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WATERTON LAKES NATIONAL PARK:

TOWARDS THE PROTECTION OF ITS WATERS

Inland Waters Directorate
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Canada

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Purpose

The purpose of this paper is to provide the rationale for the development of water quality objectives for the major lakes of Waterton Lakes National Park. A recommended water quality monitoring program is also presented.

Background

Waterton Lakes National Park is well endowed with surface waters. The majority of the water surface area of the park consists of the Upper, Middle and Lower Waterton Lakes, connected by the Bosporus and the Dardanelles, as well as the Maskinonge Lake and marsh and the Waterton River. The lakes are of high ecological, scenic and recreational importance.

The water resources of the park remain largely in an unspoiled condition. A water quality study carried out in the mid-1970's on the tributaries and main lakes of the park showed that the quality was excellent, reflecting the pristine mountain environment (Water Quality Branch, 1974; Block and Gummer, 1976). Nutrient and bacterial influences were noted around the townsite; these have since been eliminated due to an improved sewage treatment facility and relocation of the effluent discharge. In 1988, the quality of the lakes was found to remain high, with no apparent deterioration in quality since the 1970's (Munro, 1990).

It is in the interest of Waterton Lakes National Park to maintain the current high quality of its waters and to prevent any deterioration which may result from man's use of the park. The main lakes are dominant scenic and recreational (boating, water skiing, sailboarding, scuba diving, sailing) attractions as well as a source of water for downstream uses. Furthermore, Park policy states that natural resources:

> "will be protected and managed with minimal interference to the natural processes to ensure the perpetuation of naturally evolving land and water environments and their associated species". (Parks Canada 1980:41).

Waterton Lake National Park is a Biosphere Reserve under UNESCO's Man and the Biosphere program. In this capacity, the park is an international example of a balanced relationship between people and the natural environment. Sustainability of resource use within the park is, therefore, an international responsibility.

Water quality objectives serve as a tool for managing water quality such that the water is not degraded and is of suitable quality for all present and future uses. The water quality objectives should be part of the Park's long term water management plan to maintain the high water quality consistent with Park policy and the Biosphere Reserve designation.

The Approach

Water quality objectives are developed by different methods depending upon the need for the objectives, the parameters of concern, the amount of available data and a host of other factors. The approach is tailored to suit the needs of the water body concerned and the purpose(s) of the responsible agency (Blachford, 1988).

A framework for the development of water quality objectives (Appendix I) generally involves an identification of water quality issues in the subject area, selection of key water quality parameters, examination of available water quality data and water quality guidelines, followed by adoption of values which are deemed to be protective of sensitive water quality uses. This approach works well where background data are abundant, sufficient scientific information exists for the parameters of concern, and the purpose of the water quality objectives is to protect specific uses. For example, in the Poplar River basin (southern Saskatchewan), water quality objectives were developed for boron based upon short and long term flow-weighted three-year and five-year moving averages applicable only for the irrigation period to protect crops which could be adversely affected by boron.

An example more relevant to Waterton Lakes National Park is that of the water quality objectives developed for Prince Albert National Park. Currently, the latter park is the only one in the Western and Northern Region to have park-specific water quality objectives. The purpose of objectives development was to provide benchmark values for the maintenance of pristine conditions, and for protection of contact recreation (public health) and fish consumption (Canadian Parks Service, 1989; Blachford, 1988). Objectives, expressed as maximum values, were developed for phosphorus, chlorophyll, mercury in fish tissue and fecal coliforms for specific lake and lake areas.

The approach adopted for the development of water quality objectives in Waterton Lakes National Park is a departure from both of the above examples. The predominant concern, given the Park policy, is the maintenance of historic, unspoiled conditions. The quality of the water in 1988 was determined to be of as high quality as in previous years (Munro, 1990). Water quality objectives are developed, therefore, to characterize the documented levels of water quality parameters; deviations from these levels will be a warning that the status of water quality in the park is changing.

Water Quality Objectives

The water quality objectives for Waterton Lakes National Park are shown in Table 1. The objectives are expressed as ranges of values to be maintained as opposed to discrete values to be strived for. This approach is employed as it is the natural state, and thus the intrinsic variability of the water quality parameters, that must be preserved to achieve the goal of sustainable resource use.

