermittent and shallow, eutrophic lakes that experience periodic fish kills in summer and winter. Residents of the Souris River Basin have few options where to fish in their immediate vicinity. For example, Rock Lake and Pelican Lake can expect severe winterkills, on the average every second and third year respectively. Other areas such as Killarney Lake, Oak Lake, Elgin Reservoir and the Turtle Mountain lakes experience varying degrees of periodic winterkill. Habitat deterioration, estimated by winter dissolved oxygen tests, is evident in Boissevain and Turtle Head Creek reservoirs while Oak Lake, a prime angling area since 1965, suffered two severe fish kills over the last two winters. Fish stock maintenance and development attempts, including aeration experiments on large lakes, have been fruitless while costly repetitive fish stocking provides minimum qualitative and quantitative angling opportunity.

A 1976 angler creel census of the Souris River sport fishery in Manitoba, estimated angling pressure at 16,900 angler hours.(13) Northern pike, walleye and perch were the main species being caught. This does not indicate an extensive fishery but any reduction in numbers of these species would be viewed as a significant loss by the local fisherman who derives recreational benefit from the Souris River.

Winter stream flows are most critical to fish survival. The International Garrison Diversion Study Board noted that periods of low dissolved oxygen occur regularly on portions of the Souris River and are correlated with flows falling below $0.57 \text{ m}^3/\text{sec}$ (20 cfs).(8) The relationship between flow and dissolved oxygen concentration in the Souris River was further demonstrated in the Burlington Dam Task Force Report.(14) Garrison committee also noted that over the period 1960 - 1975 the median dissolved oxygen concentration under ice cover at Coulter was 1.8 mg/l and was less than 0.2 mg/l for 25 percent of the measurements. Although several factors influencing the overwintering success of fish generally, extended winter periods with oxygen levels below 1.0 ppm are critical for walleye and perch. Increasing numbers of northern pike will succumb as winter dissolved oxygen levels fall below 0.4 mg/l. The Souris River stream classification of 2B carries a dissolved oxygen objective of 47% or more saturation at the ambient temperature. Obviously present conditions often limit the realization of this objective.

Recent Ministerial policy directives state that emphasis for outdoor recreation development must be directed at regions where shortfalls exist between demand and supply. In the Souris River Basin, the demand for sport angling opportunities greatly exceed that presently available. If future angling success would improve, 50% of game and fish members have indicated that fishing effort would increase up to 40%. Future angling pressure will likely increase to approximately twice present levels.(15)

The Souris River and its tributaries are major spawning areas for all species present. Northern pike and yellow perch have an abundance of spawning grounds available to them along the Souris River valley in Manitoba upstream from Souris, as can be seen in Figure 3. Although most of the smaller creeks are intermittent their flow is usually significant for a period each spring and early summer. As such, they function as valuable spawning and nursery areas. The following summarizes particular areas.

Tributary	Identifi- cation	Approximate Length		Remarks
		Kilometers	Miles	
Oak Creek	5NG	16	10	Probably spring fed with relatively fast water and some rocky substrate. Used by mooneye, pike, bullheads and walleye for spawning. Good shelter cover. Fairly consistent seasonal flow.
Black Creek	5NG	34	21	Some gravel areas suitable for walleye and sauger spawning.
Elgin Creek	5NG	16	10	Small, limited habitat with flows dependent on release or overflow from Elgin Reservoir.
Plum Creek	5NG	35	22	Is actually a series of marshes until it nears the Souris River. Ideal spawning area for pike and perch. A major fish movement route between the Souris River and the Plum Lake-Oak Lake complex. Flows usually reduced to winterkill levels by early winter.
Pipestone Creek	5NG	83	52	In Manitoba riparian vegetation is primarily bush and grassland. Oak Lake fishery largely dependent on this river for elevation maintenance, spawning and occasional flow support beneficial for overwintering fish.

Tributary	Identifi- cation	Approximate Kilometers	Length Miles	Remarks
Jackson Creek	5NF	59	37	Occupies a shallow extensively grazed valley. Low discharge and cover. Minimal pike and sucker spawning.
Graham Creek	5NF	75	47	Similar to Jackson Creek.
Gainsborough Creek	5NF	50	31	Northern pike, perch and walleye spawn at least 5 miles upstream each spring. Mean flows from March to October is 6.5 cfs.
Antler Creek	5NF	72	45	Similar to Gainsborough Creek. Mean flows from March to October have been estimated at 17.2 cfs.
Stony Creek	5NG	56	35	Terminates in the Maple Lake - Hunter Marsh complex but is connected to the Souris River by the Maple Lake drain. Spawning pike may occasionally reach Maple Lake depending on spring flows but spring discharges have usually subsided by June and occasionally limiting their return to the Souris River.
Oak Lake	5NG			The most important sport fishing lake in southwest Manitoba.
Plum Lake	5NG			The most important pike and perch spawning area associated with the Souris River and Oak Lake. Normally winterkills but many fish move back into Oak Lake and the Souris River to overwinter.
Whitewater Lake	5NG			Not directly connected to the Souris River. No fisheries potential except for possible future fish culture.

7.0 RECREATION (See Annex 1 also)

Recreational Use: Recreation might be considered to encompass such activities as swimming, boating, canoeing, sailing, water skiing, camping, picnicing, sightseeing, sport fishing and sport hunting, all of which are available to the individual within the Souris River area under study.

There are two provincial parks, four provincially operated wayside parks, eight community sponsored recreation sites and three privately owned recreation sites in the Manitoba study area. Of the 17 outdoor recreation sites, eight are located along the Souris River. The locations of the sites are shown in Figure 4.

The two provincial parks are Turtle Mountain Provincial Natural Park and Oak Lake Provincial Recreation Park. Turtle Mountain Park has two campgrounds, one at Adam Lake and one at Max Lake. The designation of Turtle Mountain as a natural park dictates that all uses must be within its natural carrying capacity and in harmony with the natural features. Oak Lake Park provides intensive day-use recreation facilities.

The Souris River in Manitoba from the International Boundary to its confluence with the Assiniboine River is used for canoeing and casual angling.

It is expected that the demand for waterborne recreation will increase due to the paucity of good surface water in the region. Whatever water is available should be maintained at as high a level as possible.

8.0 WATER SUPPLY

- a) Municipal - Municipal use consists of institutional and public uses (schools, public buildings, fire protection, etc.) and Domestic uses (cooking, drinking, bathing, lawn irrigation, etc.). Municipal and domestic water withdrawal from the Souris River is estimated at 636,000 litres (140,000 imperial gallons) per day for the years 1975 to 1985.

Approximately one-third of the people residing in the study area in Manitoba are supplied through municipal systems. Approximately one-half of the municipal users reside in Melita or Souris, which together have a population of 2837. Of the 6111 people in the area considered as municipal users, approximately one-half rely on surface water sources; the remainder on groundwater sources.

Souris is the only community in the area using water from the main stem of the Souris River. The town has a population of 1674 with an annual water consumption of 209 million litres (46 million gallons). Average daily use is about 568,000 litres (125,000 gallons), and peak usage is about 822,000 litres (181,000 gallons). Two industries in Souris which use water from the town system are a plastics company and a cheese processor. In addition to using water from the town supply, the plastics company uses an additional 91,000 lpd (20,000 gpd) from a private well.

Deloraine uses surface water and draws approximately 62,000 m³ (50 acre-feet) annually from the Deloraine Reservoir on Turtlehead Creek.

Seven communities in the basin depend upon groundwater for their municipal water systems. It was estimated that annual usage by the seven communities amounts to 239,000 m³ (194 acre-feet).

Melita is the largest municipal user of groundwater in the study area in Manitoba. It draws 100 million litres (22 million gallons) a year from wells located adjacent to the Souris River. Two industries, a creamery and an abattoir, are large users from this system. The creamery uses about 9100 litres (2000 gallons) per day and the abattoir uses about 2300 litres (500 gallons).

The communities of Belmont, Hartney, Pierson, Reston and Wawanesa rely on groundwater for their municipal systems. None of these communities have industries which use substantial amounts of water.

- b) Rural Domestic - This use is limited to household use on farms and rural settlements that border the river.

There are approximately 12,000 people in the basin in Manitoba who are dependent upon private water systems. About 11,000 are farm residents and about 1000 people live in rural communities. Since groundwater is not available in about 20 percent of the basin, it was assumed that about one-fifth of the rural residents use surface water and four-fifths use groundwater. Assuming a domestic use of 180 lpd (40 gpd) per person, this would result in a total annual rural domestic use of about 800 million litres (176 million gallons) of which 159 million litres (35 million gallons) would be from surface water sources and the remainder from groundwater. There were no reports of rural residents utilizing water from the Souris River for domestic purposes.

9.0 MUNICIPAL AND INDUSTRIAL

The obvious and most controllable sources of contamination into the Souris River Basin are the municipal point dischargers. These are listed in Table 8. Presently, there are no municipal facilities discharging raw sewage into the Basin's area. One major source of contaminant release is the waste treatment facility serving the Town of Souris. At present, the facility consists of a septic tank system with little if any organic, nutrient or bacteriological removal. The Town is to have a secondary treatment facility operational by the end of 1981.

Wawanesa releases effluent continuously from a secondary sewage treatment facility to the Souris River. Disinfection of the effluent to levels sufficient to meet microbial standards could be a problem; however, the effluent flows are small compared with the volume of diluent in the river. The remaining communities utilize sewage lagoons. Apart from Melita, located along the main stem, impact from these facilities have not been measured in the river. It is believed that the town of Melita has a problem of hydraulic overloading of the lagoon system. Reduction of this problem could reduce the oxygen demand on the river. The industries located within the basin discharge to the municipal systems.

The Manitoba Souris Basin is dependent on outlying regional and provincial centres for manufactured foods and for services provided by the secondary and tertiary sectors. The proximity of Brandon to the Basin tempers economic expansion of Basin communities.

There are no significant primary resource industries in the study area other than agriculture. Small manufacturing and food processing plants are located in Melita and Souris. In Melita there is a creamery, an abattoir and a plastic manufacturing plant. In Souris there is a plastic manufacturing plant as well as a cheese processing plant.

There may be a 300 MW thermal electric generating station constructed in the Melita area within the long-term future development time frame. Food, fruit and vegetable processing industries will expand in this area in response to the increased level of irrigation farming.

10.0 ENVIRONMENTAL CONCERNS

Currently, there are not direct industrial discharges to the Souris River. Any new discharge would be required to meet the requirements of the Clean Environment Act and would be based on ambient water quality considerations arising from this water quality objective process.

In terms of municipal waste discharges the major problem is caused by the Town of Souris with a totally inadequate water pollution facility. Corrections to this facility are to be completed by 1981. The water pollution control facility at Melita also has shortcomings but it is believed that the impact on the Souris River is not severe. The Village of Hartney has a lagoon which does not operate properly but, again, it is believed that the impact on the Souris River would be negligible. An excessive chlorine residual in the sewage effluent from the Village of Wawanesa might have some impact on the river biota in contact with the effluent but this has not been measured. New installations would have to meet the requirements of the Clean Environment Act.

It is the natural tendency of all water bodies to age but this process is accelerating at an alarming rate in southern Manitoba, including the Souris River Watershed. Fish habitat protection and improvement, manifested by improved land use practices, reduced organic loading, more constant stream flows, water level maintenance and increased flushing, would result in improved fish populations.

Fish losses above Wawanesa are especially devastating because natural repopulation from the Assiniboine River is not possible except in flood situations, due to six dams on the Souris River. For example, the Wawanesa Dam, with an elevation difference between crest and apron of approximately 3.7 meters (12 feet), acts as a physical barrier to all species during most flows.

Limited flow, high summer water temperature, low dissolved oxygen levels and nutrient concentration are presently some of the factors limiting fish production in Manitoba portions of the Souris River. (16) The maintenance and improvement of water quality and quantity in the Souris River is paramount to the fulfillment of this directive.

A minimum flow criterion has been specified for the Souris River by the International Souris River Board of Control. A minimum of $0.57 \text{ m}^3/\text{sec}$ (20 cfs) must be passed within Manitoba during the months of June to October inclusive except during periods of severe drought when flows can be reduced below $0.57 \text{ m}^3/\text{sec}$. Unfortunately, from a fisheries perspective the $0.57 \text{ m}^3/\text{sec}$ criterion has little relevance to fisheries needs as minimum flows are not designated for spring or winter, which are two seasons (spawning and overwintering) most critical to fish survival.

The extent of the present Souris River sport fishing is limited mainly by inconsistent seasonal water flows that result in periodic fish kills. Further water withdrawals, especially in the critical winter months, could exacerbate fish survival during low flow periods. International cooperation should be sought through the Souris River Board of Control to further delineate minimum seasonal flows in the main stem of the Souris River.

The actual degradation of surface waters caused by modern agriculture is difficult to quantify. Agricultural activities can and do influence the quality of waters within a watershed. The application of fertilizers, pesticides and animal wastes to the soil, as well as crop, soil and water management practices, can materially affect the composition of water discharged from a watershed. (3)

Though the potential impact of agricultural land drainage on the deterioration of surface water quality is significant, it is not necessarily greater than natural background conditions. Figure 5 illustrates approximately the potential yield of nutrients to surface waters under various land use activities.

Agriculture is a consumer of considerable amounts of chemical fertilizers containing the same nutrients often implicated in pollution and accelerated eutrophication of surface waters. There is concern regarding the levels of nutrients transported from fertilized cropland. When surface water quality is considered, phosphorus and nitrogen are viewed as the major contaminants.

Efforts have been made to directly relate crop fertilizer application to nutrient concentrations in stream and drainage waters. A direct relationship is not likely because of the large preexisting soil reserves of plant nutrients and the natural physical and biological enrichment processes. Though mismanagement could contribute to increased nutrient load and accelerated eutrophication of surface waters, restrictions must not impede the use of chemical

fertilizers in crop production. They are not a benefit to but rather a requirement of modern agriculture. Sound economic fertilizer management and not water quality concerns will dictate fertilizer use and ensure adequate protection of surface waters.

The disposal of animal wastes from confinement livestock production units possesses a pollution potential similar to that of chemical fertilization in terms of nutrients. In addition, livestock wastes can contribute additional organic load and bacterial contamination of runoff waters. Under proper management and application, problems resulting from land disposal of livestock waste are minimal. Furthermore, land application is the most environmentally sound and acceptable disposal of livestock waste. Comparing the ratio of livestock to land with the Souris River Watershed relative to others in Manitoba, it is unlikely animal waste disposal need present a problem to surface waters.

