



Water Quality

Water Quality Criteria for Nutrients and Algae

Overview Report

Prepared pursuant to Section 2(e) of the *Environment Management Act*, 1981

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Tables

Table 1. Summary of Water Quality Criteria for Nutrients and Algae

| Water Use | Phosphorous µg/L (total) | Chlorophyll a mg/m ² |
|---|-----------------------------|------------------------------------|
| Drinking Water - lakes | 10 µg/L (maximum) | None proposed |
| Aquatic Life - streams | None proposed | 100 mg/m ² (maximum) |
| Aquatic Life - lakes (salmonids are the predominant fish species) | 5 to 15 µg/L (inclusive) | None proposed |
| Recreation - streams | None proposed | 50 mg/m ² (maximum) |

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|----------------------|----------------------|---------------|
| Recreation -lakes | 10 µg/L (maximum) | None proposed |
|----------------------|----------------------|---------------|

1. Total phosphorous in lakes is either the spring overturn concentration, if the residence time of the epilimnetic water is greater than 6 months, or the mean epilimnetic growing season concentration, if the residence time of the epilimnetic water is less than 6 months.

2. Chlorophyll a criteria in streams apply to naturally growing periphytic algae.

Preface

THE MINISTRY OF ENVIRONMENT, LANDS AND PARKS (now called Ministry of Water, Land and Air Protection) develops province-wide ambient water quality guidelines for variables that are important in the surface waters of British Columbia. This work has the following goals:

1. to provide guidelines for the evaluation of data on water, sediment, and biota
2. to provide guidelines for the establishment of site-specific ambient water quality objectives

Ambient water quality objectives for specific waterbodies will be based on the guidelines and also consider present and future uses, waste discharges, hydrology/limnology/oceanography, and existing background water quality. The process for establishing water quality objectives is more fully outlined in *Principles for Preparing Water Quality Objectives in British Columbia*, copies of which are available from the Water Quality Section of the Environmental Quality Branch.

Neither guidelines nor objectives which are derived from them, have any legal standing. The objectives, however, can be used to calculate allowable limits or levels for contaminants in waste discharges. These limits are set out in waste management permits and thus have legal standing. The objectives are not usually incorporated as conditions of the permit.

The definition adopted for a guideline is:

A maximum and/or a minimum value for a physical, chemical or biological characteristic of water, sediment or biota, which should not be exceeded to prevent specified detrimental effects from occurring

to a water use, including aquatic life, under specified environmental conditions.

The guidelines are province-wide in application, are use-specific, and are developed for some or all of the following specific water uses:

- Raw drinking, public water supply and food processing
- Aquatic life and wildlife
- Agriculture (livestock watering and irrigation)
- Recreation and aesthetics
- Industrial (water supplies)

The guidelines are set after considering the scientific literature, guidelines from other jurisdictions, and general conditions in British Columbia. The scientific literature gives information on the effects of toxicants on various life forms. This information is not always conclusive because it is usually based on laboratory work which, at best, only approximates actual field conditions. To compensate for this uncertainty, guidelines have built-in safety factors which are conservative but reflect natural background conditions in the province.

The site-specific water quality objectives are, in most cases, the same as guidelines. However, in some cases, such as when natural background levels exceed the guidelines, the objectives could be less stringent than the guidelines. In relatively rare instances, for example if the resource is unusually valuable or of special provincial significance, the safety factor could be increased by using objectives which are more stringent than the guidelines. Another approach in such special cases is to develop site-specific guidelines by carrying out toxicity experiments in the field. This approach is costly and time-consuming and therefore seldom used.

Guidelines are subject to review and revision as new information becomes available, or as other circumstances dictate.

The guidelines apply to the ambient raw water source before it is diverted or treated for domestic use.

The Ministry of Health regulates the quality of water for domestic use after it is treated and delivered by a water purveyor.

Guidelines relating to public health at bathing beaches are the same as those used by the Ministry of Health which regulates the recreation and aesthetic use.

Recommended Guidelines

These criteria are based on a detailed analysis given in a technical document. Criteria are specified separately for streams (including brooks, rivers and creeks) and lakes (including ponds and reservoirs). The criteria for streams are specified as biomass of periphytic algae. The criteria for lakes are specified as phosphorous concentration. In rare cases where a lake is shown to be nitrogen limited, nitrogen criteria can be derived. Refer to the technical document for details.

DRINKING WATER (Includes Food Processing Water)

1. Streams

No criteria recommended.