The ranges in the table represent data from the seventies and the eighties. All data were included to obtain the best possible estimate of variability. The exceptions to this are 1) the bacteriological data: levels improved significantly from the seventies to the eighties (due to improved sewage treatment practices), therefore, the 1988 data were chosen as the desirable "natural" levels to be maintained; and 2) a total of one nitrite/nitrate value and two conductance values were excluded from the data set as they

TABLE 1. WATER QUALITY OBJECTIVES FOR THE WATERTON LAKES

PARAMETER	WATER QUALITY OBJECTIVE
Dissolved Oxygen	7 - 11.4 mg/L
Turbidity	0.1 - 4 NTU
Secchi Depth	2.5 - 8 m
Fecal coliform	<2 - 10/100 ml
Fecal streptococci	<2 - 16/100 ml
Total Phosphorus	<0.003 - 0.022 mg/L
Dissolved Phosphorus	<0.03 mg/L
Total Nitrogen	0.1 - 0.64 mg/L
Dissolved Nitrogen	0.055 - 0.153 mg/L
Nitrate/nitrite	0.023 - 0.54 mg/L
Chlorophyll a	<0.001 - 0.006 mg/L
Calcium	15.7 - 31.0 mg/L
Sodium	0.03 - 4.3 mg/L
Chloride	<0.1 - 1.0 mg/L
Sulphate	1.9 - 13.4 mg/L
Conductance	109 - 211 usie/cm
Aluminum	<0.1 diss. mg/L
Arsenic	<0.0001 - 0.005 diss. mg/L
Barium	<0.08 - 0.133 mg/L
Cadmium	<0.0001 - 0.0001 mg/L
Cobalt	<0.0005 mg/L
Copper	<0.0005 - 0.0014 mg/L
Iron	<0.007 - 0.06 diss. mg/L
Lead	<0.0007 mg/L
Manganese	0.002 - 0.009 diss. mg/L
Mercury	<0.01 - 0.02 mg/L
Nickel	<0.0005 mg/L
Selenium	<0.0001 - 0.0021 diss. mg/L
Vanadium	<0.0005 - 0.0008 mg/L
Zinc	0.0005 - 0.0176 mg/L

appeared to be outliers. There was little or no difference between data for any of the parameters collected from mid-lake sites at 5 metres and 20 or 25 metres, therefore both depths were included in the range estimates.

The ranges recommended as water quality objectives are all well below Canadian guidelines for aquatic life and recreation and aesthetics (Appendix II). The guidelines have been developed to protect the most sensitive response within each use category. Guidelines for the protection of aquatic life, for example, were developed to protect all forms of aquatic life and all aspects of aquatic life cycles for indefinite durations of exposure. The superior quality of the Waterton Lakes, relative to the guidelines, does not in any way imply that deterioration to guideline levels is acceptable. Rather, it highlights the unique quality of the lakes and the importance of preserving them.

Data which are collected in the Park, including the routine Highway #6 site, should be compared to the water quality objectives to assess whether they are within or beyond the natural variability. To an extent, this is a subjective task. Firstly, data for selected years in the seventies and eighties are assessed to characterize "natural variability". These data may or may not adequately define the true variability. However, they constitute the best information available at this time and will be used until more comprehensive information becomes available. Secondly, data which may fall outside the objectives are not necessarily a concern. For example, unusually high discharge to the lakes could result in high turbidity, and consequently higher than normal nutrient and metal levels. This would be a natural water quality influence which would not require a management response in spite of exceedence of the objectives.

Water Quality Monitoring Program

Data for physical parameters for the Waterton Lakes are similar from the thirties, early fifties, late sixties, seventies and late eighties (Munro, 1990). Similarly, data for nutrients and major ions were unchanged from the seventies to the eighties. It is clear that the quality of the lakes is stable. It is important, however, to continue to periodically monitor the lakes to verify their unspoiled state and/or to identify any emerging adverse conditions.

It is recommended that the lakes be monitored at ten-year intervals at the same sites and for the same parameters as those used in the 1988 survey (Munro, 1990; Appendix III). Monitoring at the same sites and for the same parameters will permit meaningful comparison with data collected in the seventies and eighties. Linnet Lake should be added to the list of sites to be samples during the next survey due to suspected leakages from the septic field.