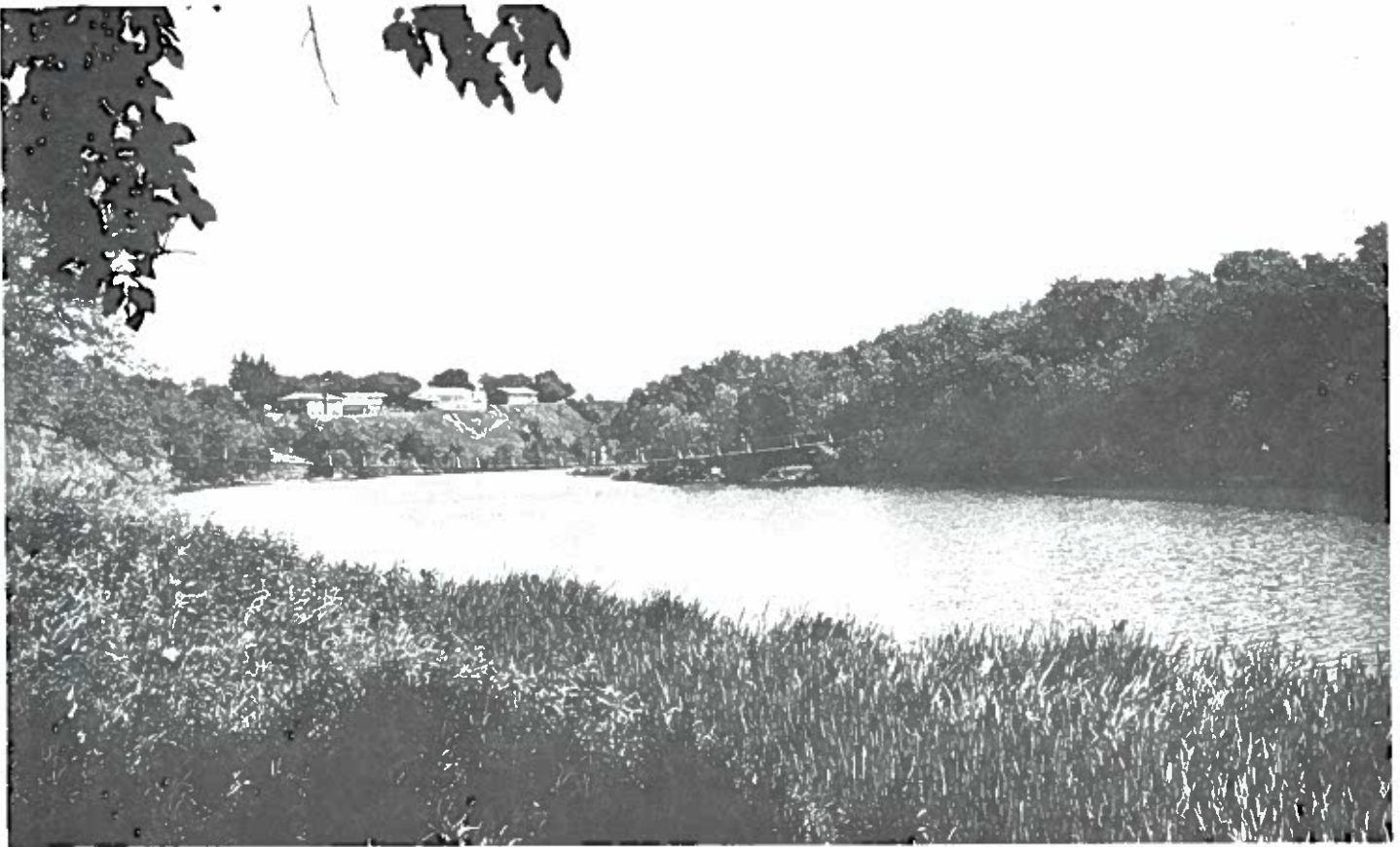
Control over direct contamination of surface waters by livestock wastes is currently regulated under environmental legislation. Livestock operations in compliance with environmental regulations are of little threat to surface water quality in terms of direct contamination by the livestock operation.

The use of pesticides in agriculture is now common. Agriculture and society in general is aware of the potential dangers of pesticides. Current safeguards including rigid registration and licencing procedures and thorough monitoring for residues have, in the past, provided good control over pesticide use.(4) Indiscriminate use of pesticides causing direct surface water contamination must be attributed to irresponsible individuals rather than users in general.

Some pesticide residues do become absorbed to soil particles and are subject to movement into surface water supplies through soil erosion.

Many of the undesirable inputs to surface waters from agricultural land drainage are the direct result of soil erosion. Sediment from surface erosion is a major transport vehicle for pollutants. Phosphorus, often the most critical nutrient in eutrophication, is absorbed to eroded soil particles. It must be noted that only part of the surface erosion from cropland reaches a stream or lake. Sediment is deposited in low areas and flatter slopes of fields and in shallow field drains. However, drainage channel and streambank erosion often produces a sediment that is completely available to the surface water system. Responsibility for sediment transport is not limited to agricultural practices but also extends throughout the drainage network.(5)

The land within the Souris River Watershed provides the base for a viable agricultural industry upon which the local economy depends. Water quality criteria must recognize the importance of this industry and ensure compatability with its current and potential production capabilities.



11.0 WATER USE CLASSIFICATIONS

The waters of the Souris River Basin have been classified according to their existing or potential uses, as described elsewhere in this report. The methodology is as outlined in Water Quality Objectives, Province of Manitoba.(6) These waters vary in suitability for Class 1 (Domestic Consumption), Class 2 (Fisheries and Recreation), Class 3 (Industrial Use), or Class 4 (Agricultural Use).

The recommended classifications are listed in Table 9 with specific classes noted and the specific water quality objectives listed. In each case the specific water quality is the most limiting value of all the uses designated. These are conveniently listed in Table 10.

It should be noted that the proposed classification has been based upon acceptable quality for the end use (consumptive, industrial, recreational, agricultural, navigational and environmental) and is not based upon the optimum economic and social benefits to society. Another way of stating this is to point out that every "use" has equal weighting in the selection of any given specific objective. One use, such as agriculture, is not given more emphasis because it is a major economic interest over another use such as recreation, which may be of marginal value economically, or serve only a relatively few people. The issue is to determine what end uses must be dropped in order to accommodate the economic realities. The final decision must, of course, take this into account.

The water classification system accepted as the basis of this report was developed by personnel of the Environmental Management Division based on current and potential water uses.

No streams, lakes or segments of the waters in the Souris River Basin have been identified as an outstanding natural resource. There are two areas being considered as ecological reserves - a prairie site on Gainsborough Creek and another on the Souris River Bend Wildlife Management area. Water quality objectives should have no bearing on either site. Therefore the designation of a non-degradation objective, as provided for in the Water Quality Objectives, is not invoked.

12.0 WATER QUALITY - SOURIS RIVER

It was necessary to classify the Souris River in order to compare the water quality with that of the Objectives. As noted in Section 11.0, Table 9, the main stem of the river from the international boundary to the junction with the Assiniboine River was classified as a 1C, 2B, 3B, 4B, 4C, 5 and 6. In the comparison, which follows of the current water quality data with the Objectives, data of the Inland Waters Directorate of the Water Quality Branch of Environment Canada for the Souris River at Coulter, Manitoba, were utilized. The data were extracted from the publication, "Water Quality Data - Manitoba (1961 - 1976)", published in 1978.(7) In addition to the Souris River at Coulter, are data from nine other stations on the main stem Souris River in Manitoba as well as five

tributaries. None of the stations contain as many data pieces as Coulter and, as a matter of fact, some were only sampled during the Souris River Basin Study. The reader is referred to the previous named report for additional water quality information.

The water quality station at Coulter, Manitoba, is the most data-rich station with close to 450 pieces of data for some parameters over the period September 1961 to October 1976. Most of the data collected as part of the water quality sector of a Souris River Basin study during the period April 1975 to October 1976 are included. This was a very intensive study, involving in total over 36,000 pieces of chemical and bacteriological data in the Souris River Basin of both Saskatchewan and Manitoba. There were a greater number of stations in Saskatchewan sampled with greater frequency; however, there was a large body of water quality information collected in both the main stem and tributaries in the Manitoba portion of the Souris River Basin. One is referred to the Souris River Basin Study Report(1), and particularly to the Water Quality Supplement for detailed information on water quality of the Souris River basin in 1975 and 1976. Later references will be made to aspects of that report.

In October 1975 the International Joint Commission (IJC) established the International Garrison Diversion Study Board. One of the charges of the Board was to examine and report on:

- a) the present state of water quality in the Souris River,
- b) the effects of present water quality on these uses, and
- c) the impacts on the quality of these waters resulting from completion and operation of the authorized plan of the Garrison Diversion Unit.

The Study Board appointed a Water Quality Committee to undertake this assignment. The outcome of this examination was a report to the IJC(2) and an Appendix entitled, "Water Quality Report"(8). The reader is referred to these documents for detailed information although aspects of these reports will be discussed in this chapter. In terms of the Souris River, data from a short river reach at the transboundary were subject to analysis for a period of record 1960 - 1974. In addition to Manitoba and Canadian agencies, the data were put together with that of North Dakota and the United States. All of the data were stored in an Environment Canada computer data storage and retrieval system (NAQUADAT) so that all data would be in a uniform format suitable for statistical analysis.

In addition, there are data available from Manitoba. Manitoba data from 1973 to the present have been computer stored. Again, there is a mix of stations from Melita to Treesbank. Most of the Manitoba data involves the Souris River at Souris. From time to time there have been a number of special studies on the Souris River. In 1955-56 the Provincial Sanitary Control Commission undertook a study to identify pollution sources. Fisheries personnel have undertaken water quality studies throughout the years. These would include, but not be limited

to, a number of occasions when fish kills were reported. Water quality experience has also been gained in assisting waterworks personnel at Souris render a consumer-acceptable water supply for the residents of that town from the Souris River. Comments will also be included towards the latter part of the chapter on these aspects.

12.1 Water Quality Data Comparison with Interim Water Quality Objectives - Souris River at Coulter

Parameters (all values are totals unless shown)	Interim Water Quality Objective	Data from Environment Canada 1978 Report - Souris River at Coulter	
		Median	90th Percentile

Aluminum (Al) as mg/l	1.0	0.14	0.52
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Aluminum was measured in the extractable form. Dependent upon extraction technique, values for total and extractable should be about the same. One could say then that the Al values are less than the objective.

<u>Ammonia</u> (N) as mg/l	0.02	<.1 (total)	0.73 (total)
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The criteria upon which the objectives were based is in terms of un-ionized ammonia. At a pH value of 7.5 to 8.0 and an average temperature of 10°C, a concentration of total ammonia of 3.0 mg/l would yield an un-ionized ammonia value of 0.02 mg/l (after Thurston et al. 1974). (9) Ammonia is in the category of a parameter that should be measured soonest since the nitrogen forms change during storage. In recent years greater precautions have been taken in terms of storage and preservation. In effect then, the data are not too credible.

<u>Arsenic</u> (As) as mg/l	0.01	<.005	0.012
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Arsenic is measured in the dissolved form. Total As would be greater than the dissolved form. At least 10% of the samples and probably more exceed the objectives. The As is probably leached from the soils.

<u>Barium</u> (Ba) as mg/l	1.0	<.1	0.3
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Barium is measured in the extractable form and therefore the data for total Ba would be greater, however, less than the objective.

<u>Beryllium</u> (Be) as mg/l	0.1	Not analyzed yet	
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<u>Boron</u> (B) as mg/l	0.3	0.16	0.31
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Boron is measured in the dissolved form and therefore total B would be greater. B objective is exceeded at least 10% of the time. Concentrations of 0.2 mg/l and 0.3 mg/l are recommended for "good" and "acceptable" standards for irrigation water. Since accumulation of Boron in the soil, rather than one irrigation application with a high concentration of Boron is the limiting factor, the suitability of the water for irrigation should be based on Median rather than the 90th percentile values of Boron. Therefore the Boron should not restrict the usefulness of this water for irrigation.

<u>Parameter</u>	<u>Interim Water Quality Objective</u>	<u>Median</u>	<u>90th Percentile</u>
<u>Cadmium (Cd) as mg/l</u>	0.01	<.001	0.002
Cd is measured in the extractable form which would likely be less than the total form. Cd objective is based on the hardness value (greater than 100 mg/l as CaCO ₃). The hardness in the Souris River exceed 100 mg/l at all times. Cd is therefore within the objective limits.			
<u>Chloride (Cl) as mg/l</u>	100	25	49
Non exceedance.			
<u>Chlorine (Cl₂) as mg/l</u>	0.01	Not applicable since there are no municipal and industrial discharges containing chlorine.	
<u>Chromium (Cr +6) as mg/l</u>	0.05		
<u>Chromium (Cr) as mg/l</u>	0.05	<.01	<.015
Only total Cr in an extractable form is measured. Values measured are below the detection limit. Cr (+6) will also be below the detection limit.			
<u>Cobalt (Co) as mg/l</u>	0.05	<.002	0.004
Although Co is measured in the extractable form, total values are expected to be in the same range.			
<u>Color, True as units</u>	15	50	80
Color is measured in the apparent form whereas the objective limit is based on the true form. The true color value will be less than the values shown (i.e., 50 and 80); however, it is expected that the objective would be exceeded (probably as a function of the decaying vegetation in the wildlife reserves in the U.S.A.). Color at the objective level cited is important to both municipal and industrial water users. In terms of domestic use it is largely an aesthetic problem. Some industries require a product water with color levels less than 15 units. Color can be removed by treatment.			
<u>Copper (Cu) as mg/l</u>	0.02	0.002	0.006
Copper is measured in the dissolved form and therefore total values will be greater than shown but much less than the objective.			
<u>Cyanide (CN) as mg/l</u>	0.005	0.009	
There is insufficient data to compute a 90th percentile. Cyanide is measured in the dissolved form and therefore total CN will exceed the value shown. Although the data base is limited, CN exceeds the objective value. Further work needs to be done on CN. The limit is significant to fish.			
<u>Detergents and Saponates</u>		Not analyzed	

<u>Parameter</u>	<u>Interim Water Quality Objective</u>	<u>Median</u>	<u>90th Percentile</u>
<u>Dissolved Oxygen as % Saturation</u>	47 or over	8.0 mg/l	12.6 mg/l

Percent saturation is a function of temperature. Corresponding temperature and DO values are not given in the data. The DO values shown could represent DO saturations from 60 to 100%. There are, however, zero (0) DO values shown. As well, special surveys through the years (especially during the winter) have identified problems with low DO's. This is a major concern with respect to fish.

<u>Faecal Coliform Organisms</u> Counts per 100 ml	100	<10	140
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There are few exceedances at this station. The main reach for the exceedance of coliforms (total and faecal) would be below the sewage outfall of the Town of Souris, which is virtually untreated. It should be noted that insufficient samples have been taken, on a monthly basis, to properly evaluate the total coliform or faecal coliform objectives.

<u>Fluoride (F) as mg/l</u>	1.0	0.2	0.42
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Fluoride is measured in dissolved form whereas total values would be somewhat higher but not to exceed the objectives.

<u>Hardness, Total (CaCO₃) as mg/l</u>	250	257	381
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Hardness values exceed objectives which relate to industrial use. This would occur particularly during the winter due to groundwater discharge. Groundwater is of poorer quality inorganically. Hardness is readily amenable to treatment.

