MINISTRY OF ENVIRONMENT, LANDS, AND PARKS

# Water Quality Assessment and Objectives for the Fraser River From Moose Lake to Hope

***Prepared pursuant to:***

Section 2 (e)
Environment Management Act, 1981

***Approved:***

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# DISCLAIMER

This report is part of the British Columbia Ministry of Environment, Lands and Parks’ *Water Quality Assessment and Objectives* series. Its contents do not necessarily reflect the view and policies of Environment Canada.

# SUMMARY

THIS DOCUMENT is one in a series that describes ambient Water Quality Objectives for British Columbia. It has two parts: the following overview and a technical appendix which is available as a separate document. The overview provides general information about water quality in the main stem of the Fraser River from Moose Lake to Hope in three main River reaches. These reaches are from Moose Lake to Tete Jaune Cache, from Tete Jaune Cache to the Nechako River confluence, and from the Nechako River confluence to Hope. The technical appendix presents details of a recent water quality assessment for these reaches and forms the basis for recommendations and objectives presented in the overview. The overview is intended for both technical readers and others who may not be familiar with the process of setting water quality objectives. Separate tables listing water quality objectives and monitoring recommendations are included for those readers requiring data about these waterbodies. A separate report will be published on water quality objectives for the Fraser River from Hope to Sturgeon and Roberts Banks.

The Fraser River is home to both resident and anadromous species of fish. There are 26 species of resident fish documented as being in the Fraser River above Hope, with most species being in the river as far north as the Chilcotin River. Salmonid species are present in large numbers and make the Fraser River a world-class system for these fish species. Runs have increased during the 1980s for all species of salmon in the River. This same decade had the largest average runs for chinook, chum, and sockeye salmon. Consistent achievement of water quality objectives in the Fraser River is critical for the continued success and sustainability of the Fraserís salmon resource.

Most water contamination in the River above Hope is related to treated wastewater discharges from pulp and paper mills located at Prince George and Quesnel as well as treated municipal sewage discharges from Prince George, Williams Lake, Quesnel, Lytton, and Lillooet. Flows from the Thompson River, a tributary to the Fraser, carry the treated wastewater from a pulp mill and a municipal sewage discharge from the City of Kamloops.

This report describes the specific Water Quality Objectives recommended to protect aquatic life, wildlife, livestock watering, irrigation, and drinking water supplies in all three reaches of the Fraser River Basin from Moose Lake to Hope.

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# PREFACE

## Purpose of Water Quality Objectives

WATER QUALITY OBJECTIVES are tools for the effective management of water resources. They describe conditions that water managers have agreed should be met in order to protect the most sensitive designated uses of fresh, estuarine, and coastal marine waters. They are used in conjunction with other management tools such as effluent controls and pollution prevention planning to achieve high standards of water quality.

Water Quality Objectives are being prepared for specific bodies of fresh, estuarine, and coastal marine surface waters of British Columbia by the Ministry of Environment, Lands, and Parks as part of their mandate to responsible water resource management. Objectives are prepared only for those waterbodies and water quality characteristics that may be affected by human activity now or in the future.

## How Objectives Are Determined

WATER QUALITY OBJECTIVES are based on water quality criteria which are numerical concentrations for chemical, physical, radiological, biological characteristics of water, biota (plant and animal life) or sediment to their effects on water use necessary to protect and enhance designated uses of water. These same guidelines may also be used as a basis for the development of Water Quality Objectives for specified sites.

Water Quality Objectives are numerical concentrations established to support and protect the most sensitive designated use of water at a specified site. They are derived from the guidelines by considering local water quality, water uses, water movement, waste discharges, and socio-economic factors.

Water Quality Objectives are based on the best scientific information available at the time the Objectives are developed. When insufficient information exists, provisional Water Quality Objectives may be applied until the data required to develop formal Water Quality Objectives are available. Provisional objectives are deliberately conservative, and a monitoring or study program is required that will lead to the establishment of permanent objectives.

Water Quality Objectives are set to protect the most sensitive designated water use at a specific location. Designated uses of water include the following:

- raw drinking water, public water supply, and food processing
- fish, other aquatic life, and wildlife
- agriculture (livestock watering and irrigation)
- recreation and aesthetics
- industrial water supplies

Each objective for a location may be based on the protection of a different water use, depending on the uses that are most sensitive to the physical, chemical, or biological characteristics affecting that waterbody.

## How Objectives Are Used

WATER QUALITY OBJECTIVES have no legal standing at this time and therefore, can not be directly enforced. Water management in BC is enforced through permits issued for effluent discharges with controls placed on, and enforcement actions for volumes and concentrations of contaminants discharged. The limits set are based upon best available technology for treatment.

Water Quality Objectives do provide policy direction for resource managers for the protection of water uses in specific waterbodies. Objectives provide a reference for the evaluation of water quality, the issuing of discharge permits, water withdrawal licenses and orders, and the management of fisheries and the province's land base. They also provide a reference against which the state of water quality in a particular waterbody can be checked, and help to determine whether basin-wide water quality studies should be initiated. Water Quality Objectives are also a standard for assessing the Ministry's performance in protecting water uses.

## Objectives and Monitoring

Water Quality Objectives are established to protect all the uses which may take place in a water body. Monitoring is undertaken to determine compliance with the stated Water Quality Objectives and whether the designated water uses are being protected. Monitoring usually takes place at a critical time when

a water quality specialist has determined that the Water Quality Objectives may not be met. It is assumed that if all designated water uses are protected at the critical time, then they also will be protected at other times when the threat is less. The monitoring usually takes place during a five-week period, which allows the specialists to measure the worst, as well as the average condition in the water. For some water bodies, the monitoring period and frequency may vary, depending upon the nature of the problem, severity of threats to designated water uses, and the way the objectives are expressed (i.e., mean value, maximum value).