It may be practical, over time, to eliminate some of the sites due to similarities in water quality within and between lakes. For example, the quality of Middle Waterton Lake can be adequately represented without the data from the sites south and southeast of the Catholic Youth Camp. Similarly, the quality of Upper Waterton Lake can be characterized without data from the site south of Waterton. It is not recommended to drop these sites before the next survey, however, as a third complete set of data for all sites would be beneficial background data before modifying the program.

It is not expected, given current development plans for the park, that specific water quality concerns will arise in the foreseeable future. It is upon this premise that the ten-year sampling interval is recommended. Any change in park management, visitor use, sewage treatment practices, global factors, etc., which may adversely affect the lakes or tributaries to the main lakes should precipitate a water sampling survey as soon as possible. Monthly sampling at the site Waterton River at Highway #6 may also reveal the need for a survey within the ten-year interval.

Periodic surveys should be carried out to investigate the effect of effluent release to the Waterton River. The release site is downstream of the routine Highway #6 site and upstream of the Park boundary. The discharge had little or no measureable effect on the river in 1985 (Elliot, 1985). Surveys approximately every five years will confirm that the effluent release practice does not degrade water leaving the Park or alert operators to the need to improve the practice.

A survey of contaminant levels in fish collected from remote lakes in Waterton Lake National Park in 1987 showed a different pattern of contaminant accumulation in fish tissue relative to fish from northern and eastern Canada (Lockhart _et_ _al_., 1990). The organochlorines identified in the fish are likely a result of aerial deposition from sources external to the park. There were only sufficient (three) fish from two lakes (Goat Lake, Lineham Lake) of comparable size, age and sexual maturity for the organochlorine analyses. It is recommended that the survey be repeated for a greater number of lakes and a larger sample size (minimum 10). Given the unusual results relative to other areas, the limited sample sizes and the external (i.e. not within control of Waterton Lakes National Park) source of the contaminants, the survey should be repeated in the early 90's and at five-year intervals thereafter.

Analyses were also carried out for a variety of metals in fish tissue (Lockhart et al., 1990) in four lakes (Goat, Lone, Lineham, Twin). Sample sizes varied from three to four fish per lake. It is recommended that the survey be repeated at the same lakes with a larger sample size and a greater variety of metals.

The monitoring recommendations for organic contaminants and metals in fish tissue are summarized in Appendix IV.

Conclusions

The high natural quality of the Waterton Lakes must be protected from any interferences to natural aquatic processes and to the future use and enjoyment of the resource. Water quality objectives with concurrent monitoring and studies will aid in managing the water quality to achieve these goals.