<u>Iron, Total (Fe) as mg/l</u>	0.3	0.33	0.77
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Iron is measured in the extractable form. Total values would be about the same. Although the values exceed the objectives, the important iron form is dissolved and the median level for dissolved iron is 0.01 mg/l. It would not be a problem in municipal or domestic water supply.

<u>Lead (Pb) as mg/l</u>	0.03	<.004	0.008
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Lead is measured in the extractable form. Total values would be higher but considerably less than the objective level of 0.03 mg/l.

<u>Lithium (Li) as mg/l</u>	2.5 mg/l	Not analyzed	
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<u>Manganese (Mn) as mg/l</u>	0.05 mg/l	0.09	1.0
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Manganese, like iron, is measured in the extractable form whereas the important form to the water user is dissolved. The median value for Mn was <.01 (dissolved).

<u>Parameter</u>	<u>Interim Water Quality Objective</u>	<u>Median</u>	<u>90th Percentile</u>
<u>Mercury (Hg) as mg/1</u>	0.0002	<.00005	0.00006

The extractable form of Hg is measured whereas the total would be higher but no doubt less than the objective limit.

<u>Methylene Blue as mg/1</u> <u>Active Substances</u> (MBAS)	0.5	Not analyzed	
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<u>Molybdenum (Mo) as mg/1</u>	0.01	<.05	<.10
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The objective is below the detection limit. The form measured is extractable which would be lower than the total.

<u>Nickel (Ni) as mg/1</u>	0.025	0.006	0.01
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Form measured is extractable and it is expected that the total Ni would be higher; however, less than the objective.

<u>Nitrate-Nitrite (N) as mg/1</u>	10.0	0.3	1.4
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Nitrate-Nitrite is measured in dissolved form. The objective applies to the usefulness of a water as a water supply source (to prevent methemoglobinemia in infants less than six months). Nitrate is significant in low levels in terms of algae production. Sawyer has suggested a level of 0.3 mg/1 to forego problems of nuisance algal growth. The nitrogen to phosphorous ratio is also important (10:1 has been proposed as a good guideline for indicating normal conditions). Notwithstanding nitrogen runoff sources, plants can fix atmospheric nitrogen which becomes available to the aquatic ecosystem. Recent tentative studies undertaken on behalf of the Inland Waters Directorate showed that the Souris River water column near Coulter was nitrogen-limiting (algae growths prevented due to shortage of N in appropriate form).

<u>Nitrite (N) as mg/1</u>	10.0	Not analyzed separately from NO ₃ -NO ₂	
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Pesticides

In many cases only few samples taken of a limited numbers of pesticides. Only Alpha BHC, Lindane and 2, 4-D have values above the detection limit, which is much below the objective limit.

<u>pH (pH units)</u>	6.5 - 9.0	6.8 (low) to 9.3 (high)	Non exceedance
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<u>Phenol (ic compounds) as mg/1</u>	0.001	0.005	0.011
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Little data available although the data available shows consistent exceedance of objectives. The source of the phenolic compounds would seem to be algae metabolites. On a number of occasions the Souris River has

<u>Parameter</u>	<u>Interim Water Quality Objective</u>	<u>Median</u>	<u>90th Percentile</u>
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been singled out as the source of phenolic compounds at the Portage la Prairie water treatment plant. Further work needs to be done on this parameter which can affect taste and odour in a water supply.

<u>Polychlorinated Biphenyls</u> as mg/l (PCB)	0.000002		
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There is no information available concerning total PCB's. Values for Arochlor 1248, 1254 and 1260 are all below the detection limit. The detection limit is at least an order of 10 higher than the objective value. Perhaps the examination of biological specimens would demonstrate the importance of PCB in this basin.

<u>Radioactive Material</u>		Not analyzed	
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<u>Selenium (Se)</u> as mg/l	0.01	0.0005	<.001
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Se measured in dissolved form. Total Se would be higher but would be expected to be less than the objective value.

<u>Silver (Ag)</u> as mg/l	0.05	Not analyzed	
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<u>Sodium (Na)</u>	60% total cations	43%	46%
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Non exceedance

<u>Specific Conductance</u> as μ mhos	1000	750	1210
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Conductivity and TDS will be discussed later in the chapter in terms of the seasonal variations with the impact of ice-covered flows (baseline flow being largely groundwater) on TDS and the concomitant ions and radicals such as hardness and bicarbonate. The median value is always below the upper limit for "good" irrigation water and the 90th percentile value is well within the "acceptable level for irrigation water. There is no concern for irrigation usage.

<u>Sulphate (SO₄)</u> as mg/l	250	158	351
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Approximately 20% of values exceed objectives. Sulphates will be singled out for later discussion. The 90th percentile value is below the limit for "acceptable" irrigation water. There is no concern for irrigation usage.

<u>Sulfide (H₂S)</u> as mg/l	0.002	Not analyzed	
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<u>Temperature</u> °C $\Delta T = 1.0$			
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There are no thermal sources near the international boundary and therefore no man-induced temperature changes.

<u>Parameter</u>	<u>Interim Water Quality Objective</u>	<u>Median</u>	<u>90th Percentile</u>
<u>Thallium</u> (Tl) as mg/l	0.05	Not analyzed	
<u>Threshold Odor Number</u>	4	Not analyzed	
<u>Total Coliform Organisms</u> Counts per 100 ml	500	29	452

See earlier discussion on Faecal Coliforms.

<u>Total Dissolved Solids</u> (TDS) 1000 as mg/l	606	1161
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Slight exceedance. TDS as a function of seasonal variation will be discussed later in the chapter. The median value is always below the upper limit for "good" irrigation water and the 90th percentile value is well within the "acceptable" level for irrigation water. There is no concern for irrigation usage.

Toxic Algae

Algae are present that cause tastes and odors and filter clogging at water treatment facilities. Water blooms of algae also form from time to time and both algae respiration and bloom collapse can cause oxygen deficiencies. It is suspected that at times toxic algae metabolites can be present, particularly when certain blue-green algae are present such as *Anabaena flos-aqueae*.

<u>Turbidity</u> (JTU)	25	9.3	37
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Turbidity values exceed the objective particularly during the higher flows, (propensity to soil, bank and bed erosion). The Coulter station is a few miles below a wildlife reserve, which would tend to remove some of the suspended material. Turbidity would be highest during the spring runoff period.

Unspecified Toxic Substances

Only analyzed if there is a site specific problem.

<u>Uranium</u> (U) as mg/l	0.01	Not analyzed	
<u>Vanadium</u> (V) as mg/l	0.1	Not analyzed	
<u>Zinc</u> (Zn) as mg/l	2.0	0.006	0.020

Zn is measured in the extractable form. Total Zn would be higher but would not exceed the objective. In terms of protection of aquatic biota, bioassays may be required.

As noted above, water quality data are available at other main stem and tributary stations and a similar comparison could be made with the water quality objective proposed. This was done on a casual basis and in general most constituents are within 10% of the values found at Coulter, except Wawanesa where chlorine is discharged continuously with the municipal effluent.

For the information of the reader, water quality data summary tables for the Souris River at Coulter have been reproduced from the 1978 publication of Environment Canada (Table 11).

12.2 Supplementary Water Quality Information

a) International Garrison Diversion Study Board Report (2)

Seasonal water quality data for TDS, SS, the major ions, nutrients, DO and coliforms for the Souris River at Westhope-Coulter are summarized in Table 12. TDS follows a seasonal pattern from a winter median of 1,126 mg/l to a spring median of 395 mg/l. The high winter TDS values are associated with near zero flow and the large proportion of groundwater high in TDS. Snowmelt runoff accounts for the reduced TDS values in spring. Flow regimes during summer and fall are intermediate between spring and winter and the TDS reflects this intermediate condition. The major portion of TDS is made up of total hardness (Ca and Mg), Na, SO₄, Cl and HCO₃. Concentrations of these ions follow a seasonal pattern similar to TDS. On the basis of the limited historic record, nitrate (NO₃) and P do not show any consistent seasonal variations. Throughout the year, median values for NO₃ range from 0.11 to 0.48 mg/l, whereas P values range from 0.23 to 0.39 mg/l. Median values for DO range from 0.1 to 13.8 mg/l throughout the year. The lower values normally occur in winter in conjunction with ice cover and low flows. There is a paucity of coliform data; however, the median most probable number (MPN) values per 100 milliliter (ml) ranges from 23 to 547. The high values occur in the fall which corresponds with the release of sewage effluent from urban centers. Most of the trace elements occur near the detection limit in the Souris River. In spite of their widespread use, pesticides, herbicides and industrial chemicals are rare in the Souris River. Organochlorine forms (e.g., DDT) were not detected in the nearly 150 samples analyzed. Organophosphate forms (e.g., malathion) were not detected in the six samples taken. The herbicide 2,4-D was detected in the range of 0.03 to 0.39 micrograms per liter (µg/l) being found in 120 of the 144 samples collected. Other forms of the chlorophenoxy acids (e.g., 2,4-DB and 2,4,5-T) were not detected in the samples. Industrial chemicals, polychlorinated biphenyls (PCB), in the range of 0.03 to 0.06 µg/l were detected in up to 10% of the more than 100 samples collected.

b) Sanitary Survey of Souris River in 1955-56

The then Manitoba regulatory agency undertook a moderate sanitary survey of the Souris River in 1955-56 (Provincial Sanitary Control Commission; Sanitary Survey of the Souris River)(10). A number of the findings which follow are still applicable to this day:

- (1) Bacterially, except for the area immediately downstream from Souris, there is no measure of pollution in the river.
- (2) The flow in the river is very low at times during the summer and under ice cover.
- (3) There is a high algal population in the waters of the river; which at times has been known to affect the quality of the water at Portage la Prairie as well as the waterways of the Souris.

c) Souris River Basin Study 1978 (1)

Two Federal-Provincial water committees, established under the Canada Water Act, set up a Souris River Basin Working Group in 1970 charging it with the responsibility of designing a study program for the formulation of a plan for managing the water and related resources of the Canadian portion of the basin. A report on the study was concluded in 1978 and the Water Quality recommendations resultant from the report follow:

"WATER QUALITY

"29. IT IS RECOMMENDED THAT SOURIS PROVIDE SECONDARY WASTE TREATMENT EITHER BY MEANS OF A SEWAGE LAGOON WITH ADEQUATE STORAGE CAPACITY TO PREVENT WINTER DISCHARGE OR BY A CONVENTIONAL SEWAGE TREATMENT PLANT.

"30. IT IS RECOMMENDED THAT THERE BE INCREASED SURVEILLANCE OF INTENSIVE LIVESTOCK OPERATIONS TO DETERMINE IF ANY SUCH OPERATIONS ARE CAUSING PROBLEMS: IF PROBLEMS ARE IDENTIFIED, IT IS RECOMMENDED THAT A PROGRAM BE DEVELOPED TO COPE WITH THE SITUATION."

In recognition of concerns over effluent from intensive livestock operations in the Qu'Appelle River basin, a policy and assistance program was developed and is being implemented to rectify the situation. A similar program if deemed necessary could be considered for implementation in the Souris River basin.

"31. IT IS RECOMMENDED THAT SURFACE WATER QUALITY OBJECTIVES SPECIFIC TO THE SOURIS RIVER BE PREPARED."

The surface water quality objectives would provide the basis for establishing wastewater treatment and effluent disposal requirements.

"32. IT IS RECOMMENDED THAT EXISTING WATER QUALITY MONITORING PROGRAMS WITHIN THE SOURIS RIVER BASIN BE REVIEWED WITH RESPECT TO THEIR ADEQUACY AND ACTION TAKEN TO PROVIDE IMPROVEMENTS, AND FURTHER, THAT THE OPERATION OF THE AUTOMATIC MONITORING STATIONS AT THE TWO INTERNATIONAL BOUNDARY CROSSINGS BE CONTINUED."

An assessment of available water quality information, undertaken early in the Board's study, indicated a number of inadequacies and deficiencies with regard to the availability of water quality data within the basin. Accordingly, it was found necessary to supplement existing data with an intensive sampling and analysis program.

The quality of water in the Souris River in Manitoba is affected, to a considerable degree, by activities in North Dakota. Indications are that most of the pollution is caused by the wildlife refuges situated along the Souris River between Lake Darling and Westhope. Pollution is also caused by effluents from municipal sewage treatment facilities and by return flows from irrigation projects. Expansion of any of these activities would cause further water quality deterioration in the Souris River in Manitoba. Projects, such as the proposed Garrison Diversion Unit, could cause increases in suspended solids, dissolved solids and salts and heavy metals. Projects involving water diverted from other basins could introduce foreign biota into the Souris River.

d) Water Quality Index - Manitoba

Another item relates to a Water Quality Index (developed by Manitoba) based upon seven parameters(11). Data for the period 1973-77 were examined at a number of Souris River locations. In most cases, the index indicated a water quality ranging from satisfactory to quite satisfactory. Where the index was depressed it was generally due to high phosphate values.

e) Water Supply Investigations

In terms of producing domestic water supply for the Town of Souris from the Souris River, the main problems have been that of handling trace organics originating from decaying vegetation and algae metabolites during the open water period (especially the summer) and the higher incidence of dissolved solids, particularly the hardness bearing salts, when the base flow is restricted to groundwater discharge (during the winter under ice conditions). A finished municipal water supply should contain less than 150 mg/l of total hardness (as CaCO_3) and this level is difficult to achieve during the winter due to the raw water hardness.

f) Fishery Studies

Another major problem has been the reduction of dissolved oxygen which generally occurs during the winter in conjunction with ice cover (lack of re-aeration) and low flows. Fish kills have resulted from this condition.