# INTRODUCTION

The Fraser River drains about one-quarter of the Province of British Columbia, and extends from the Alberta-British Columbia border in the north and east, to the estuary and the River confluence with the Strait of Georgia, in the south and west of the Province (see Figure 1). The purpose of this report was to develop Water Quality Objectives in the Fraser River from Hope to Moose Lake to provide policy direction to resource and environment managers for the protection of designated uses of waterbodies within the stretch of the waterbody defined by this report. Others that may find the information useful include environmental scientists and other agency staff including regulators, habitat biologists, and water quality specialists. The public will also find the Water Quality Objectives useful for assessing the health of their environment, articulating concerns about existing uses of resources in their environment, and monitoring the performance of various government agencies cooperating to maintain acceptable high levels of water quality in the Fraser River Basin.

# THE FRASER RIVER FROM MOOSE LAKE TO HOPE PROFILE

## Hydrology

The Fraser River exhibits a classic perpetual annual snow melt hydrograph pattern due to its extensive snow pack and massive basin storage. High flows take place from May to August, with 64% of the annual volume runoff taking place during this time. Low flow months are consistently between November and April. The extreme lowest mean monthly discharges (ten year, seven-day low flows in parentheses) have ranged from 4.06 (4.10) $m^3/s$ at Red Pass, to 20.6 (21.0) $m^3/s$ at McBride, to 97 (110) $m^3/s$ at Shelley (just upstream from Prince George), to 218 (232) $m^3/s$ at Marguerite (downstream from Quesnel), to 482 (563) $m^3/s$ at Hope. These compare to extreme high flows at the same stations of 235 $m^3/s$, 918 $m^3/s$, 3470 $m^3/s$, 5390 $m^3/s$, and 10800 $m^3/s$, respectively.

## Water Uses

Water uses in each of the three reaches of the Fraser River designated in this document are similar. Consumptive water uses include domestic water supply (including livestock watering) withdrawals in all three reaches, and irrigation water supplies below Prince George. Fisheries values are considered to be high, with 26 resident species using the river upstream from Hope, and five salmon species migrating to and spawning in tributaries upstream from Hope. The returns of these five species increased during the 1980's, with the largest average runs for the decade being recorded in the 1980's for chinook, chum, and sockeye salmon.

Recreational water use along the Fraser River is generally limited, since the precipitous geography of the upper and middle Fraser reaches allows for only a low to moderate recreational use. Primary-contact recreation does not normally occur along the Fraser River itself, since the tributaries are generally warmer and less turbid. River rafting (secondary-contact) is popular, with over 60 companies using the Fraser River or 36 of its tributaries.

## Waste Water Discharges

There are no significant direct discharges of wastewater to the Fraser River between Moose Lake and Tete Jaune Cache. The most significant discharges to the Fraser River between Tete Jaune Cache and the Nechako River confluence are from the Northwood Pulp Mill and the Prince George Pulp and Intercontinental Mills at Prince George. Significant improvements to effluent quality have been made at all pulp mills since 1991. Downstream from the Nechako River confluence are municipal-type discharges from the Prince George area, treated sewage discharges from Williams Lake, Lytton, and Lillooet, as well as discharges from the two pulp mills (and the municipal-type discharge) at Quesnel.

Non-point sources are also impacting water quality, especially forestry operations, in every major tributary entering the mainstem Fraser. Studies performed on the impacts of forestry on fish habitat or water quality indicate that historically, there has been severe sedimentation of stream gravel used for salmonid spawning and greatly increased sediment and nutrient loadings which have reduced light penetration.

Agricultural inputs to the Fraser River are likely greatest downstream from Hope. In this reach of the river, considerably more land is in agricultural use, more fertilizers are used, and more livestock are housed. These activities lead to increased ammonia, nutrient, oxygen-demanding and bacteriological loadings to the river. In the urbanized areas of the watershed, stormwater runoff increases concentrations of metals, nutrients, and suspended solids.

# WATER QUALITY ASSESSMENT AND OBJECTIVES

## Water Quality Assessment

The data examined in the present assessment indicate that the water quality of the Fraser River was generally fair to good in all reaches. Information on water and sediment quality, contaminants in fish tissues, and the abundance and diversity of benthic invertebrate populations near the major effluent discharges were evaluated. The River was generally well-buffered to acidic inputs, with moderate water hardness. Metal concentrations generally met guidelines to protect aquatic life. Dissolved oxygen concentrations were occasionally below the guidelines for minimum concentrations to protect aquatic life. Colour was generally below guidelines for drinking water supplies but turbidity and suspended solids concentrations were such that water would require filtration for drinking water supplies. Bacteriological concentrations were generally below guidelines for drinking water supplies.

The highest concentrations of organochlorine compounds in sediments were found at sites downstream from Hope, likely due to slower river velocities in this area. Reduced flow allows finer sediment particles, which adsorb higher concentrations of organics, to settle out.

Resident fish from Moose Lake had the highest lead and molybdenum concentrations in muscle along the length of the river. Fish from McBride had the highest concentrations in muscle of cadmium, copper, chromium, and nickel. Fish collected near Lillooet had the highest concentrations of arsenic, cadmium, copper, and zinc in livers. Dioxins and furans in fish collected upstream from Prince George and upstream from the Nechako River confluence were low compared to fish collected from below the pulp mills at Prince George and Quesnel. Mountain whitefish collected downstream from Quesnel had the highest dioxin and furan concentrations. It is important to note that levels of dioxins and furans have declined dramatically over the past few years.

## Water Quality Objectives

Water Quality Objectives proposed for the three reaches of the Fraser River from Moose Lake to Hope are summarized in Table 1. The objectives are based on B.C. approved and working criteria, the Canadian Water Quality Guidelines developed by the Canadian Council of Ministers of the Environment for water quality, and on available data on ambient water quality, waste discharges, water uses, and stream flows.

Where insufficient information exists, provisional Water Quality Objectives may be applied until the data required to develop formal, definitive Water Quality Objectives are available. Provisional objectives are deliberately conservative, and a monitoring or study program is specified that will lead to the establishment of permanent objectives. Permanent objectives are established when the information available about the local conditions and water quality guidelines is complete.