2. Lakes

For lakes used as a source of drinking water, the total phosphorous concentration should not exceed 10 µg/L.

The criterion will ensure that algae will not exceed acceptable limits in surface waters being used as a supply source. This will minimize treatment costs and reduce risk of taste and odour from algae. The criterion will also ensure that deeper waters, which are cooler and may be used preferentially as a source of water, are protected from low oxygen concentrations caused by excess algal growth. Low oxygen levels could result in undesirable concentrations of hydrogen sulphide, soluble iron and manganese compounds, and organic carbon. For details of phosphorous sampling see the section on application of criteria which follows.

RECREATION AND AESTHETICS

1. Streams

The criterion recommended is less than 50 mg/m² chlorophyll a.

The criterion is specified as this index of algal biomass rather than nutrients since there are several other conditions of water velocity, light, temperature and invertebrate grazing pressure which must be satisfied

before nutrients become the most important factor limiting stream algal growth. The level of biomass was determined on the basis of information from the literature and experiences reported from British Columbia.

2. Lakes

The criterion recommended is less than 10 µg/L total phosphorous.

The major consideration in the recreational use or aesthetic attractiveness in lakes is water clarity. Since the concentration of phosphorous can be directly related to water clarity, the criterion value was chosen to insure high water clarity in lakes.

AQUATIC LIFE

1. Streams

For protection of aquatic life in streams, a maximum biomass of 100 mg/m² chlorophyll a is suggested.

This criterion is designed primarily to protect fish habitat and changes in communities of organisms such as invertebrates which are important themselves or which may be important fish-food organisms.

2. Lakes

It is not possible to specify a single phosphorous concentration to achieve protection of aquatic life in lakes.

A range of total phosphorous concentrations (5-15 µg/L) is suggested as the criterion which can be used as the basis for site specific water quality objectives.

The criterion is limited in application to include only lakes where salmonid species are the fish of major importance.

Application of the Guidelines

Criteria are proposed to protect water resources in British Columbia from degradation caused by excessive amounts of algae which may impair human use of lakes and streams. Where problem concentrations of algae occur, over-supply of nutrients (generally phosphorous) is the cause. A general goal in dealing with the eutrophication problem is to quantify the amounts of algae which cause problems, and the concentrations of phosphorous which may be associated with algal problems, in order to set limits which would protect specific uses.

Because of fundamental differences between lakes and streams, the criteria are specified in terms of different parameters and different measurement units. For lakes, a clear relationship has been established between phosphorous and algal biomass whereas no such relationship exists in streams. Thus for lakes, phosphorous concentration provides the best indicator of actual or potential problems. For streams there are many factors which determine the amount of algae which will be present and phosphorous is much less important. Thus for streams, the algal biomass itself must be measured to determine actual or potential problems.

For lakes, phosphorous concentrations are measured at spring overturn (if the epilimnetic water residence time is greater than six months) or measured through the growing season (if the epilimnetic water residence time is less than six months). The timing of spring overturn in lakes can vary considerably in different parts of the province and even from year to year in an individual lake. Spring overturn can be considered to occur when the water column is isothermal prior to the presence of significant algal growth (less than 0.5 µg/L chlorophyll a). Samples should be taken from near the surface (one metre), near the bottom, and at one or two intermediate depths. Mean growing season phosphorous concentration should be calculated by sampling at three-week intervals over the summer growing period (generally May to September) from near the surface, at the middle of the epilimnion and near the bottom of the epilimnion. The mean concentration over the summer growing period is then compared to the criterion.

For lakes, a general correspondence between phosphorous concentration and mean growing season chlorophyll a, as well as water clarity or hypolimnetic oxygen deficit, exists. For example, a phosphorous concentration of 10 µg/L results in a chlorophyll a concentration of 2.0 to 2.5 µg/L. The potential thus exists for setting chlorophyll a criteria or water clarity criteria, however this is advantageous only in special cases. In general it is best to use phosphorous concentration as the criterion.

For streams, the criteria levels apply to naturally growing periphytic algae as opposed to algae growing on artificial substrates. Sub-samples are to be taken randomly from the stream section and the mean biomass of the sample is to be compared to the criterion. The criterion should not be exceeded by the mean sample value obtained at any one time.

No criteria for protection of estuarine or marine waters from eutrophication are proposed due to the lack of information available on levels of nutrients or algal biomass which would be desirable in BC coastal waters.