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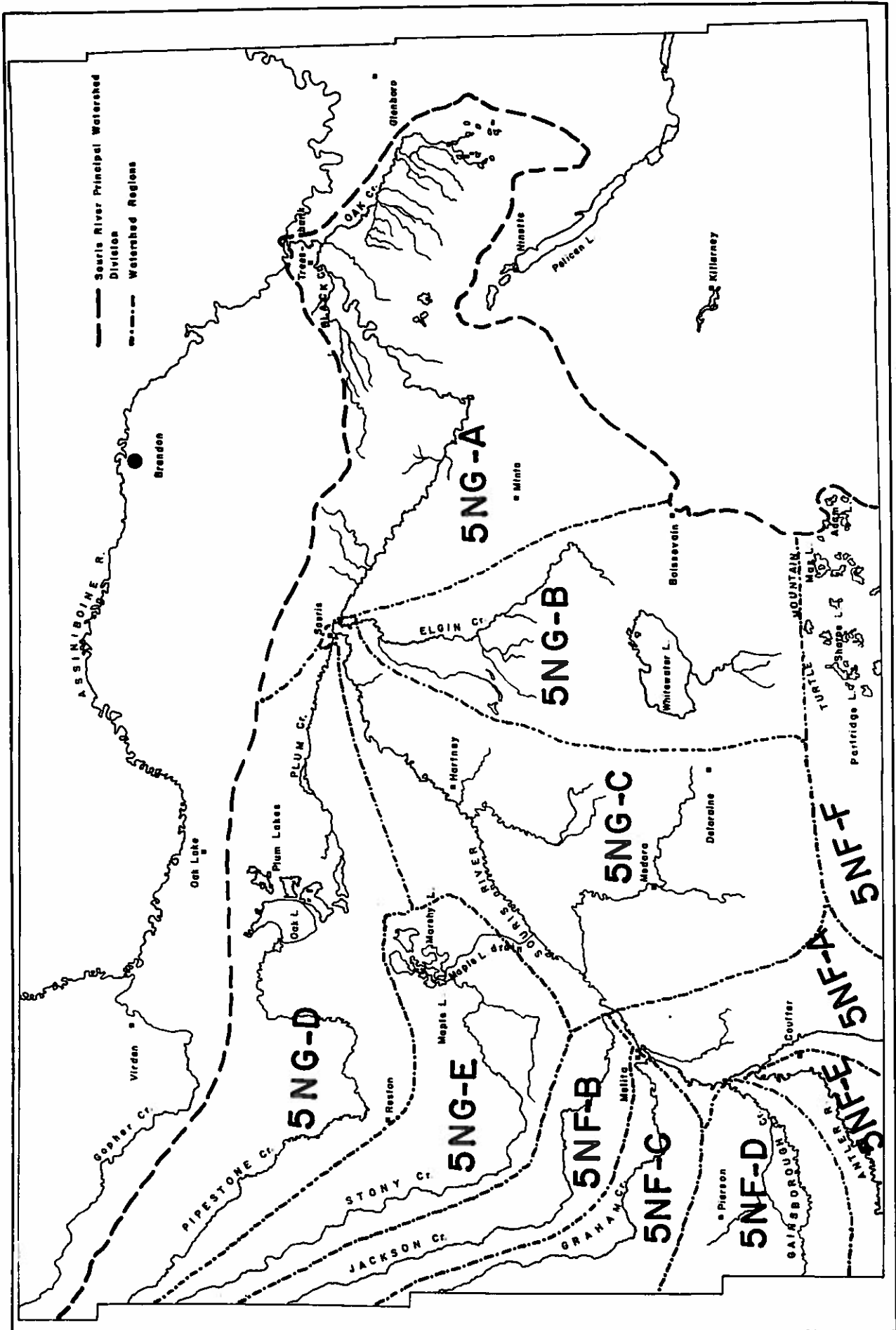


Figure 1. Souris River Principal Watershed

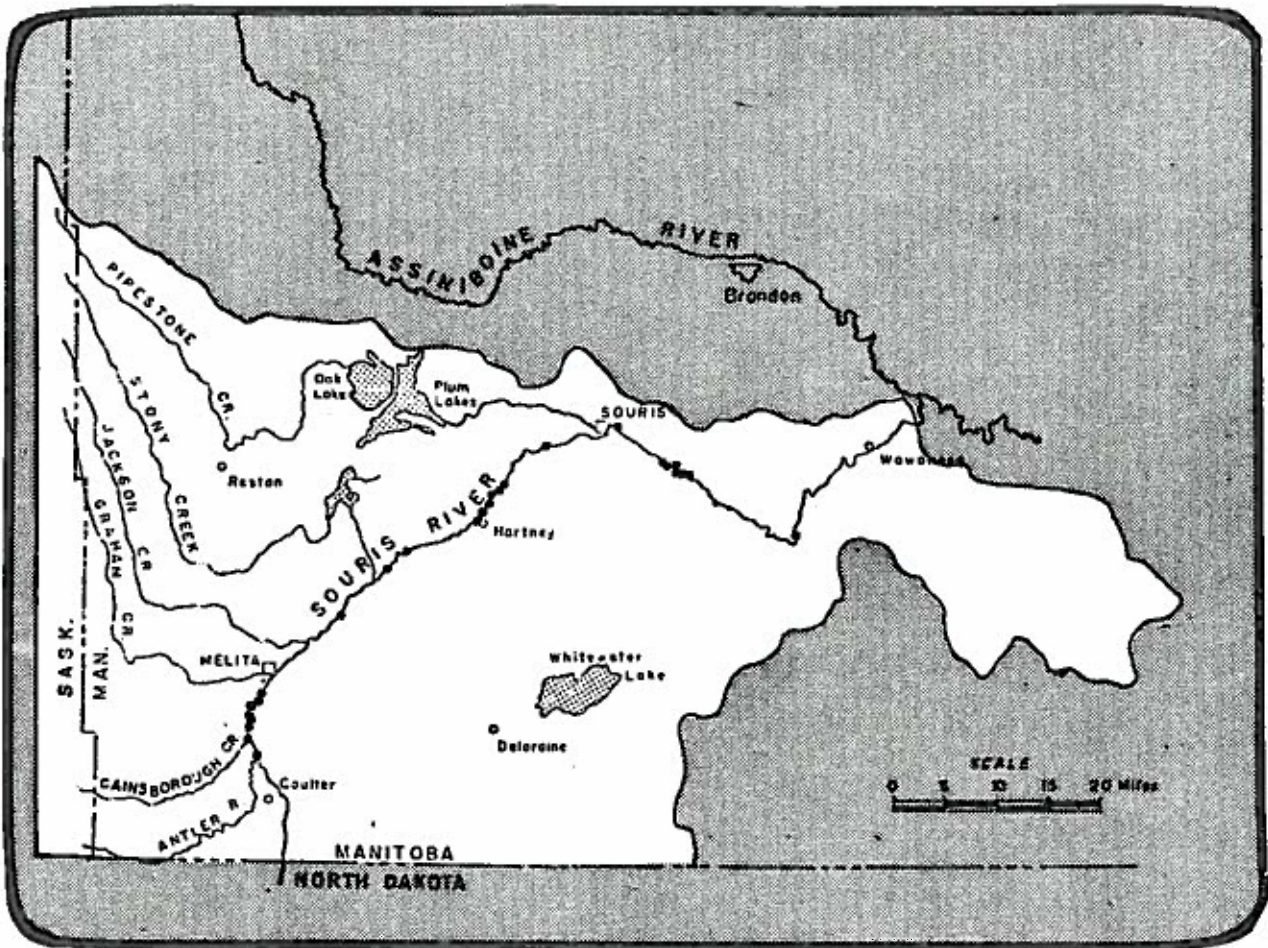


Figure 3. Gamefish Spawning Areas – Manitoba

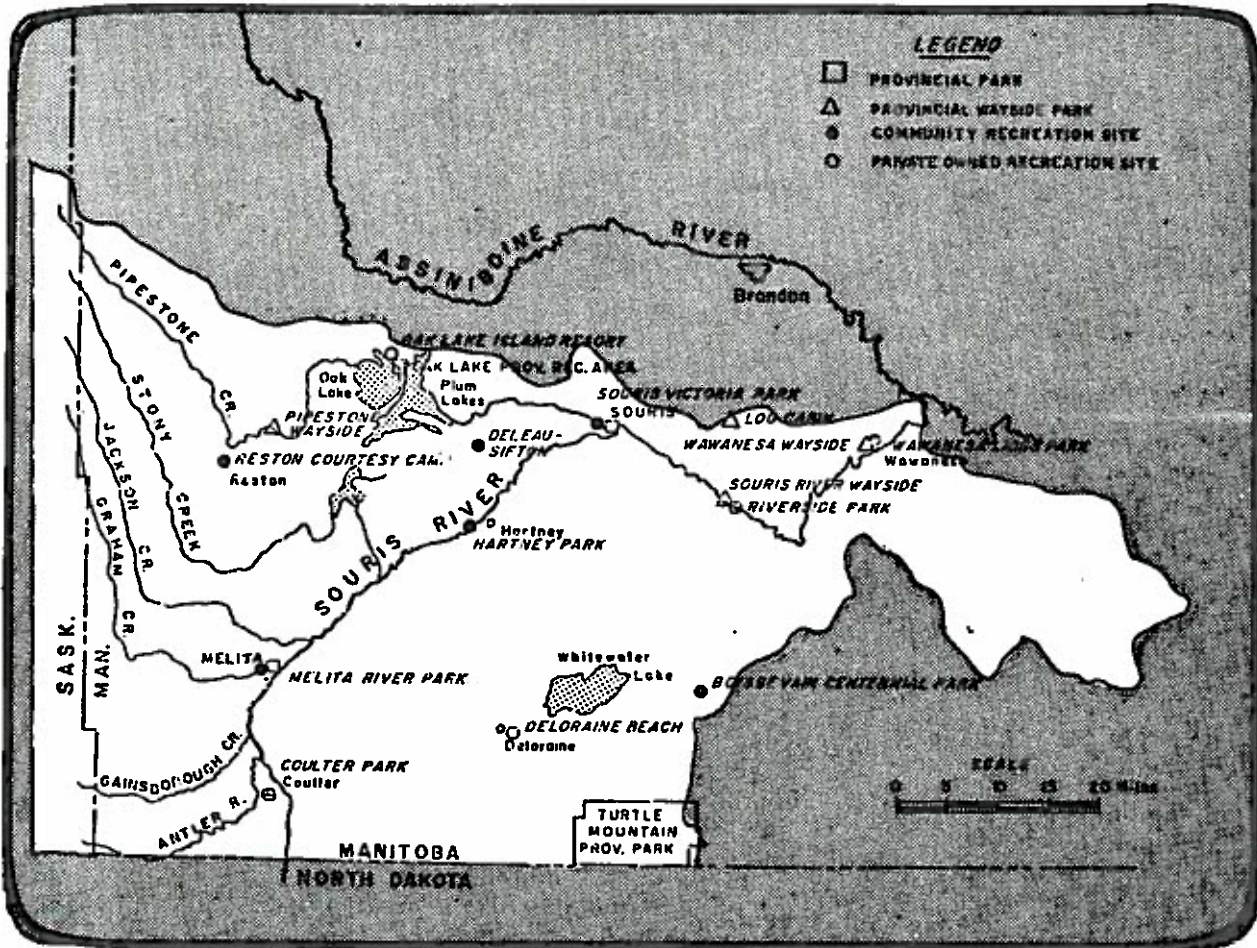


Figure 4. Existing Recreational Developments – Manitoba

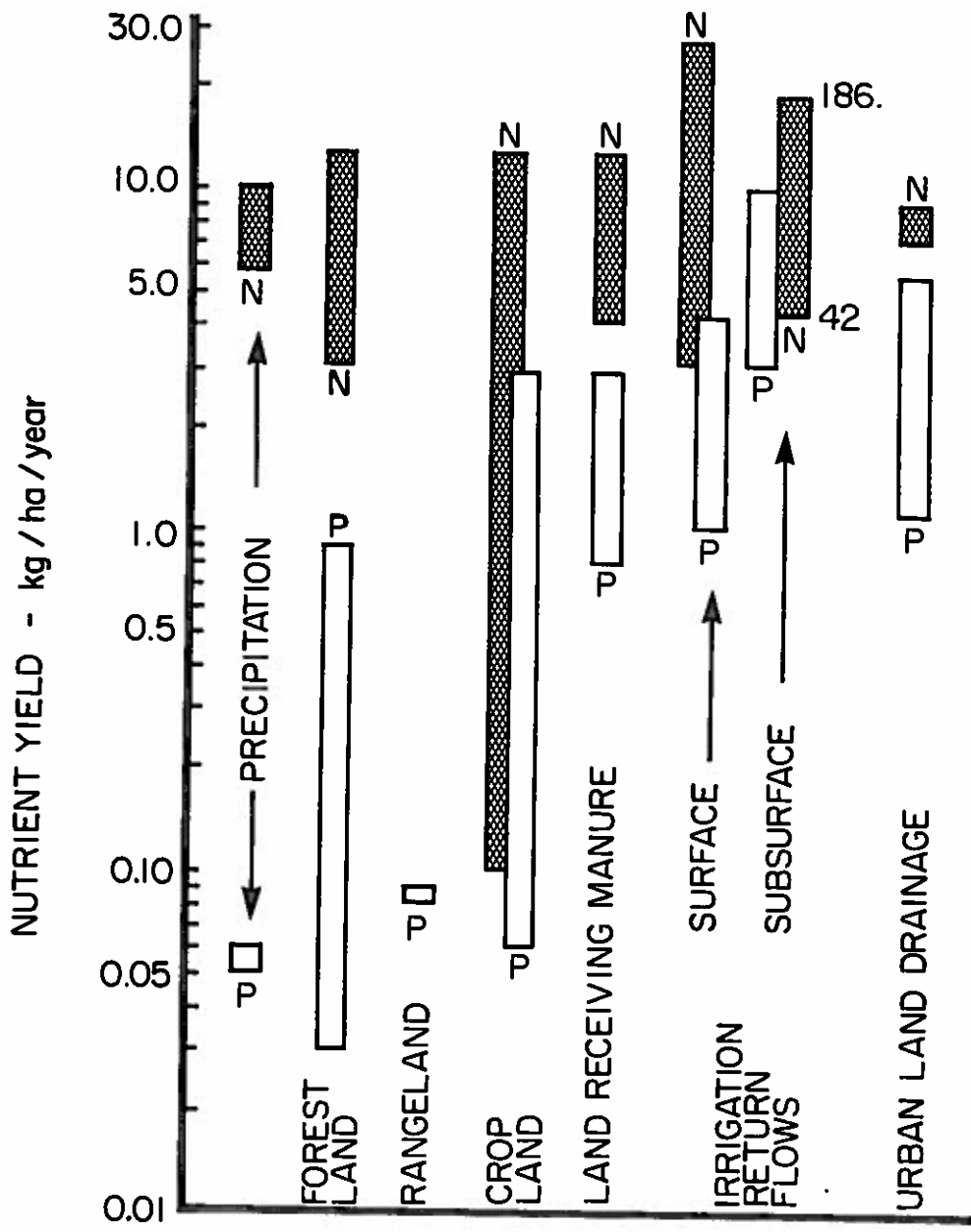


Fig. 5. RANGE OF POTENTIAL YIELD OF TOTAL NITROGEN AND TOTAL PHOSPHORUS FROM VARIOUS LAND USE ACTIVITIES (3)

TABLE 1

REGIONS	IDENTIFICATION	APPROXIMATE MANITOBA		PERCENT OF	
		AREA [Km ²	(sq. m.)]	BASIN	WATERSHED
Coulter	5NF-A	511	(198)	16.8	5.1
Jackson Creek	5NF-B	413	(160)	13.6	4.1
Graham Creek	5NF-C	381	(148)	12.5	3.8
Gainsborough Creek	5NF-D	363	(140)	11.9	3.6
Antler River	5NF-E	959	(371)	31.5	9.6
Turtle Mountain	5NF-F	416	(160)	13.7	4.2
TOTAL MELITA DIVISION	5NF	3043	(1177)	100.0	30.4
Minto	5NG-A	1705	(660)	24.5	17.0
Elgin Creek	5NG-B	1374	(532)	19.7	13.7
Medora	5NG-C	1450	(561)	20.9	14.5
Plum Creek	5NG-D	1469	(569)	21.1	14.7
Stoney Creek	5NG-E	959	(371)	13.8	9.6
TOTAL HARTNEY DIVISION	5NG	6957	(2693)	100.0	69.6
TOTALS FOR SOURIS RIVER	5N	10000	(3870)	-	100.0

Table 1: Regions of the Souris River Principal Watershed, Identification and Approximate Surface Area in Km² (sq. mi.).