Depending on the circumstances, Water Quality Objectives may already be met in a waterbody, or may describe water quality conditions which can be met in the future. To limit the scope of the work, objectives are only being prepared for waterbodies and for water quality characteristics which may be affected by human activity now and in the foreseeable future.

Designated water uses for all three reaches of the Fraser River from Moose Lake to Hope are for the protection of aquatic life, wildlife, recreation, livestock watering, and drinking water supplies. Irrigation water is to be protected downstream from Prince George.

Water Quality Objectives which are based on approved or draft B.C. water quality guidelines include those for dioxins and furans, chlorophenols, microbiological indicators, ammonia, nitrite, nitrate, and pH. The objectives are required to ensure that inputs from non-point source discharges, pulp and paper mills, and the sewage treatment plants do not impair water uses. An objective is proposed for pH as a range of values. The upper value will control the formation of toxic quantities of ammonia. Different dissolved oxygen levels, based on the Ministry's modification of the CCREM (now known as the CCME) guidelines in the Technical Appendix, are proposed for the waterbodies.

## Monitoring Recommendations

Monitoring programs should be designed and coordinated to determine the degree to which Water Quality Objectives are being met. Monitoring of ecosystem responses will provide a means of identifying situations where more restrictive effluent standards may be required or where Water Quality Objectives need to be adjusted to meet water management goals.

The long-term purpose of monitoring is to detect a pre-determined degree of change at a significant frequency when monitoring is performed at a level of effort to confer reliable information. If a parameter is consistently within one order of magnitude of the Water Quality Objective, monitoring should be continued at the same frequency. If the objective is exceeded, the monitoring effort should be increased to determine the extent the objective is exceeded. The actual monitoring undertaken will depend upon regional resources.

A recommended monitoring design is included as Table 6. Should the objectives be exceeded, some water uses may be threatened at some time in the future.

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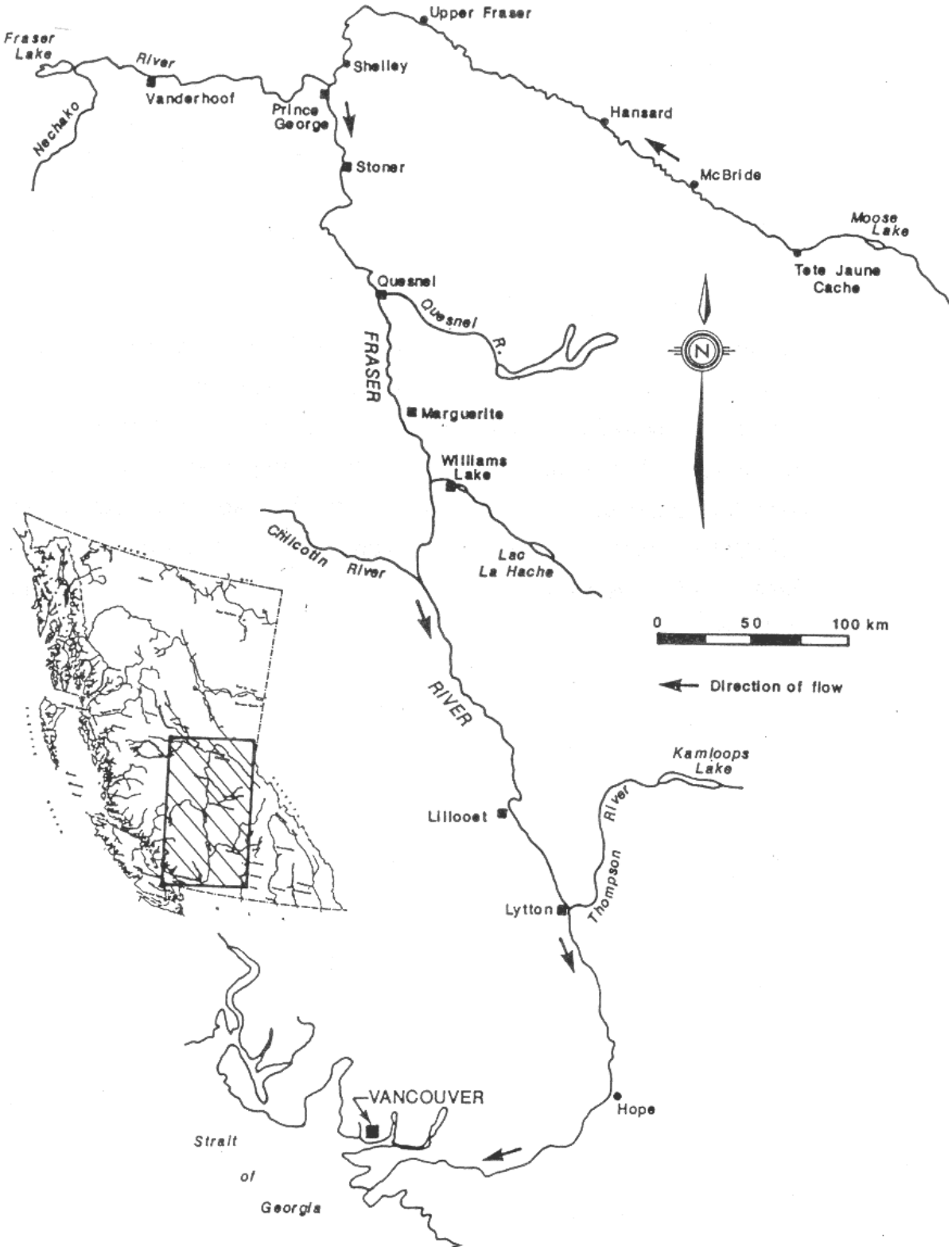
# LOCATION MAP



# WATER QUALITY OBJECTIVES AND MONITORING TABLES

THE FOLLOWING TABLES provide a summary of the objectives data and monitoring recommendations.