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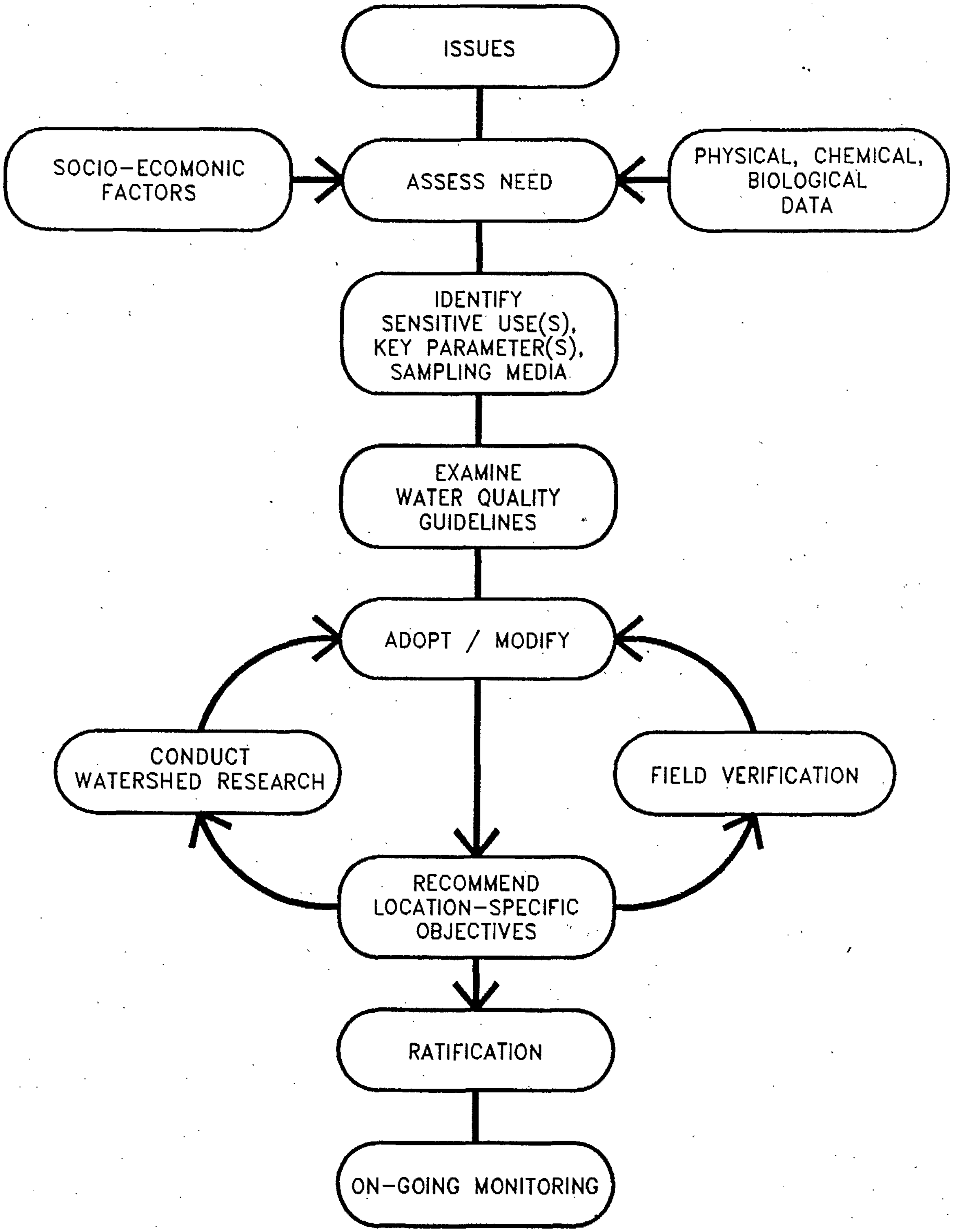
APPENDIX I

PROCEDURE FOR DEVELOPMENT OF LOCATION-SPECIFIC WATER QUALITY OBJECTIVES



Appendix II: Water Quality Values for the Waterton Lakes and Canadian Guidelines

PARAMETER	WATERTON LAKES		CANADIAN GUIDELINES		
	RANGE	MEAN	DRINKING WATER+	AQUATIC LIFE	RECREATION AND AESTHETICS
Dissolved Oxygen	7 - 11.4 mg/L	9.5 mg/L		5.0 - 9.5 mg/L	
Turbidity	0.1 - 4 NTU	1.0 NTU	1 NTU		Max increase of 5.0 NTU
Secchi Depth	2.5 - 8 m	5.1 m			Min. 1.2 m
Fecal coliform	<2 - 10/100 ml	3.0/100 ml	No detectable organisms		<200/100 ml
Fecal streptococci	<2 - 16/100 ml	5.0/100 ml			
Total Phosphorus	<0.003 - 0.055 mg/L	0.0036 mg/L			
Dissolved Phosphorus	<0.03 mg/L	<0.0015 mg/L			
Total Nitrogen	0.1 - 0.64 mg/L	0.28 mg/L			
Dissolved Nirtogen	0.055 - 0/153 mg/L	0.111 mg/L			
Nitrate/nitrite	0.023 - 0.54 mg/L	0.133 mg/L	10 mg/L		
Chlorophyll a	<0.001 - 0.006 mg/L	0.002 mg/L			
Calcium	15.7 - 31.0 mg/L	17.8 mg/L			
Sodium	0.3 - 4.3 mg/L	0.6 mg/L			
Chloride	<0.1 - 1.0 mg/L	0.31 mg/L	250 mg/L		
Sulphate	1.9 - 13.4 mg/L	3.66 mg/L	500 mg/L		
Conductance	109-211 usie/cm	127 usie/cm			
*Aluminum	<0.1 diss.	0.05		0.005 - 0.1 mg/L	
Arsenic	<0.0001 - 0.005 diss.	0.00045	0.05 mg/L	0.05 mg/L	
Barium	<0.08 - 0.133	0.089	1.0 mg/L		
Cadmium	<0.0001 - 0.0001	0.00005	5.0 µ/L	0.2 - 1.8 mg/L	
Coabalt	<0.0005	0.00025			
Copper	<0.0005 - 0.0014	0.0006	1.0 mg/L	2.0 - 4.0 µg/L	
Iron	<0.007 - 0.06 diss.	0.02	0.3 mg/L	0.3 mg/L	
Lead	<0.0007	0.00035	0.05 mg/L	1.0 - 7.0 µg/L	
Manganese	0.002 - 0.009 diss.	0.0035	0.05 mg/L		
Mercury	<0.01 - 0.02	0.006	1.0 µg/L	0.1 µg/L	
Nickel	<0.0005	0.00025		25 - 150 µg/L	
Selenium	<0.0001 - 0.0021 diss.	0.00024	0.01 mg/L	1.0 µg/L	
Vanadium	<0.0005 - 0.0008	0.00028			
Zinc	0.0005 - 0.0176	0.002	5.0 mg/L	0.03 mg/L	