TABLE 2

Water Development Projects in the Souris River Principal Watershed Division

WATER DEVELOPMENT PROJECT	YEAR CONSTRUCTED	WATER SOURCE	STORAGE CAPACITY 10 ⁵ m ³ (AC-FT)	PRINCIPAL PURPOSE
Oak Lake	1964	Pipestone Creek	Lake Level Control	Recreation
Deloraine Reservoir	1962	Turtlehead Creek	17.3 (1400)	Mun. Water Supply
Elgin Dam	1965	Elgin Creek	6.4 (520)	Stock Watering
Melita Dam No. 1	1937	Souris River	9.6 (780)	Stock Watering
Melita Dam No. 2	1937	Souris River	5.9 (480)	Stock Watering
Napinka Dam	1938	Souris River	12.3 (1000)	Stock Watering
Hartney Dam	1941	Souris River	2.7 (220)	Stock Watering
Souris Dam	1952	Souris River	5.1 (410)	Mun. Water Supply
Wawanesa Dam	1951	Souris River	3.9 (320)	Stock Watering

51

TABLE 3

Population for the Manitoba Souris Basin, Brandon and Manitoba

Location	1951	1971	1976	% Change 1951-1976
Manitoba Souris Basin	22,731	18,720	17,917	-21.2
Brandon	20,598	31,150	34,901	69.4
Manitoba	776,541	988,247	1,021,506	31.5

TABLE 4

Population Trends in Manitoba Souris Basin

<u>URBAN</u>	<u>1951</u>	<u>1961</u>	<u>1971</u>	<u>1976</u>
Melita	781	1,038	1,132	1,169
Souris	1,584	1,841	1,674	1,712
Settlements More Than 500	2,391	2,493	2,569	2,541
Urban Totals	4,756	5,372	5,375	5,422
<u>RURAL</u>				
Settlements Less Than 500	617	475	382	408
Farm	13,719	11,977	9,521	12,087**
Other*	3,639	3,788	3,442	
Rural Totals	17,975	16,240	13,345	12,495
Manitoba Souris Basin Totals	22,731	21,612	18,720	17,917

* Includes Indian Reservations 59 and 59A

** Farm Plus Other

TABLE 5

Existing and Projected Population Levels

<u>Location</u>	<u>Existing Level 1976</u>	<u>Immediate Future 1986</u>	<u>Distant Future 2000</u>	
Brandon	34,901	40,000	50,000	
Manitoba Souris Basin			with water shortage	without water shortage
Melita	1,169	1,400	1,700	2,100
Souris	1,712	1,800	1,900	2,300
4 Settlements # More Than 500	2,541	2,600	2,500	2,600
Rural	12,495	12,000	9,000	11,000
Manitoba Souris Basin Total	17,917	17,800	15,100	18,000

TABLE 6

Labour Force and Employment in Manitoba

<u>Location</u>	<u>TOTAL LABOUR FORCE</u>		<u>LEVEL OF EMPLOYMENT</u>		<u>UNEMPLOYED</u>		<u>LABOUR FORCE % CHANGE 1971 over 1961</u>
	<u>1961</u>	<u>1971</u>	<u>1961</u>	<u>1971</u>	<u>1961</u>	<u>1971</u>	
Manitoba	343,928	419,905	334,386	392,960	9,542	26,945	22.1
Manitoba Souris Basin	12,105	12,445	11,980	12,045	125	400	2.8
Economic Region	29,909	35,305	29,481	33,665	1,640	1,640	18.0

(Reference "Souris River Basin Study: Agriculture & Economic Studies. Supplements 6 & 7")

TABLE 7

LAND USE AND AGRICULTURAL PRODUCTION
IN THE SOURIS RIVER WATERSHED OF MANITOBA

From Statistics Canada - 1976 Census of Agriculture

Item	Souris River Watershed	All Of Manitoba	% Souris River Watershed of Manitoba
<u>Total Land Area (Acres)</u>	2,709,120	27,474,560 ^{1/}	9.86
<u>Total Farm Acres</u>	2,294,326	19,026,326	12.05
Crop Land ^{2/}	1,199,516	9,507,495	12.61
Pasture	87,160	769,191	11.33
Summerfallow	361,345	2,308,305	15.65
Vegetables ^{3/}	88	5,400	1.63
Other ^{4/}	34,148	300,533	11.36
TOTAL IMPROVED ACRES	1,682,257	12,890,824	13.05
Woodland	40,285	928,410	4.33
Other Unimproved	571,784	5,207,021	10.98
TOTAL UNIMPROVED ACRES	612,069	6,135,431	9.97
Under Roads, Towns, etc.	414,794	8,448,234	4.91
Number of Farms (All Agricultural Holdings with Sales of \$50+)	2,966	32,104	9.23
Number of Farms With Sales of \$1200 +	2,918	29,963	9.73
Value of Sales (Million \$)	\$87.6 ^{5/}	\$689.4 ^{5/}	12.70
Total Dairy Cows and Heifers	5,139	114,085	4.50
Total Other Cattle	170,955	1,285,792	13.29
Number of Hogs	34,391	625,934	5.94
Number of Hens and Chickens	134,328	5,857,913	2.29
Number of Year Round Labour	195	3,518	5.54
No. Man Weeks Hired Labour	15,828	285,107	5.55

^{1/} 1976 Census of Canada - Catalogue 92-831. This covers the Southern part of the Province only. It does not include Census Divisions 19, 21, 22, & 23.

^{2/} See Appendix A for items under Cropland.

^{3/} Includes fruit trees, cut flowers and other horticultural crops.

^{4/} Includes barnyards, home gardens, lanes and roads. Also includes cultivated land lying idle or new breaking not yet seeded to a crop.

^{5/} These are comparative figures basis classification of farms on economic performance.

APPENDIX "A" (to Table 7)
CROP LAND ACRES ^{1/} - 1976

Crop	Manitoba Souris River Basin	All of Manitoba	Souris River Basin as a % of Manitoba
	(acres)	(acres)	%
Wheat	531,734	3,815,904	13.9
Oats	157,524	1,224,685	12.9
Barley	168,249	1,647,364	10.2
Flaxseed	113,732	523,294	21.7
Rapeseed	28,709	231,006	12.4
Rye	20,571	92,743	22.1
Mixed Grains	9,543	172,847	5.5
Grain Corn	128	16,562	.8
Field Peas	346	37,831	.9
Buckwheat	962	43,697	2.2
Sunflowers	3,097	49,869	6.2
Mustard Seed	1,634	18,367	8.9
Field Beans	125	7,350	1.7
Tame Hay	148,571	1,425,705	10.4
Silage Corn	1,725	32,612	5.3
Other Fodder ^{2/}	11,050	76,383	14.5
Potatoes	5,954	34,576	17.2
Sugar Beets	—	33,026	—
Other Field Crops	654	16,217	4.0

^{1/} In 1976, there were 7,208 sq. ft. of land under greenhouses and in mushroom beds. This compares with 1,049,925 sq. ft. for the province. About 300 acres were irrigated. This compares with 7,643 acres for the province.

^{2/} Includes oats for hay.

TABLE 8

WASTE PRODUCTION INVENTORY

SOURIS RIVER BASIN

DISCHARGE	TYPE OF TREATMENT	HYDRAULIC LOAD		BACTERIOLOGICAL QUALITY TOTAL COLIFORM*	WASTE DISCHARGE kg/yr			COMMENTS
		MIG/YR	M ³ x1000/YR		BOD ₅	TOTAL PHOSPHORUS	TOTAL KJELDHAL NITROGEN	
Wawanesa	R.B.C.	7.0	31.8	**L ² 1500	380	350	270	Continuous Discharge
Boissevain	Aer. Lagoon	34.3	155.9	**L 1000	3890	1100	3270	Continuous Discharge
Elgin	C. Lagoon	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	
Deloraine	C. Lagoon	14.2	64.6	**L 500	990	260	1210	Fall & Spring Discharge
Hartney	C. Lagoon	8.1	36.8	Unknown	Unknown	Unknown	Unknown	
Maskada	C. Lagoon	3.6	16.4	**L 1500	400	50	170	Fall Discharge
Reston	C. Lagoon	9.6	43.6	Unknown	Unknown	Unknown	Unknown	
Souris	Septic Tank	54.4	247.3	150000+	316300	7650	23100	Replacement Facility Under Construction
Melita	C. Lagoon	44.0	200.0	**L 500	5990	920	3000	Fall Discharge
Pierson	C. Lagoon	4.9	22.3	**L 1500	530	70	150	Spring & Fall Discharge

* MPN/100 ml

** less than

M³ means cubic meter BOD₅ means 5-day biochemical oxygen demand

TABLE 9

Proposed Classification of Surface Waters in the Souris River Basin By Region				
REGION	IDENTIFICATION	WATERS	PROPOSED CLASSIFICATION	SPECIFIC OBJECTIVE (See Column on Table 10)
Coulter	5NF-A	Souris River	1C, 2B, 3B, 4B, 4C, 5, 6	XIII
Jackson Creek	5NF-B	Jackson Creek*	1C, 2B, 3B, 4B, 4C, 5, 6	XIII
Graham Creek	5NF-C	Graham Creek*	1C, 2B, 3B, 4B, 4C, 5, 6	XIII
Gainsborough Creek	5NF-D	Gainsborough Creek*	1C, 2B, 3B, 4B, 4C, 5, 6	XIII
Antler River	5NF-E	Antler River*	1C, 2B, 3B, 4B, 4C, 5, 6	XIII
Turtle Mountain	5NF-F	{Max Lake {Sharpe Lake	2B	XII
Minto	5NG-A	{Oak Creek* {Black Creek*	1C, 2B, 3B, 4B, 4C, 5, 6	XIII
Elgin Creek	5NG-B	{Elgin Creek* {Whitewater Lake	2C	XI
Medora	5NG-C	Souris River	1C, 2B, 3B, 4B, 4C, 5, 6	XIII
Plum Creek	5NG-D	{Pipestone Cr* {Oak Lake {Plum Lake {Plum Creek*	1C, 2B, 3B, 4B, 4C, 5, 6	XIII
Stony Creek	5NG-E	{Stony Creek* {Marshy Lake	2C	XI

* All the creeks may dry up and are therefore considered "Intermittent". An intermittent (or seasonal) stream is one that flows only at certain times of the year when it receives water from springs or from some surface source such as melting snow. Technically, an intermittent watercourse means a watercourse for which a minimum daily discharge of zero is present in any one year over a 50 year period.

At the present stage of development, few farmers depend directly upon intermittent streams for livestock watering; however, some dugouts adjacent to intermittent streams are used for this purpose. The dugouts would be filled from the streams during the spring and summer freshets. As mentioned previously the lack of dependable water supplies is a serious deterrent to the development of the livestock industry.

Many waters categorized as "Intermittent" are of significant value to fisheries since they provide pike spawning and nursery habitat. They should be of suitable classification (i.e. 2B) to permit the propagation of northern pike and, to a lesser extent, walleye during their spring spawning and for at least two months afterward while their progeny are allowed an adequate development period before beginning their downstream migration. In some cases, fish will persist in pools along the watercourse.

In terms of waste water releases, the water quality objectives must be met for all flow conditions exceeding the 7-day 10-year low flow period. Generally this flow is zero in an intermittent stream. There may be circumstances when waste discharge would be prevented below the flows identified as the 7-day 10-year low flow (e.g. to protect a municipal water supply or a fishery). This situation would generally be handled during the permitting process.

TABLE 10

Manitoba Specific Water Quality Objectives

PARAMETER	UNITS	XI	XII	XIII
Aluminum (Al)	mg/l	---	---	1.0
Ammonia (N)	mg/l	0.02	0.02	0.02
Arsenic, Total (As)	mg/l	---	---	0.01
Barium (Ba)	mg/l	---	---	1.
Beryllium (Be)	mg/l	---	---	0.1
Boron (B)	mg/l	---	---	0.3
Cadmium (Cd)	mg/l	(K)	(K)	(K)
Chloride (Cl)	mg/l	200.	200.	100.
Chlorine (Cl ₂)	mg/l	0.01	0.01	0.01
Chromium (Cr ⁶⁺)	mg/l	0.1	0.1	0.05
Chromium, Total (Cr)	mg/l	---	---	0.05
Cobalt (Co)	mg/l	---	---	0.05
Colour, True	JTU	100.	30.	15.
Copper, Cu)	mg/l	0.02 (L)	0.02 (L)	0.02 (L)
Cyanide (CN)	mg/l	0.005	0.005	0.005
Detergents & Saponates	mg/l	---	---	40.
Dissolved Oxygen	% sat'n mg/l	35 or over (M)	47 or over (M)	47 or over (M)
Faecal Coliform Organisms	counts per 100 ml	400. (S)	200. (Q)	100. (C)
Fluoride (F)	mg/l	1.5	1.5	1.0
Hardness, Total (CaCO ₃)	mg/l	---	---	250.
Iron, Total (Fe)	mg/l	---	---	0.3
Lead (Pb)	mg/l	0.03	0.03	0.03
Lithium (Li)	mg/l	---	---	2.5
Manganese (Mn)	mg/l	---	---	0.05
Mercury (Hg)	mg/l	0.0002	0.0002	0.0002
Methylene Blue Active Substance (Foaming Agent) (MBAS)	mg/l	---	---	0.5
Molybdenum (Mo)	mg/l	---	---	0.01

TABLE 10 (Cont.)