To protect water uses in a waterbody, objectives specify a range of values for characteristics (variables) that may affect these uses. These values are maximum and/or minimum values that are not to be exceeded.

Some readers may be unfamiliar with terms such as: maximum concentration, 30-day average concentration, 90th percentile, and not applicable (NA). Maximum concentration means that a value for a specific variable should not be exceeded; 30-day average concentration means that a value should not be exceeded during a period of 30 days, when five or more samples are collected at approximately equal time intervals. The term 90th percentile indicates that 9 out of 10 values should be less than a particular value. Not applicable (NA) means that water uses are not threatened for that particular variable.

TABLE 1

WATER QUALITY OBJECTIVES FOR THE FRASER RIVER FROM MOOSE LAKE TO HOPE

| Waterbodies | Fraser R., Moose L. to Tete Jaune Cache | Fraser R., Tete Jaune Cache to Nechako R. | Fraser R. from Nechako R. to Hope |
|---|---|---|---|
| Designated Water Uses | aquatic life, wildlife, drinking water (partial treatment), livestock, irrigation, secondary-contact recreation | | |
| Characteristics | | | |
| Fecal coliforms[1] | not applicable | ≤ 100/cL 90th percentile | |
| Enterococci[1] | not applicable | ≤ 25/cL 90th percentile | |
| Total Chlorine Residual | not applicable | Average ≤ 2 µg/L | |
| Suspended solids[2] | 10 mg/L maximum increase (upstream < 100 mg/L)<br>10% maximum increase (upstream > 100 mg/L) | | |
| Turbidity[2] | 5 NTU maximum | 1 NTU maximum increase (upstream <5 NTU)<br>5 NTU maximum increase (upstream < 50 NTU)<br>10% maximum increase (upstream > 50 NTU) | |
| Colour - true | 15 TCU maximum | 15 TCU maximum (June-September)<br>75 TCU maximum (October-May)<br>10% maximum increase (upstream > 15 or 75 TCU, respectively) | |
| Temperature ($^{o}$C) | not applicable | Maximum change 1 $^{o}$C | |
| Total ammonia-N | not applicable | See Tables 2 and 3 | |
| Nitrite-N | not applicable | See Table 4 | |
| Nitrate-N + Nitrite-N | not applicable | 10 mg/L maximum | |
| Periphyton chlorophyll-a[3] | not applicable | 50 mg/m$^2$ maximum | |
| pH[4] | 6.5-8.5 | | |
| Dissolved oxygen | not applicable | Higher of 80% saturation or 8.0 mg/L minimum<br>11.0 mg/L when salmonid embryos and larvae present (November–April) | |
| Lead, total | 0.8 µg/g maximum in edible fish muscle | | |
| PCBs, total | 2.0 µg/g maximum in edible fish muscle<br>0.1 µg/g maximum in whole fish | | |
| Chlorophenols | not applicable | See Table 5 | |
| AOX | not applicable | No increase at 95% confidence level | |
| Dehydroabietic Acid | not applicable | Maximum 8 µg/L at pH 7.0<br>Maximum 12 µg/L at pH 7.5 | |
| Total Resin Acids | not applicable | Maximum 25 µg/L at pH 7.0<br>Maximum 45 µg/L at pH 7.5 | |

TABLE 1

WATER QUALITY OBJECTIVES FOR THE FRASER RIVER FROM MOOSE LAKE TO HOPE (CONTINUED)

| Waterbodies | Fraser R., Moose L. to Tete Jaune Cache | Fraser R., Tete Jaune Cache to Nechako R. | Fraser R. from Nechako R. to Hope |
|---|---|---|---|
| Designated Water Uses | aquatic life, wildlife, drinking water (partial treatment), livestock, irrigation | | |
| Characteristics | | | |
| Dioxins and Furans<br>2,3,7,8-$T_4$CDD equivalents | not applicable | Maximum (dissolved) 0.06 pg/L in water<br>Maximum 0.25 pg/g (normalized to 1% organic carbon) in sediments<br>Maximum 50 pg/g (wet-weight) in lipids of fish muscle or fish eggs | |

Note: While Water Quality Objectives do not apply in initial dilution zones where acutely toxic conditions are not permitted, they do apply to discrete samples of water and sediment from all other parts of the Fraser River from Moose Lake to Hope. In practise, the extent of initial dilution zones is defined on a site-specific basis, with due regard to water uses, aquatic life, including migratory fish, and other waste discharges. However, where sufficient site-specific data is not available for defining initial dilution zones for the objectives established, provisional initial dilution zones will be defined as extending up to 100 metres downstream from a discharge, and occupying no more than 25% of the stream width around the discharge point, from the bed of the stream to the surface. It is also important to note that objectives for fish apply to all parts of the river, including fish in the initial dilution zone.

[1]The average and the 90th percentiles are calculated from at least five weekly samples collected in a period of thirty days. For values recorded as less than the detection limit, the detection limit itself should be used in calculating the statistic. The 90th percentile can be extrapolated by graphical methods when fewer than ten samples are collected.

[2]The increase (in mg/L or NTU) is over levels measured at a site upstream from a discharge or series of discharges and as close to them as possible, and applies to downstream values.

[3]The maximum is based on an average calculated from at least five randomly located samples from natural substrates at each site on any sampling date.

[4]Measurements may be made in-situ, but must be confirmed in the laboratory if the objective is not achieved.