* Metals are expressed as total, except where indicated; and as mg/L.
\+ Guidelines for Canadian Drinking Water Quality, Health and Welfare Canada

APPENDIX III RECOMMENDED MONITORING PROGRAM FOR THE WATERTON LAKES

Sites

- Waterton Lake at the International Boundary
- Waterton Lake South of Waterton
- Waterton Lake at Waterton
- Waterton Lake at Bosporus
- Middle Waterton Lake East-Northeast of Linnet Lake
- Middle Waterton Lake South of Catholic Youth Camp, South Shore
- Middle Waterton Lake South of Catholic Youth Camp, North Shore
- Middle Waterton Lake Southeast of Catholic Youth Camp
- Waterton Lake above the Dardanelles
- Lower Waterton Lake at mouth of Dardanelles
- Linnet Lake
- Blakiston Brook at Crandell Campground

Depth

Five metres

Frequency

Ten-year intervals

Parameters

Field Physicals:
- Conductance
- pH
- Turbidity
- Dissolved Oxygen
- Temperature
- Secchi Depth

Lab Physicals:
- Conductance
- pH
- Turbidity
- Temperature
- Colour
- Non-filterable residue

Bacteria:
- Total Coliform
- Fecal Coliform
- Fecal Streptococci

Major Ions:
- Total Alkalinity
- Phenol Alkalinity
- Calcium
- Magnesium
- Fluoride
- Potassium
- Sodium
- Chloride
- Silica
- Sulphate

Nutrients:
- Total Phosphorus
- Dissolved Phosphorus
- Dissolved Nitrogen
- Particulate Nitrogen
- Nitrite/Nitrate
- Particulate Organic Carbon
- Dissolved Organic Carbon

Metals/Trace Elements:
- Cadmium
- Cobalt
- Nickel
- Copper
- Lead
- Zinc
- Barium
- Vanadium
- Mercury
- Dissolved Aluminum
- Dissolved Arsenic
- Dissolved Selenium
- Dissolved Iron
- Dissolved Manganese

Chlorophyll a

* The routine monitoring site (Waterton River at Highway #6) is sampled monthly for various parameters. This is an on-going Water Quality Branch activity.

APPENDIX IV RECOMMENDED MONITORING PROGRAM FOR FISH TISSUE IN WATERTON LAKES NATIONAL PARK

Sites

Lone Lake	Upper Waterton Lake
Goat Lake	Middle Waterton Lake
Twin Lakes	Lower Waterton Lake
Lineham Lakes	

Frequency

Repeat survey in 1991, then at five-year intervals thereafter.

Parameters

Organochlorines:
- Sum of tetra-, penta-, and hexachlorobenzenes
- Sum of alpha, beta and gamma hexachlorocyclohexanes
- Sum of p, p′-DDT, p, p′-DDD, pp′-DDE, o, p-DDT
- Sum of chlordane-related peaks
- Sum of 85 congeners of PCBs
- Toxaphene
- Dieldrin

Metals:
- Copper
- Cadmium
- Selenium
- Mercury
- Zinc

* These parameters should be reanalyzed in the next survey for purposes of comparison with 1987 data. In addition, other organic contaminants could be added as appropriate, and aluminum, vanadium, chromium, nickel, barium and arsenic should be added for baseline metal information.

DUE DATE

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