Manitoba Specific Water Quality Objectives

PARAMETER	UNITS	XI	XII	XIII
Nickel (Ni)	mg/l	0.025	0.025	0.025
Nitrate-Nitrite (N)	mg/l	---	---	10.
Nitrite (N)	mg/l	---	---	10.
Pesticides		---	---	Table "1"
Pesticides		Table "2"	Table "2"	Table "2"
pH		5.0-9.3	6.5-9.0	6.5-9.0
Phenol (ic compounds)	mg/l	---	---	0.001
Polychlorinated Biphenyls (PCB)	mg/l	0.000002	0.000002	0.000002
Radioactive Material		(X)	(X)	(X)
Selenium (Se)	mg/l	(DD)	(DD)	0.01 or (DD)
Silver (Ag)	mg/l	(DD)	(DD)	0.05 or (DD)
Sodium (Na)		---	---	60% Total Cations
Specific Conductance	µmhos	---	---	2000.
Sulphate (SO ₄)	mg/l	---	---	250.
Sulphide (H ₂ S)	mg/l	0.002	0.002	0.002
Temperature	C°	2.0 (O)	1.0 (O)	1.0 (O)
Thallium (Tl)	mg/l	0.05	0.05	0.05
Threshold Odour Number		---	---	4.
Total Coliform Organisms	counts per 100 ml	1000. (U)	500. (R)	500. (R)
Total Dissolved Solids	mg/l	---	---	1000.
Toxic Algae		---	---	(BB)
Turbidity	JTU	25.	25.	25.
Unspecified Toxic Substances		---	---	(CC)
Uranium (U)	mg/l	0.01 or (DD)	0.01 or (DD)	0.01 or (DD)
Vanadium (V)	mg/l	---	---	0.1
Zinc (Zn)	mg/l	(DD)	(DD)	2.0 or (DD)

NOTES (to Table 10)

- (C) At least 90% of the samples in any consecutive 30-day period should have a faecal coliform density of less than 100 MPN per 100 millilitres.
- (K) 0.01 milligrams per litre for waters with hardness greater than 100 milligrams per litre. (CaCO₃)
0.004 milligrams per litre for waters with hardness lower than 100 milligrams per litre. (CaCO₃)
- (L) Or not greater than 1/10 the 96-hour LC50 value.
- (M) Percent saturation is at the ambient temperature.
- (O) No change greater than stated degrees Celsius beyond the natural minimum and maximum temperatures.
- (Q) The median (50 percentile) based on not less than 5 samples per month should be not greater than 200 MPN per 100 millilitres.
- (R) The median (50 percentile) based on not less than 5 samples per month should be not greater than 500 MPN per 100 millilitres.
- (S) The median (50 percentile) based on not less than 5 samples per month should be not greater than 400 MPN per 100 millilitres.
- (U) The median (50 percentile) based on not less than 5 samples per month should be not greater than 1000 MPN per 100 millilitres.
- (X) Not to exceed the lowest concentrations permitted to be discharged to an uncontrolled environment as prescribed by the appropriate authority having control over their use.
- (BB) Avoid use of water bearing heavy growth of blue-green algae.
- (CC) None at levels harmful either directly or indirectly.
- (DD) .01 of the 96-hour LC50 value.

TABLE 11

WATER QUALITY DATA 1961-1976 (SUMMARY)

STATION **00MA05NF0001** FOR PERIOD **21/09/61 TO 07/12/76**
 LAT. **49 ° 5 ' 30 "** LONG. **100 ° 56 ' 50 "**
 SOURIS RIVER AT COULTER, MANITOBA

	02041S SPECIFIC CONDUCT.	02041L SPECIFIC CONDUCT.	02011L COLOUR APPARENT	02073L TURBIDITY	10101L ALKALINITY TOTAL	10151L ALKALINITY PHENOL PHTHALEIN	10301S PH	10301L PH	00210L SATURATION INDEX (CALCD.)	00211L STABILITY INDEX (CALCD.)
	USIE CM	USIE CM	REL UNITS	JTU	CACO3 MG/L	CACO3 MG/L	PH UNITS	PH UNITS	PH UNITS	PH UNITS
SAMPLES	144	448	443	446	475	424	148	450	339	339
LOW	9	136	L5	0.5	36	0.0	6.8	5.7	-3.1	3.8
HIGH	2257	5292	150	185.	2022	52.6	9.3	9.5	2.4	11.9
AVERAGE	813	1005	54	15.	312	2.2				
STD.DEV	372	495	21	18.	167	7.0				
PERCNT:10TH	500	585	30	2.5	176	0.0	7.6	7.4	-0.1	5.6
25TH	605	724	40	4.7	231	0.	8.0	7.7	0.3	5.9
MEDIAN 50TH	750	892	50	9.3	279	0.0	8.3	8.0	0.8	6.5
75TH	865	1137	60	18.0	345	0.	8.6	8.3	1.2	7.1
90TH	1210	1573	80	37.	467	7.3	8.8	8.7	1.5	7.7

BACKUP CODES

01F

01F

	11201L SODIUM ABSORPTION RATIO	10603L HARDNESS TOTAL	10602L HARDNESS TOTAL (CALCD.)	10401L RESIDUE NONFILTR.	10501L RESIDUE FIXED NONFILTR.	10451L RESIDUE FILTERABLE	10551L RESIDUE FIXED FILTERABLE	36002F COLIFORMS TOTAL	36012F COLIFORMS FECAL
	REL UNITS	CACO3 MG/L	CACO3 MG/L	MG/L	MG/L	MG/L	MG/L	MF NO/100ML	MF NO/100ML
SAMPLES	446	243	204	202	229	89	78	98	87
LOW	0.29	67.4	38.1	L1	1	101	80	7	0
HIGH	9.42	881.	1507.0	300	216	1939	1539	2320	2300
AVERAGE	2.70	325.	282.7	35	25	683	537	150	80
STD.DEV	1.10	162.	137.1	45	35	362	298	301	282
PERCNT:10TH	1.50	186.	182.1	5	L1	349	231	L10	4
25TH	1.95	232.	226.0	9	4	479	361	L10	L10
MEDIAN 50TH	2.56	265.	257.1	19	13	606	477	29	L10
75TH	3.31	374.	301.0	41	28	790	629	210	20
90TH	4.13	589.	381.0	75	56	1161	939	452	140

BACKUP CODES

02L

01L

11L

	00203L TOTAL DISSOLVED SOLIDS (CALCD.)	11103L SODIUM DISSOLVED	11103L POTASSIUM DISSOLVED	20101L CALCIUM DISSOLVED	12102L MAGNESIUM DISSOLVED	06301L CARBONATE (CALCD.)	06201L BICARBONATE (CALCD.)	09105L FLUORIDE DISSOLVED	17203L CHLORIDE DISSOLVED	16303L SULPHATE DISSOLVED
	MG/L	NA MG/L	K MG/L	CA MG/L	MG MG/L	CO3 MG/L	HCO3 MG/L	F MG/L	CL MG/L	SO4 MG/L
SAMPLES	445	449	449	449	255	424	424	258	450	449
LOW	64	6.4	3.2	10.0	2.4	0	44	L.05	1.8	4.8
HIGH	3897	843.	92.0	445.	269.	63	2465	0.98	225.	1095.
AVERAGE	638	113.	15.2	62.	38.	3	377	0.23	28.	197.
STD.DEV	345	72.	6.4	38.	22.	8	208	0.14	18.	122.
PERCNT:10TH	359	47.0	9.9	31.2	21.6	0	200	0.08	10.9	101.
25TH	452	70.	11.3	42.2	28.8	0	257	0.13	16.0	129.
MEDIAN 50TH	551	99.2	13.5	52.8	35.2	0	337	0.20	25.2	158.
75TH	724	134.	17.0	72.3	42.0	0	423	0.27	33.8	230.
90TH	1060	200.	22.3	104.	53.6	9	572	0.42	49.0	351.

BACKUP CODES

01L 02L

02L 01L

03L 02L

01L

02L 03L 04L

02L 01L 06L

06L 04L 01

TABLE 11

WATER QUALITY DATA 1961-1976 (SUMMARY)

STATION **00MA05NF0001** FOR PERIOD **21/09/61** TO **07/12/76**
 LAT. **49° 5' 30"** LONG. **100° 56' 50"**
 SOURIS RIVER AT COULTER, MANITOBA

	06001L CARBON TOTAL ORGANIC C MG/L	06051L CARBON TOTAL INORGANIC C MG/L	06101L CARBON DISSOLVED ORGANIC C MG/L	06604P CYANIDE DISSOLVED CN MG/L	06532P PHENOLIC MATERIAL MG/L	06711L CHLORO- PHYLL A MG/L	08101F OXYGEN DISSOLVED O2 MG/L	08201F OXYGEN BIOCHEM. DEMAND-BOD O2 MG/L	08401L OXYGEN CONSUMED O2 MG/L	14102L SILICA REACTIVE SiO2 MG/L
SAMPLES	174	174		5	11	64	148	141	94	443
LOW	6.0	19.0		L.005	0.001	L.001	0.0	G.2	4.2	0.1
HIGH	58.0	194.		0.012	0.032	0.059	15.7	29.3	28.1	65.0
AVERAGE	21.5	59.		0.009	0.007	0.011	8.0	5.7	16.6	10.8
STD.DEV	7.0	32.		0.003	0.009	0.010	3.3	4.3	5.2	8.1
PERCNT:10TH	14.	28.			L.002	L.005	3.9	1.8	10.4	2.4
25TH	16.	42.		0.008	L.002	L.005	6.7	2.7	12.7	5.1
MEDIAN 50TH	20.	51.		0.009	0.005	0.007	8.0	4.9	16.4	9.3
75TH	25.	62.		0.012	0.006	0.013	10.3	6.6	20.7	14.2
90TH	30.	96.			0.011	0.022	12.6	10.7	23.0	22.6
BACKUP CODES					35P 31P		01S	02L 01L		01L

	07001L NITROGEN TOTAL KJELDAHL N MG/L	07106L NITROGEN DISSOLVED NO3 & NO2 N MG/L	07506F NITROGEN TOTAL AMMONIA N MG/L	07551L NITROGEN DISSOLVED AMMONIA N MG/L	15413L PHOSPHORUS TOTAL P MG/L	15103L PHOSPHORUS DISSOLVED P MG/L	15207F PHOSPHORUS TOTAL ORTHO PO4 P MG/L	15255L PHOSPHORUS DISSOLVED ORTHO PO4 P MG/L	15363L PHOSPHORUS DISSOLVED INORG. PO4 P MG/L
SAMPLES	158	298	138	88	198	85	143	28	90
LOW	0.7	L.001	L.02	L.1	L.005	0.02	0.	0.006	0.011
HIGH	6.4	8.36	3.2	5.0	3.20	0.45	1.80	0.510	1.01
AVERAGE	1.9	0.55	0.3	0.2	0.35	0.17	0.20	0.117	0.24
STD.DEV	1.0	0.90	0.5	0.7	0.36	0.12	0.24	0.102	0.17
PERCNT:10TH	1.0	L.01	0.03	L.1	0.10	0.026	0.02	0.022	0.059
25TH	1.2	0.03	L.1	L.1	0.196	0.05	0.05	0.054	0.120
MEDIAN 50TH	1.6	0.294	L.1	L.1	0.29	0.170	0.16	0.100	0.204
75TH	2.1	0.640	0.2	0.1	0.388	0.26	0.28	0.145	0.319
90TH	3.1	1.38	0.73	0.2	0.554	0.340	0.39	0.220	0.443
BACKUP CODES	03L	05L 08L	05L 01F		06L		05L 07L		64L 56L

	03301P LITHIUM EXTRBLE. LI MG/L	05105L BORON DISSOLVED B MG/L	13101L ALUMINUM DISSOLVED AL MG/L	13302P ALUMINUM EXTRBLE. AL MG/L	23301P VANADIUM EXTRBLE. V MG/L	24302P CHROMIUM EXTRBLE. CR MG/L	25101L MANGANESE DISSOLVED MN MG/L	25304P MANGANESE EXTRBLE. MN MG/L	26102L IRON DISSOLVED FE MG/L	26304P IRON EXTRBLE. FE MG/L
SAMPLES	20	45	65	28	29	38	110	49	113	44
LOW	0.013	L.01	L.01	L.10	0.001	L.010	L.010	0.005	L.001	L.05
HIGH	0.150	0.40	0.27	1.2	L.05	0.018	0.65	5.20	16.0	2.4
AVERAGE	0.059	0.17	0.10	0.2	0.04	0.012	0.02	0.39	0.2	0.4
STD.DEV	0.039	0.09	0.06	0.2	0.02	0.003	0.07	0.83	1.5	0.4
PERCNT:10TH	0.028	0.08	0.02	L.10	0.003	L.010	L.010	L.01	L.01	0.19
25TH	0.034	0.11	0.06	L.10	0.005	L.010	L.010	0.05	0.010	0.26
MEDIAN 50TH	0.048	0.16	0.08	0.14	L.05	L.010	L.010	0.092	0.010	0.33
75TH	0.064	0.19	0.14	0.29	L.05	L.015	L.010	0.41	0.030	0.52
90TH	0.13	0.31	0.19	0.52	L.05	L.015	0.02	1.0	0.060	0.77
BACKUP CODES		03L 01L			02P		04P 04L	03L 04L 05P	04P 01L 04L	01L

TABLE 11

WATER QUALITY DATA 1961-1976 (SUMMARY)

STATION **00MA05NF0001** FOR PERIOD **21/09/61 TO 12/10/76**

LAT. **49 ° 5 ' 30 "** LONG. **100 ° 56 ' 50 "**

SOURIS RIVER AT COULTER, MANITOBA

	27302P COBALT EXTRBLE.	29105L COPPER DISSOLVED	29305P COPPER EXTRBLE.	30105L ZINC DISSOLVED	30305P ZINC EXTRBLE.	33104L ARSENIC DISSOLVED	34102L SELENIUM DISSOLVED	38301P STRONTIUM EXTRBLE.
	CO MG/L	CU MG/L	CU MG/L	ZN MG/L	ZN MG/L	AS MG/L	SE MG/L	SR MG/L
SAMPLES	40	14	48	10	48	46	38	32
LOW	L.001	L.001	L.001	L.001	L.001	0.0017	0.0003	0.10
HIGH	0.007	0.021	0.072	0.012	0.34	0.028	L.001	0.77
AVERAGE	0.002	0.004	0.007	0.005	0.02	0.006	0.001	0.33
STD.DEV	0.001	0.005	0.013	0.004	0.05	0.005	0.000	0.21
PERCNT:10TH	L.001	L.001	L.001	0.001	L.001	0.0022	0.0003	0.13
25TH	L.001	L.001	0.001	0.002	0.002	0.003	L.0005	0.21
MEDIAN 50TH	L.002	0.002	0.003	0.005	0.006	L.005	0.0005	0.25
75TH	0.003	0.005	0.005	0.008	L.01	0.006	L.001	0.32
90TH	0.004	0.006	0.012	0.01	0.020	0.012	L.001	0.74
BACKUP CODES		05P	01L	04L	01L 04P	03L		
	42301P MOLYBDENUM EXTRBLE.	47301P SILVER EXTRBLE.	48302P CADMIUM EXTRBLE.	56301P BARIUM EXTRBLE.	80311P MERCURY EXTRBLE.	82103P LEAD DISSOLVED	82302P LEAD EXTRBLE.	28302P NICKEL EXTRBLE.
	MO MG/L	AG MG/L	CD MG/L	BA MG/L	HG UG/L	PB MG/L	PB MG/L	NI MG/L
SAMPLES	26	29	38	33	42	4	36	33
LOW	L.01	L.00	L.001	0.1	L.05	L.004	L.001	L.001
HIGH	L.10	0.02	0.017	0.8	0.23	0.004	0.048	0.012
AVERAGE		0.01	0.002	0.2	0.06	0.004	0.005	0.005
STD.DEV		0.00	0.003	0.2	0.03	0.000	0.010	0.003
PERCNT:10TH	L.05	L.01	L.001	0.1	L.05		L.001	L.001
25TH	L.05	L.01	L.001	L.1	L.05	L.004	L.001	0.002
MEDIAN 50TH	L.05	L.01	L.001	L.1	L.05	L.004	L.004	0.006
75TH	L.05	L.01	L.001	0.2	L.05	0.004	0.004	0.008
90TH	L.10	L.01	0.002	0.3	0.06		0.008	0.010
BACKUP CODES								