TABLE 2

MAXIMUM CONCENTRATION OF TOTAL AMMONIA NITROGEN FOR PROTECTION OF AQUATIC LIFE (mg/L-N)

| | Temperature | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| pH | 0°C | 1°C | 2°C | 3°C | 4°C | 5°C | 6°C | 7°C | 8°C | 9°C | 10°C |
| 6.5 | 27.7 | 28.3 | 27.9 | 27.5 | 27.2 | 26.8 | 26.5 | 26.2 | 26 | 25.7 | 25.5 |
| 6.6 | 27.9 | 27.5 | 27.2 | 26.8 | 26.4 | 26.1 | 25.8 | 25.5 | 25.2 | 25 | 24.7 |
| 6.7 | 26.9 | 26.5 | 26.2 | 25.9 | 25.5 | 25.2 | 24.9 | 24.6 | 24.4 | 24.1 | 23.9 |
| 6.8 | 25.8 | 25.5 | 25.1 | 24.8 | 24.5 | 24.2 | 23.9 | 23.6 | 23.4 | 23.1 | 22.9 |
| 6.9 | 24.6 | 24.2 | 23.9 | 23.6 | 23.3 | 23 | 22.7 | 22.5 | 22.2 | 22 | 21.8 |
| 7 | 23.2 | 22.8 | 22.5 | 22.2 | 21.9 | 21.6 | 21.4 | 21.1 | 20.9 | 20.7 | 20.5 |
| 7.1 | 21.6 | 21.3 | 20.9 | 20.7 | 20.4 | 20.2 | 19.9 | 19.7 | 19.5 | 19.3 | 19.1 |
| 7.2 | 19.9 | 19.6 | 19.3 | 19 | 18.8 | 18.6 | 18.3 | 18.1 | 17.9 | 17.8 | 17.6 |
| 7.3 | 18.1 | 17.8 | 17.5 | 17.3 | 17.1 | 16.9 | 16.7 | 16.5 | 16.3 | 16.2 | 16 |
| 7.4 | 16.2 | 16 | 15.7 | 15.5 | 15.3 | 15.2 | 15 | 14.8 | 14.7 | 14.5 | 14.4 |
| 7.5 | 14.4 | 14.1 | 14 | 13.8 | 13.6 | 13.4 | 13.3 | 13.1 | 13 | 12.9 | 12.7 |
| 7.6 | 12.6 | 12.4 | 12.2 | 12 | 11.9 | 11.7 | 11.6 | 11.5 | 11.4 | 11.3 | 11.2 |
| 7.7 | 10.8 | 10.7 | 10.5 | 10.4 | 10.3 | 10.1 | 10 | 9.92 | 9.83 | 9.73 | 9.65 |
| 7.8 | 9.26 | 9.12 | 8.98 | 8.88 | 8.77 | 8.67 | 8.57 | 8.48 | 8.4 | 8.32 | 8.25 |
| 7.9 | 7.82 | 7.71 | 7.6 | 7.51 | 7.42 | 7.33 | 7.25 | 7.17 | 7.1 | 7.04 | 6.98 |
| 8 | 6.55 | 6.46 | 6.37 | 6.29 | 6.22 | 6.14 | 6.08 | 6.02 | 5.96 | 5.91 | 5.86 |
| 8.1 | 5.21 | 5.14 | 5.07 | 5.01 | 4.95 | 4.9 | 4.84 | 4.8 | 4.75 | 4.71 | 4.67 |
| 8.2 | 4.15 | 4.09 | 4.04 | 3.99 | 3.95 | 3.9 | 3.86 | 3.83 | 3.8 | 3.76 | 3.74 |
| 8.3 | 3.31 | 3.27 | 3.22 | 3.19 | 3.15 | 3.12 | 3.09 | 3.06 | 3.03 | 3.01 | 2.99 |
| 8.4 | 2.64 | 2.61 | 2.57 | 2.54 | 2.52 | 2.49 | 2.47 | 2.45 | 2.43 | 2.41 | 2.4 |
| 8.5 | 2.11 | 2.08 | 2.06 | 2.03 | 2.01 | 1.99 | 1.98 | 1.96 | 1.95 | 1.94 | 1.93 |
| 8.6 | 1.69 | 1.67 | 1.65 | 1.63 | 1.61 | 1.6 | 1.59 | 1.58 | 1.57 | 1.56 | 1.55 |
| 8.7 | 1.35 | 1.33 | 1.32 | 1.31 | 1.3 | 1.29 | 1.28 | 1.27 | 1.26 | 1.26 | 1.25 |
| 8.8 | 1.08 | 1.07 | 1.06 | 1.05 | 1.04 | 1.04 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 |
| 8.9 | 0.871 | 0.863 | 0.856 | 0.849 | 0.844 | 0.839 | 0.836 | 0.833 | 0.832 | 0.831 | 0.83 |
| 9 | 0.703 | 0.697 | 0.692 | 0.688 | 0.685 | 0.682 | 0.681 | 0.681 | 0.68 | 0.681 | 0.68 |