TABLE 11

WATER QUALITY DATA 1961-1976 (SUMMARY)

STATION **00MA05NF0001** FOR PERIOD **14/02/73 TO 12/10/76**
 LAT. **49 ° 5 ' 30 "** LONG. **100 ° 56 ' 50 "**
 SOURIS RIVER AT COULTER, MANITOBA

	18000L P,P-DDT	18010L P,P-DDD	18020L P,P-DDE	18030L P,P- METHOXY- CHLOR	18040L HEPTACHLOR	18045L HEPTACHLOR EPOXIDE	18050L ALPHA- ENDO- SULFAN	18055L BETA- ENDO- SULFAN	18070L GAMMA- BHC (LINDANE)	18075L ALPHA- BHC
	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
SAMPLES	38	38	38	38	38	38	38	37	41	8
LOW	L.004	L.002	L.001	L.002	L.001	L.002	L.001	L.003	L.001	0.002
HIGH	L.004	L.002	L.001	L.012	6.001	L.002	L.001	L.03	0.004	0.01
AVERAGE					0.159				0.002	0.01
STD.DEV					0.973				0.001	0.00
PERCNT:10TH	L.004	L.002	L.001	L.012	L.001	L.002	L.001	L.003	L.001	
25TH	L.004	L.002	L.001	L.012	L.001	L.002	L.001	L.003	L.001	0.005
MEDIAN 50TH	L.004	L.002	L.001	L.012	L.001	L.002	L.001	L.003	L.001	0.006
75TH	L.004	L.002	L.001	L.012	L.001	L.002	L.001	L.003	0.002	0.007
90TH	L.004	L.002	L.001	L.012	L.001	L.002	L.001	L.003	0.003	

BACKUP CODES

	18130L ALDRIN	18150L DIELDRIN	18160L AROCOR 1254 (PCB'S)	18161L AROCOR 1248 (PCB'S)	18162L AROCOR 1280 (PCB'S)	18520L MCPA	10711P NTA NITRILOTRI ACETIC AC. H3NTA MG/L	18075L ALPHA- BHC
	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
SAMPLES	38	38	41	41	32	42	2	8
LOW	L.001	L.002	L.024	L.02	L.055	L.2	L.01	0.002
HIGH	L.001	L.002	L.032	L.032	L.100	L.2	L.01	0.01
AVERAGE								0.01
STD.DEV								0.00
PERCNT:10TH	L.001	L.002	L.032	L.024	L.055	L.2		
25TH	L.001	L.002	L.032	L.024	L.055	L.2		0.005
MEDIAN 50TH	L.001	L.002	L.032	L.024	L.055	L.2	L.01	0.006
75TH	L.001	L.002	L.032	L.024	L.055	L.2		0.007
90TH	L.001	L.002	L.032	L.024	L.06	L.2		

BACKUP CODES

	18500L 2,4-D	18510L 2,4,5-T	18550L 2,4-DB	18555L 2,4-DP	18180L BARBAN	18370L TRI- FLURALIN	18250L MALATHION	18360L DIALATE
	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
SAMPLES	42	42	41	42	6	4	7	6
LOW	L.004	L.002	L.009	L.004	L.09	L.01	L.01	L.02
HIGH	0.322	0.071	L.009	L.004	L.09	L.01	L.01	L.02
AVERAGE	0.045	0.004						
STD.DEV	0.057	0.011						
PERCNT:10TH	L.004	L.002	L.009	L.004				
25TH	0.01	L.002	L.009	L.004	L.09	L.01	L.01	L.02
MEDIAN 50TH	0.025	L.002	L.009	L.004	L.09	L.01	L.01	L.02
75TH	0.061	L.002	L.009	L.004	L.09	L.01	L.01	L.02
90TH	0.1	L.002	L.009	L.004				

BACKUP CODES

TABLE 12

Summary of Water Quality for Period of Record, Souris River at Westhope - Coulter. 1/

<u>PARAMETER</u>	<u>STATISTIC</u>	<u>DEC-FEB</u>	<u>MAR-MAY</u>	<u>JUNE-AUG</u>	<u>SEPT-NOV</u>
Total Dissolved Solids (Calc) (mg/l)	Low	847	233	454	515
	Median	1126	395	551	625
	High	1609	570	765	1029
Suspended Solids (mg/l)	Low	4	5	8	9
	Median	29	19	20	31
	High	162	58	45	76
Total Hardness as CaCO ₃ (mg/l) ³	Low	374	131	217	233
	Median	546	206	256	296
	High	841	281	316	397
Sodium (mg/l)	Low	142	27	59	90
	Median	200	59	101	116
	High	280	96	154	205
Potassium (mg/l)	Low	18	9	10	12
	Median	22	11	13	16
	High	30	15	18	23
Sulphate (mg/l)	Low	226	58	129	118
	Median	358	117	157	167
	High	486	176	303	336
Chloride (mg/l)	Low	33	10	14	19
	Median	45	17	27	29
	High	72	33	37	54
Bicarbonate (mg/l)	Low	544	127	246	323
	Median	667	240	324	410
	High	1030	357	406	546
Nitrate as N (mg/l)	Low	0.01	< 0.001	0.02	0.03
	Median	0.11	0.14	0.27	0.48
	High	0.59	0.85	0.71	0.70
Total Phosphorous (mg/l)	Low	0.15	0.14	0.12	0.08
	Median	0.39	0.23	0.33	0.25
	High	2.47	0.67	0.87	0.52
Dissolved Oxygen (mg/l)	Low	0.1	0.8	2.5	4.3
	Median	1.8	9.5	6.8	9.9
	High	13.0	13.8	9.0	11.1
Total Coliform (Most Probable Number per 100 ml)	Low	-	< 10	-	-
	Median	23	15	350	547
	High	-	24	-	-

1/ Period of record 1960-74 except for nutrient data (1969-74). Low values are the 10th percentile, medians are the 50th percentile and high values are the 90th percentile. Blanks occur where data are too few to calculate statistically. < = less than.

RECREATIONAL WATER QUALITY REQUIREMENTS IN THE SOURIS RIVER BASIN

The area included in the Souris River Basin in Manitoba was extensively reviewed regarding present uses and potential for recreation during preparation of the 1978 Souris River Basin Study. Activities related to water use included sport fishing, swimming, boating, canoeing, sailing, and water skiing. Other water-related activities included camping, picnicing, sight-seeing and sport hunting, all of which are available to the individual within the Souris River area under study.

Water based recreation opportunities are at a premium in this area of Manitoba, and the studies on future recreation needs for this region show that demand will continue to increase. The Souris River Basin Study shows that in 1977 the existing water-related recreation opportunities were insufficient to supply fully the needs of the regional population, and by 1987, regional demand will outstrip regional ability to provide all types of water-related recreational opportunities. The fact that the need for recreation opportunities for tourism purposes was not considered by the study in arriving at the above deficits underscores the scarcity and hence the relative importance of water-based recreation activity areas in the Souris River Watershed. Limited availabilities of water surface areas and a natural water quality adversely affected by low flow conditions in summer and winter further reduce water-based recreation options in the area. The preservation of recreation water use options is therefore strongly indicated to be of high priority.

Turtle Mountain Provincial Park comprises most of the Turtle Mountain Watershed region within Manitoba. As Turtle Mountain is designated as a natural park, it is recommended that the water quality goal for this area be determined by the highest water quality occurring naturally. The water quality objective at this time is to maintain, to the extent possible given the natural conditions, all water bodies usable for recreation purposes in such a condition as to permit their utilization for body contact activities such as swimming, water skiing and sport fishing. The same objectives hold true for the Oak Lake/Plum Creek Region due to the heavy recreational use made of the Oak Lake area.

The remainder of the Souris River Basin is used infrequently for body contact recreation. Fishing, canoeing and boating do take place, however, and these uses are increasing in popularity. The water quality objectives for the Souris River should reflect these important recreational activities. The ultimate goal for this River should probably be for a quality consistent with body contact activities, for verbal presentations made in the public participation portion of the Souris Study revealed that swimming in the Souris River had been a much participated-in activity in the past.

This goal will assume greater significance should any of the water reservoirs proposed in the Souris River Basin Study having recreational potential be constructed. The demand for recreation on any of these projects could be expected to be high, especially for regionally scarce activities such

as water skiing, swimming, fishing and power-boating. The prospect of completion of any of these projects in the near future should, therefore, be reviewed carefully in the setting of short and mid-term water quality objectives.

Another major provincial natural park, Spruce Woods Provincial Park is located approximately 25 miles downstream of the confluence of the Souris and Assiniboine. This Park provides opportunities for beach and swimming activities and the combined qualities of these two rivers should reflect this requirement at this point.

This portion of the report was introduced at the public hearings held on November 5, 1979, and November 12, 1979, in Melita and Souris respectively, as an addition to Section 7.0, RECREATION.

LETTERS FROM THE CHAIRMAN,
THE CLEAN ENVIRONMENT COMMISSION,
DATED SEPTEMBER 14 AND OCTOBER 25, 1979

File: 1882.0

MANITBA
CLEAN ENVIRONMENT COMMISSION

Office of the Chairman
Box 4, 139 Tuxedo Avenue
Winnipeg, Manitoba
R3N 0H6

September 14, 1979

To: Municipalities, Organizations and Interested
Persons in the Souris River Watershed

In 1978, the Souris River Basin Study Board appointed by the governments of Canada, Manitoba and Saskatchewan issued its exhaustive twelve-volume report. This report recommended that surface water quality objectives be prepared for the Souris River watershed. A detailed proposal for Souris River Watershed Surface Water Quality Objectives has accordingly been prepared by the Environmental Management Division of the Department of Mines, Natural Resources and Environment. This proposal is in conformance with recommendations previously made by The Clean Environment Commission and accepted in principle by the Minister, the Honourable A. Brian Ransom.

The Minister has requested the Commission to conduct public hearings and submit a report and recommendations. To ensure this report takes account of the desires and expectations of watershed residents, the Commission is requesting representations and briefs from municipalities, organizations, enterprises and private citizens within the watershed and from provincial and national organizations and government bodies. These briefs and representations should be submitted by October 25, 1979, if possible. The dates and locations of the hearings will be announced in the near future.

Speakers will be available over the next several weeks from the Department of Mines, Natural Resources and Environment to explain the significance of the water quality objectives to municipal councils, organizations and groups. Also, copies of the Water Quality Classification Proposal will be available for distribution on request in the near future. Please contact this office to arrange for the services of speakers or to request copies of the proposal.

Yours truly,



Guy E. Moore,
Chairman.

File: 1882.0



Office of the Chairman
Box 4, 139 Tuxedo Avenue
Winnipeg, Manitoba
R3N 0H6

October 25, 1979

Re: Souris River Watershed Division
Proposed Classification of Surface Water

We are enclosing for your information the attached *Proposed Classification of Manitoba's Surface Water Souris River Principal Watershed Division* prepared at the request of the Honourable A. Brian Ransom, Minister of Mines, Natural Resources and Environment by the Environmental Management Division of that Department. The proposal deals with the quality of surface water necessary to support human and environmental requirements in future years and touches on matters in which every resident of the Souris River Watershed has a direct interest.

The Clean Environment Commission has been requested by the Minister to hold hearings to receive public reaction in connection with the attached proposal. These hearings will be held in the Legion Hall on Main Street in Melita, Monday, November 5, 1979, and in the Town Council Chambers in Souris, Monday, November 12, 1979, both at 10:00 a.m.

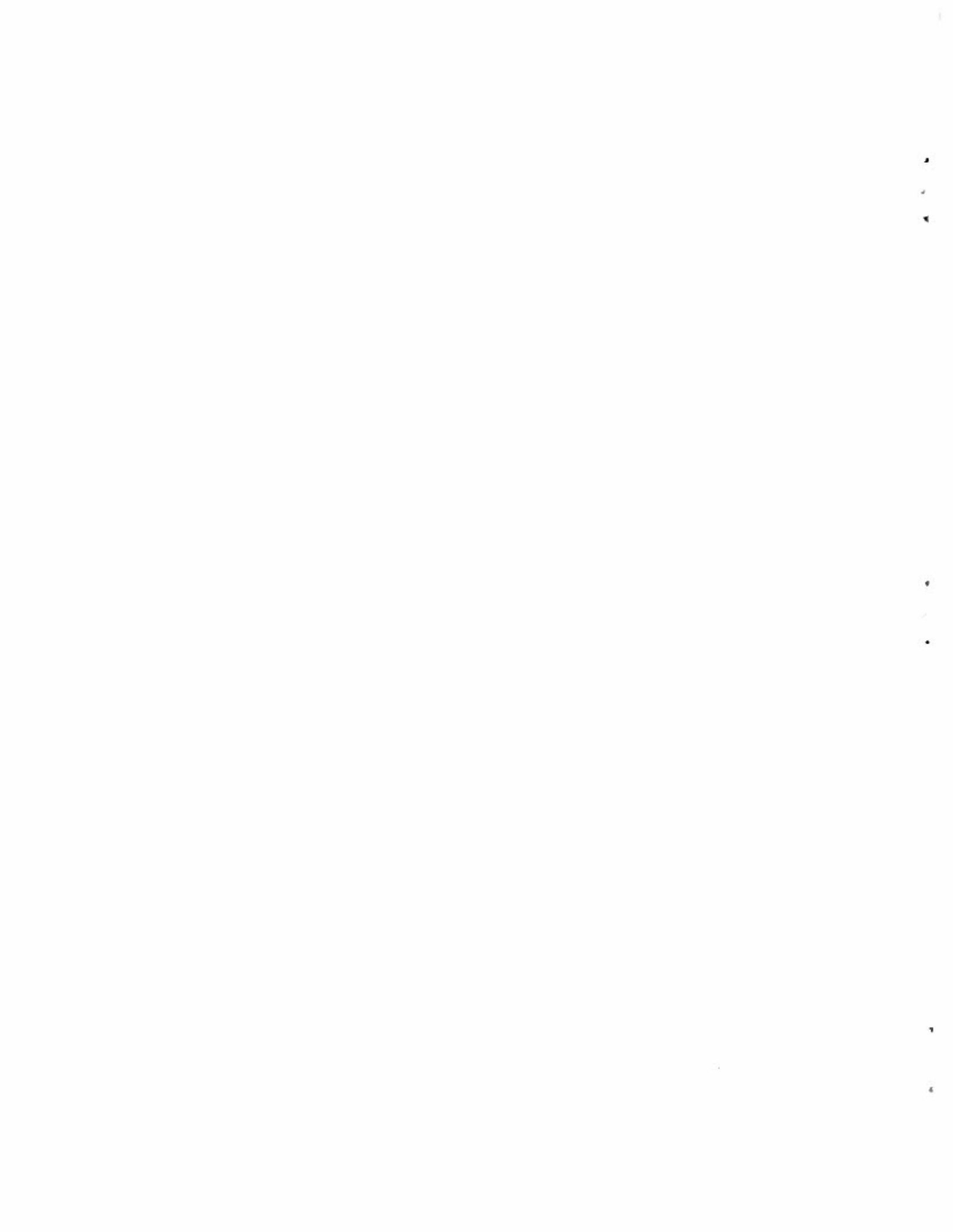
You are requested to review the contents of the attached proposal and forward any comments, objections or recommendations for the guidance of the Commission in completing its report and recommendations for submission to the Minister. It is also requested that you or a representative of your organization take part in one or both of the hearings. We look forward to seeing you at that time.