| | Temperature | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| pH | 11°C | 12°C | 13°C | 14°C | 15°C | 16°C | 17°C | 18°C | 19°C | 20°C |
| 6.5 | 25.2 | 25 | 24.8 | 24.6 | 24.5 | 24.3 | 24.2 | 24 | 23.9 | 23.8 |
| 6.6 | 24.5 | 24.3 | 24.1 | 23.9 | 23.8 | 24.6 | 23.5 | 23.3 | 23.3 | 23.2 |
| 6.7 | 23.7 | 23.5 | 23.3 | 23.1 | 23 | 22.8 | 22.7 | 22.6 | 22.5 | 22.4 |
| 6.8 | 22.7 | 22.5 | 22.3 | 22.2 | 22 | 21.9 | 21.8 | 21.7 | 21.6 | 21.5 |
| 6.9 | 21.6 | 21.4 | 21.3 | 21.1 | 21 | 20.8 | 20.7 | 20.6 | 20.5 | 20.4 |
| 7 | 20.3 | 20.2 | 20 | 19.9 | 19.7 | 19.6 | 19.5 | 19.4 | 19.3 | 19.2 |
| 7.1 | 18.9 | 18.8 | 18.7 | 18.5 | 18.4 | 18.3 | 18.2 | 18.1 | 18 | 17.9 |
| 7.2 | 17.4 | 17.3 | 17.2 | 17.1 | 16.9 | 16.8 | 16.8 | 16.7 | 16.6 | 16.5 |
| 7.3 | 15.9 | 15.7 | 15.6 | 15.5 | 15.4 | 15.3 | 15.2 | 15.2 | 15.1 | 15.1 |
| 7.4 | 14.2 | 14.1 | 14 | 13.9 | 13.9 | 13.8 | 13.7 | 13.6 | 13.6 | 13.5 |
| 7.5 | 12.6 | 12.5 | 12.4 | 12.4 | 12.3 | 12.2 | 12.2 | 12.1 | 12.1 | 12 |
| 7.6 | 11.1 | 11 | l0.9 | 10.8 | 10.8 | 10.7 | 10.7 | 10.6 | 10.6 | 10.5 |
| 7.7 | 9.57 | 9.5 | 9.43 | 9.37 | 9.31 | 9.26 | 9.22 | 9.81 | 9.15 | 9.12 |
| 7.8 | 8.18 | 8.12 | 8.07 | 8.02 | 7.97 | 7.93 | 7.9 | 7.87 | 7.84 | 7.82 |
| 7.9 | 6.92 | 6.88 | 6.83 | 6.79 | 6.75 | 6.72 | 6.69 | 6.67 | 6.65 | 6.64 |
| 8 | 5.81 | 5.78 | 5.74 | 5.71 | 5.68 | 5.66 | 5.64 | 5.62 | 5.61 | 5.6 |
| 8.1 | 4.64 | 4.61 | 4.59 | 4.56 | 4.54 | 4.53 | 4.51 | 4.5 | 4.49 | 4.49 |
| 8.2 | 3.71 | 3.69 | 3.67 | 3.65 | 3.64 | 3.63 | 3.62 | 3.61 | 3.61 | 3.61 |
| 8.3 | 2.97 | 2.96 | 2.94 | 2.93 | 2.92 | 2.92 | 2.91 | 2.91 | 2.91 | 2.91 |
| 8.4 | 2.38 | 2.37 | 2.36 | 2.36 | 2.35 | 2.35 | 2.35 | 2.35 | 2.35 | 2.36 |
| 8.5 | 1.92 | 1.91 | 1.91 | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 | 1.91 | 1.92 |
| 8.6 | 1.55 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.55 | 1.55 | 1.56 | 1.57 |
| 8.7 | 1.25 | 1.25 | 1.25 | 1.25 | 1.25 | 1.26 | 1.26 | 1.27 | 1.28 | 1.29 |
| 8.8 | 1.02 | 1.02 | 1.02 | 1.02 | 1.03 | 1.03 | 1.04 | 1.05 | 1.06 | 1.07 |
| 8.9 | 0.832 | 0.834 | 0.838 | 0.842 | 0.847 | 0.853 | 0.861 | 0.87 | 0.88 | 0.891 |
| 9 | 0.684 | 0.688 | 0.692 | 0.698 | 0.704 | 0.711 | 0.72 | 0.729 | 0.74 | 0.752 |

TABLE 3
AVERAGE 30-DAY CONCENTRATION OF TOTAL AMMONIA NITROGEN FOR PROTECTION OF AQUATIC LIFE (mg/L-N)

| | Temperature | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| pH | 0°C | 1°C | 2°C | 3°C | 4°C | 5°C | 6°C | 7°C | 8°C | 9°C | 10°C |
| 6.5-7.1 | 2.08 | 2.05 | 2.02 | 1.99 | 1.97 | 1.94 | 1.92 | 1.9 | 1.88 | 1.86 | 1.84 |
| 7.2 | 2.08 | 2.05 | 2.02 | 1.99 | 1.96 | 1.95 | 1.92 | 1.9 | 1.88 | 1.86 | 1.85 |
| 7.3 | 2.08 | 2.05 | 2.02 | 1.99 | 1.97 | 1.95 | 1.92 | 1.9 | 1.88 | 1.86 | 1.85 |
| 7.4 | 2.08 | 2.05 | 2.02 | 2 | 1.97 | 1.95 | 1.92 | 1.9 | 1.88 | 1.87 | 1.85 |
| 7.5 | 2.08 | 2.05 | 2.02 | 2 | 1.97 | 1.95 | 1.93 | 1.91 | 1.88 | 1.87 | 1.85 |
| 7.6 | 2.09 | 2.05 | 2.03 | 2 | 1.97 | 1.95 | 1.93 | 1.91 | 1.89 | 1.87 | 1.85 |
| 7.7 | 2.09 | 2.05 | 2.03 | 2 | 1.98 | 1.95 | 1.93 | 1.91 | 1.89 | 1.87 | 1.86 |
| 7.8 | 1.78 | 1.75 | 1.73 | 1.71 | 1.69 | 1.67 | 1.65 | 1.63 | 1.62 | 1.6 | 1.59 |
| 7.9 | 1.5 | 1.48 | 1.46 | 1.44 | 1.43 | 1.41 | 1.39 | 1.38 | 1.36 | 1.35 | 1.34 |
| 8 | 1.26 | 1.24 | 1.23 | 1.21 | 1.2 | 1.18 | 1.17 | 1.16 | 1.15 | 1.14 | 1.13 |
| 8.1 | 1 | 0.989 | 0.976 | 0.963 | 0.952 | 0.942 | 0.932 | 0.922 | 0.914 | 0.906 | 0.899 |
| 8.2 | 0.799 | 0.788 | 0.777 | 0.768 | 0.759 | 0.751 | 0.743 | 0.736 | 0.73 | 0.724 | 0.718 |
| 8.3 | 0.636 | 0.628 | 0.62 | 0.613 | 0.606 | 0.599 | 0.594 | 0.588 | 0.583 | 0.579 | 0.575 |
| 8.4 | 0.508 | 0.501 | 0.495 | 0.489 | 0.484 | 0.479 | 0.475 | 0.471 | 0.467 | 0.464 | 0.461 |
| 8.5 | 0.405 | 0.4 | 0.396 | 0.381 | 0.387 | 0.384 | 0.38 | 0.377 | 0.375 | 0.372 | 0.37 |
| 8.6 | 0.324 | 0.32 | 0.317 | 0.313 | 0.31 | 0.308 | 0.305 | 0.303 | 0.301 | 0.3 | 0.298 |
| 8.7 | 0.26 | 0.257 | 0.254 | 0.251 | 0.249 | 0.247 | 0.246 | 0.244 | 0.243 | 0.242 | 0.241 |
| 8.8 | 0.208 | 0.206 | 0.204 | 0.202 | 0.201 | 0.2 | 0.198 | 0.197 | 0.197 | 0.196 | 0.196 |
| 8.9 | 0.168 | 0.166 | 0.165 | 0.163 | 0.162 | 0.161 | 0.131 | 0.131 | 0.131 | 0.131 | 0.131 |