Yours truly,

A handwritten signature in dark ink, appearing to read "Guy E. Moore". The signature is written in a cursive style.

Guy E. Moore,
Chairman.

Enclosure



This particular advertisement appeared in the October 9, 1979, edition of the Winnipeg Free Press. Copies of the advertisement also appeared in the Winnipeg Tribune on the same date; in the Killarney Guide on October 2, 1979; in the Deloraine Times & Star, the Boissevain Recorder, the Melita New Era, the Souris Plaindealer, the Brandon, and the Glenboro Gazette on October 3, 1979; and in the Carberry News Express, the Reston Recorder, and the Belmont News on October 4, 1979.

MANIT^{BA}

THE CLEAN ENVIRONMENT COMMISSION NOTICE OF PUBLIC HEARING REGARDING THE APPLICATION OF SURFACE WATER QUALITY OBJECTIVES AND STREAM CLASSIFICATION TO THE SOURIS RIVER BASIN

Notice is hereby given that pursuant to the provisions of The Clean Environment Act, public hearings concerning the application of surface water quality objectives and stream classification to the Souris River basin will be held as follows:

Monday November 5, 1979, 10:00 a.m. Legion Hall, Main Street, MELITA, Manitoba.

Monday November 12, 1979, 10:00 a.m. Town Council Chambers, Civic Centre Building, 100-2nd Street, SOURIS, Manitoba.

Representations are invited from the public and from municipalities, organizations, associations, companies, government departments and institutions to identify the needs, concerns and desires of area residents in connection with current and potential surface water utilization for drinking, recreation, agriculture, fishing and industry of water courses in the Souris River basin. The purpose of receiving briefs and representations is to enable the Commission to prepare a report and recommendations for submission to the Minister of Mines, Natural Resources and Environment.

The preparation of water quality objectives for the watershed is in accordance with a recommendation of the Canada/Manitoba/Saskatchewan Souris River Basin Study Board. The objectives and classifications to be considered are those recommended in the Commission's *Report on a Proposal Concerning Surface Water Quality Objectives and Stream Classification for the Province of Manitoba*. Copies of this report are available from the Commission on request.

Any person wishing to make a representation before the Commission or proposing to submit a written representation to the Commission is requested to so advise the Commission at Box 4, 139 Tuxedo Avenue, Winnipeg R3N 0H6 in writing or by telephoning at 895-5333.

ADVERTISEMENT OF PUBLIC HEARINGS

LIST OF EXHIBITS

LIST OF EXHIBITS

- Exhibit 1 - *Report on a Proposal Concerning Surface Water Quality Objectives and Stream Classification for the Province of Manitoba*, The Clean Environment Commission, May 4, 1978, revised May 1979.
- Exhibit 2 - Letter from the Honourable A. Brian Ransom to Mr. Guy E. Moore, December 19, 1978.
- Exhibit 3 - Advertisement of public hearings published by The Clean Environment Commission.
- Exhibit 4 - Letter from Mr. Guy E. Moore, Chairman, The Clean Environment Commission, September 14, 1979.
- Exhibit 4A - Letter from Mr. Guy E. Moore, October 25, 1979.
- Exhibit 5 - *Proposed Classification of Manitoba's Surface Water Souris River Principal Watershed Division*, Environmental Management Division, September 1979.
- Exhibit 5A - Insert for Exhibit 5, *Recreational Water Quality Requirements in the Souris River Basin*, Parks Division, October 1979.
- Exhibit 6 - Letter from J. P. Bruce, Assistant Deputy Minister, Environment Canada to Guy E. Moore, October 31, 1979.
- Exhibit 7 - Brief of the Manitoba Department of Agriculture to The Clean Environment Commission Regarding Proposed Classification of Manitoba's Surface Water, Souris River Principal Watershed Division.
- Exhibit 8 - Brief on the Proposed Classification of Manitoba's Surface Water Souris River Principal Watershed on behalf of the Town of Melita.
- Exhibit 9 - Brief of the Council of the Rural Municipality of Arthur.
- Exhibit 10 - Brief of the Souris River Water Commission regarding the Surface Water Quality, Souris River Basin.
- Exhibit 11 - Brief of the Melita and District Chamber of Commerce.
- Exhibit 12 - Letter from Manitoba Forestry Association Incorporated to Mr. Guy E. Moore, September 20, 1979.

WATER QUALITY OBJECTIVES FOR MANITOBA AS APPLIED
TO SURFACE WATER CLASSIFICATION IN THE
SOURIS RIVER PRINCIPAL WATER SHED DIVISION

WATER QUALITY OBJECTIVES FOR MANITOBA AS APPLIED TO SURFACE WATER
 CLASSIFICATION IN THE SOURIS RIVER PRINCIPAL WATERSHED DIVISION

The following data provide detailed descriptions of the water quality objectives associated with the stream classifications recommended for adoption in Table 9 of Appendix "B" to this report. The source of these descriptions is Part II, Appendix "D", Clean Environment Commission Report on a Proposal Concerning Surface Water Quality Objectives and Stream Classification for the Province of Manitoba, May 1978 (revised May 1979).

Class 1C - Domestic Consumption

The quality of this class of the waters shall be such that with treatment consisting of coagulation, sedimentation, filtration, softening, storage and chlorination, or other equivalent treatment processes, the treated water will meet in all respects the acceptable limits of the Canadian Drinking Water Standards and Objectives 1968 for drinking water, and any revisions, amendments or supplements thereto. This objective will ordinarily be restricted to waters not considered to afford adequate protection against contamination from surface or other sources of pollution.

<u>Substance or Characteristic</u>	<u>Acceptable Limit or Range</u>
Arsenic (As)	0.01 mg/l
Barium (Ba)	1 mg/l
Boron (B)	5.0 mg/l
Cadmium (Cd)	0.01 mg/l
Chloride (Cl)	250 mg/l
Chromium (Cr ⁶⁺)	0.05 mg/l
Color	15
Copper (Cu)	1 mg/l
Cyanide (CN)	0.01 mg/l
Faecal Coliform Organisms	At least 90% of the samples in any consecutive 30 day period should have a faecal coliform density of less than 100 MPN per 100 ml.
Fluoride (F)	1.2 mg/l
Iron (Fe)	0.3 mg/l
Lead (Pb)	0.05 mg/l
Manganese (Mn)	0.05 mg/l
Mercury (Hg)	0.002 mg/l
Methylene Blue Active Substance (MBAS)	0.5 mg/l

<u>Substance or Characteristic</u>	<u>Acceptable Limit or Range</u>
Nitrate and Nitrite (N)	10 mg/l
pH	5.0 - 9.0
Phenol	0.001 mg/l
Radioactive Material	Not to exceed the lowest concentrations permitted to be discharged to an uncontrolled environment as prescribed by the appropriate authority having control over their use.
Selenium (Se)	0.01 mg/l
Silver (Ag)	0.05 mg/l
Sulphate (SO ₄)	250 mg/l
Threshold Odour Number	4
Total Coliform Organisms	At least 90% of the samples in any consecutive 30 day period should have a total coliform density of less than 1000 MPN per 100 ml.
Total Dissolved Solids	1000 mg/l
Turbidity	25
Zinc (Zn)	5 mg/l

Class 2B - Fisheries and Recreation

The quality of this class of the waters shall be such as to permit the propagation and maintenance of cool or warm water sport or commercial fishes and be suitable for aquatic recreation of all kinds, including bathing, for which the waters may be usable.

<u>Substance or Characteristic</u>	<u>Acceptable Limit or Range</u>
Ammonia (N) unionized	0.02 mg/l
Cadmium (Cd)	0.01 mg/l for waters with hardness greater than 100 mg/l (CaCO ₃) 0.004 mg/l for waters with hardness lower than 100 mg/l (CaCO ₃)
Chloride (Cl)	200 mg/l
Chlorine (Cl ₂)	0.01 mg/l
Chromium (Cr ⁶⁺)	0.1 mg/l
Colour	30
Copper (Cu)	0.02 mg/l or not greater than 1/10 the 96-hour LC50 value
Cyanide (CN)	0.005 mg/l

<u>Substance or Characteristic</u>	<u>Acceptable Limit or Range</u>
Dissolved Oxygen	47% or more saturation at the ambient temperature
Faecal Coliform Organisms	The median (50 Percentile) based on not less than 5 samples per month should be not greater than 200 MPN per 100 ml.
Fluoride (F)	1.5 mg/l
Lead (Pb)	0.03 mg/l
Mercury (Hg)	0.0002 mg/l
Nickel (Ni)	0.025 mg/l
pH	6.5 - 9.0
Polychlorinated Biphenyls (PCB)	0.000002 mg/l
Radioactive Material	Not to exceed the lowest concentrations permitted to be discharged to an uncontrolled environment as prescribed by the appropriate authority having control over their use.
Selenium (Se)	0.01 of the 96-hour LC50 value
Silver (Ag)	0.01 of the 96-hour LC50 value
Sulphide (H ₂ S)	0.002 mg/l
Temperature	No change greater than 1.0° Celsius beyond natural minimum and maximum temperatures.
Thallium (Tl)	0.05 mg/l
Total Coliform Organisms	The median (50 percentile) based on not less than 5 samples per month should be not greater than 500 MPN per 100 ml.
Turbidity	25
Uranium (U)	0.01 mg/l or .01 of the 96-hour LC50 value
Zinc (Zn)	.01 of the 96-hour LC50 value

Class 3B - Industrial Consumption

The quality of this class of the waters shall be such as to permit their use for general industrial purposes, except for food processing, with only a moderate degree of treatment.

<u>Substance or Characteristic</u>	<u>Acceptable Limit or Range</u>
Arsenic (As)	0.05 mg/l
Barium (Ba)	1 mg/l
Cadmium (Cd)	0.01 mg/l
Chromium (Cr ⁶⁺)	0.05 mg/l
Chloride (Cl)	100 mg/l
Cyanide (CN)	0.2 mg/l
Faecal Coliform Organisms	The median (50 percentile) based on not less than 5 samples per month should be not greater than 200 MPN per 100 ml.
Fluoride (F)	1.5 mg/l
Hardness (CaCO ₃)	250 mg/l
Lead (Pb)	0.05 mg/l
pH	6.0 - 9.0
Radioactive Material	Not to exceed the lowest concentrations permitted to be discharged to an uncontrolled environment as prescribed by the appropriate authority having control over their use.
Selenium (Se)	0.01 mg/l
Silver (Ag)	0.05 mg/l
Total Coliform Organisms	At least 90% of the samples in any consecutive 30 day period should have a total coliform density of less than 5000 MPN per 100 ml.

Class 4B - Agriculture and Wildlife

The quality of this class of the waters shall be such as to permit their use for irrigation without significant damage or adverse effects upon crops, vegetation or soil, and represents irrigation water of acceptable quality.

<u>Substance or Characteristic</u>	<u>Acceptable Limit or Range</u>
Aluminum (Al)	1.0 mg/l
Arsenic (As)	0.1 mg/l
Beryllium (Be)	0.1 mg/l
Boron (B)	0.3 mg/l
Cadmium (Cd)	0.01 mg/l
Chloride (Cl)	350 mg/l

<u>Substance or Characteristic</u>	<u>Acceptable Limit or Range</u>
Chlorine (Cl ₂)	0.05 mg/l
Chromium, Total (Cr)	0.05 mg/l
Cobalt (Co)	0.05 mg/l
Copper (Cu)	0.20 mg/l
Detergents and Saponates	40 mg/l
Faecal Coliform Organisms	The median (50 percentile) based on not less than 5 samples per month should be not greater than 1000 MPN per 100 ml.
Fluoride (F)	1.0 mg/l
Iron (Fe)	5.0 mg/l
Lead (Pb)	5.0 mg/l
Lithium (Li)	2.5 mg/l
Manganese (Mn)	0.2 mg/l
Mercury (Hg)	0.005 mg/l
Molybdenum (Mo)	0.01 mg/l
Nickel (Ni)	0.20 mg/l
Nitrate and Nitrite (N)	30 mg/l
pH	5.0 - 9.0
Radioactive Materials	Not to exceed the lowest concentrations permitted to be discharged to an uncontrolled environment as prescribed by the appropriate authority having control over their use.
Selenium (Se)	0.02 mg/l
Sodium (Na)	60% of total cations as milli-equivalents per litre.
Specific Conductance	2000 µmho/cm
Sulphate (SO ₄)	400 mg/l
Sulphide (H ₂ S)	5 mg/l
Total Dissolved Solids (Filterable Residue)	1500 mg/l
Vanadium (V)	0.10 mg/l
Zinc (Zn)	2.0 mg/l

Class 4C - Agriculture and Wildlife

The quality of this class of the waters shall be such as to permit their use by livestock and wildlife without inhibitory or injurious effects. The limits or concentrations of substances or characteristics given below shall not be exceeded in the waters.

<u>Substance or Characteristic</u>	<u>Acceptable Limit or Range</u>
Aluminum (Al)	5.0 mg/l
Arsenic (As)	0.05 mg/l
Boron (B)	5.0 mg/l
Cadmium (Cd)	0.05 mg/l
Chromium, Total (Cr)	1.0 mg/l
Cobalt (Co)	1.0 mg/l
Copper (Cu)	0.5 mg/l
Faecal Coliform Organisms	The median (50 percentile) based on not less than 5 samples per month should be not greater than 200 MPN per 100 ml.
Fluoride (F)	2.0 mg/l
Lead (Pb)	0.1 mg/l
Mercury (Hg)	0.01 mg/l
Nitrate and Nitrite (N)	100 mg/l
Nitrite (N)	10 mg/l
Pesticides	Not to exceed the limits listed in Table "2"
pH	5.5 - 9.0
Radioactive Materials	Not to exceed the lowest concentrations permitted to be discharged to an uncontrolled environment as prescribed by the appropriate authority having control over their use.
Selenium (Se)	0.05 mg/l
Sulphate (SO ₄)	500 mg/l
Total Dissolved Solids (Total Salinity)	3000 mg/l
Toxic Algae	Avoid use of water bearing heavy growth of blue-green algae.
Unspecified Toxic Substances	None at levels harmful either directly or indirectly
Vanadium (V)	0.1 mg/l
Zinc (Zn)	25 mg/l