| | Temperature | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| pH | 11°C | 12°C | 13°C | 14°C | 15°C | 16°C | 17°C | 18°C | 19°C | 20°C |
| 7.8 | 1.57 | 1.56 | 1.55 | 1.54 | 1.53 | 1.42 | 1.32 | 1.23 | 1.14 | 1.07 |
| 7.9 | 1.33 | 1.32 | 1.31 | 1.31 | 1.3 | 1.21 | 1.12 | 1.04 | 0.97 | 0.904 |
| 8 | 1.12 | 1.11 | 1.1 | 1.1 | 1.09 | 1.02 | 0.944 | 0.878 | 0.818 | 0.762 |
| 8.1 | 0.893 | 0.887 | 0.882 | 0.878 | 0.874 | 0.812 | 0.756 | 0.704 | 0.655 | 0.611 |
| 8.2 | 0.714 | 0.709 | 0.706 | 0.703 | 0.7 | 0.651 | 0.606 | 0.565 | 0.527 | 0.491 |
| 8.3 | 0.571 | 0.568 | 0.566 | 0.564 | 0.562 | 0.523 | 0.487 | 0.455 | 0.424 | 0.396 |
| 8.4 | 0.458 | 0.456 | 0.455 | 0.453 | 0.452 | 0.421 | 0.393 | 0.367 | 0.343 | 0.321 |
| 8.5 | 0.369 | 0.367 | 0.366 | 0.366 | 0.365 | 0.341 | 0.318 | 0.298 | 0.278 | 0.261 |
| 8.6 | 0.297 | 0.297 | 0.296 | 0.296 | 0.296 | 0.277 | 0.259 | 0.242 | 0.227 | 0.213 |
| 8.7 | 0.241 | 0.24 | 0.24 | 0.241 | 0.241 | 0.226 | 0.212 | 0.198 | 0.186 | 0.175 |
| 8.8 | 0.196 | 0.196 | 0.196 | 0.197 | 0.198 | 0.185 | 0.174 | 0.164 | 0.154 | 0.145 |
| 8.9 | 0.16 | 0.161 | 0.161 | 0.162 | 0.163 | 0.153 | 0.144 | 0.136 | 0.128 | 0.121 |
| 9 | 0.132 | 0.132 | 0.133 | 0.134 | 0.135 | 0.128 | 0.121 | 0.114 | 0.108 | 0.102 |

- the average of the measured values must be less than the average of the corresponding individual values in Table 3.
- each measured value is compared to the corresponding individual values in Table 3. No more than one in five of the measured values can be greater than one-and-a-half times the corresponding objective values in Table 3.

TABLE 4

MAXIMUM AND 30-DAY AVERAGE NITRITE (N) CONCENTRATIONS TO PROTECT AQUATIC LIFE

| Chloride Concentration (mg/L) | Maximum Nitrite–N Concentration (mg/L) | 30-Day Average Nitrite–N Concentration* (mg/L) |
|---|---|---|
| <2 | 0.06 | 0.02 |
| 2-4 | 0.12 | 0.04 |
| 4-6 | 0.18 | 0.06 |
| 6-8 | 0.24 | 0.08 |
| 8-10 | 0.30 | 0.10 |
| >10 | 0.60 | 0.20 |

*The 30-day average chloride concentration should be used to determine the appropriate 30-day average nitrite objective.

TABLE 5

MAXIMUM CONCENTRATIONS OF CHLOROPHENOLS TO PROTECT AQUATIC LIFE

| Chlorophenol Objective (µg/L ) | | | Chlorophenol Objective (µg/L ) | | |
|---|---|---|---|---|---|
| 2-MCP | any pH | 0.90 | 2,3,6-TCP | pH 7.3 | 0.32 |
| 3-MCP | any pH | 0.50 | 2,4,5-TCP | < pH 7.9 | 0.08 |
| 4-MCP | any pH | 0.70 | 2,4,5-TCP | pH 7.9 | 0.24 |
| 2,3-DCP | any pH | 0.20 | 2,4,6-TCP | < pH 7.5 | 0.12 |
| 2,4-DCP | any pH | 0.30 | 2,4,6-TCP | pH 7.5 | 0.50 |
| 2,5-DCP | any pH | 0.30 | 3,4,5-TCP | any pH | 0.06 |
| 2,6-DCP | < pH 7.9 | 0.30 | 2,3,4,5-TTCP | < pH 7.5 | 0.04 |
| 2,6-DCP | pH 7.9 | 0.90 | 2,3,4,5-TTCP | pH 7.5 | 0.20 |
| 3,4-DCP | any pH | 0.20 | 2,3,4,6-TTCP | < pH 7.1 | 0.04 |
| 3,5-DCP | < pH 8.1 | 0.12 | 2,3,4,6-TTCP | pH 7.1 | 0.30 |
| 3,5-DCP | pH 8.1 | 0.35 | 2,3,5,6-TTCP | < pH 7.1 | 0.02 |
| 2,3,4-TCP | < pH 7.9 | 0.10 | 2,3,5,6-TTCP | pH 7.1-pH 8.1 | 0.10 |
| 2,3,4-TCP | pH 7.9 | 0.30 | 2,3,5,6-TTCP | > pH 8.1 | 0.25 |
| 2,3,5-TCP | < pH 7.9 | 0.08 | 2,3,4,5,6-PCP | < pH 6.9 | 0.02 |
| 2,3,5-TCP | pH 7.9 | 0.25 | 2,3,4,5,6-PCP | pH 6.9-pH 7.9 | 0.10 |
| 2,3,6-TCP | < pH 7.3 | 0.06 | 2,3,4,5,6-PCP | > pH 7.9 | 0.30 |

TABLE 6

RECOMMENDED WATER QUALITY MONITORING FOR THE FRASER RIVER FROM MOOSE LAKE TO HOPE

| Site Number | Location | Frequency | Date | Variables |
|---|---|---|---|---|
| New Site | Fraser River at outlet from Moose Lake | 5 times weekly in 30 days | May - June | Suspended solids<br>Turbidity |
| New Site | Fraser River at Red Pass | | | |
| E206580 | Fraser River @ Hansard | 5 times weekly in 30 days | January - March | Dissolved oxygen<br>pH |
| New Site | Fraser River above Nechako R confluence and below mills outfalls | | | Temperature |
| New Site | Fraser River above Quesnel | | | MF fecal |
| 0600011 | Fraser River below Quesnel (Marguerite) | | | Enterococci<br>Escherichia coli<br>Residual chlorine |
| E206581 | Fraser River at Hope | | | NH3–N<br>NO3–N<br>NO2–N<br>Colour - true<br>Turbidity<br>Suspended solids<br>AOX<br>Dehydroabietic acid<br>Total resin acids<br>Dioxins and furans (H2O) |
| | | once - 3 replicates per site | | Dioxins and furans (sed) |
| | Site with suitable natural substrate near the following: | | July–Sept | Periphyton chlorophyll-a |
| | Fraser River at Hansard | | | Lead, PCBs, Dioxins & furans (fish) |
| E206580 | Fraser River at Stoner | | | |
| E206182 | Fraser River above Quesnel | | | (Minimum of 3 species with 5 individuals per species at each site) |
| New Site | Fraser River at Marguerite | | | |
| | Fraser River at Hope | | | |
| 0600011 | | | | |
| E206581 | | | | |

# GLOSSARY

**Adsorbable Organic Halides (AOX)** A measure of the sum total of all halogenated organic compounds, including those that are chlorinated.

**Ambient** Refers to conditions in the receiving environment.

**Anthropogenic** Relates to, or involves, the impact of man.

**Biochemical Oxygen Demand (BOD)** A measure of the amount of dissolved oxygen used by bacteria to decompose organic waste in water. Thus, the greater the degree of pollution by organic wastes, the greater the BOD.

**Chlorophenols** A group of toxic chlorinated organic compounds commonly associated with wood preservatives and pulp mill effluent.

**Chlorophyll a** The green pigment of plants which is used to indicate the abundance of plant (usually phytoplankton) and algal life. The greater the density of chlorophyll a measured, the greater the abundance of photosynthetic organisms.

**Contaminant** A substance that is not naturally present in the environment, or is present in elevated concentrations above natural background levels in sufficient concentrations to cause an environmental effect.

**Designated Water Use** A water use that is to be protected at a specific location (eg. aquatic life, wildlife, drinking water, water for livestock, irrigation, recreation and aestheitcs, and industry).

**Dioxins and Furans** A family of chlorinated organic compounds, some of which are highly toxic. They are formed as byproducts of chemical production that involves chlorine and high temperatures or during combustion where a source of chlorine is present (eg. chlorine bleaching of wood pulp and waste incineration).

**Disinfection** The process of destroying microorganisms in water by the application of a chemical agent (disinfectant) such as chlorine.

**Effluent** Complex liquid waste material (eg. sewage or liquid industrial wastes) discharged to the environment.

**Enterococci** A group of bacteria whose population density is strongly associated with the incidence of gastrointestinal disease caused by swimming in fresh water.

**Fecal Coliforms** A group of bacteria often used to measure the sanitary quality of water because they are present in virtually all warm-blooded animals in numbers far exceeding various microbial pathogens.

| | |
|---|---|
| **Nutrient** | Substance (element or compound) necessary for the growth and development of plants and animals. |
| **PCBs (polychlorinated biphenyls)** | A group of 209 chlorinated organic compounds, some of which are highly toxic. They were widely used as fire retardants in electrical transformers and capacitors, as plasticizers and waterproofing agents, and in inking processes. PCBs are persistent, accumulate in the food web, and are suspected carcinogens. |
| **Periphyton** | Organisms attached to submerged plants. |
| **pH** | Value representating acidity or alkalinity of a solution. Expressed as the negative of the logarithm (base 10) of the hydrogen ion concentration of the solution. Scale ranges from 0 to 14: pH 7 is neutral; pH< 7 is acid; pH> 7 is alkaline. |
| **Plankton** | Plants (phytoplankton) and animals (zooplankton), usually microscopic, floating in aquatic systems. |
| **Primary Sewage** | Denotes a level of effluent from which suspended solids have been removed by skimming floating materials and gravity settling in sedimentation tanks. |
| **Salmonid** | Fish of the family Salmonidae;. including trout, salmon, and char. |
| **Secondary Sewage** | Denotes a level of effluent with suspended solids and Biochemical Oxygen Demand (BOD) are further reduced from primary by chemical or microbial biodegradation. |
| **Tertiary Sewage** | Denotes a level of effluent above secondary in which an advanced reduction in nutrients, suspended solids, BOD, and contaminants have been achieved as a function of the treatment system involved. |
| **(B.C. Approved and Working ) Water Quality Criteria** | Physical, chemical, and biological qualities of water, sediment, and biota recommended by the B.C. Ministry of Environment, Lands and Parks to be protective of a designated water use. |
| **(Canadian) Water Quality Guideline** | Numerical concentration or narrative statement recommended by the Canadian Council of Ministers of the Environment to support and maintain a designated water use. |
| **Water Quality Objective** | A Water Quality Criterion or Guideline adapted to protect the most sensitive designated water use at a specified location with an adequate degree of safety, taking local circumstances into account. |