# Water Quality

## Ambient Water Quality Objectives For The Bonaparte River

### Overview Report

*Water Management Branch*
*Resource Quality Section*
*Ministry Of Environment*

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Original Signed By Ben Marr
Deputy Minister
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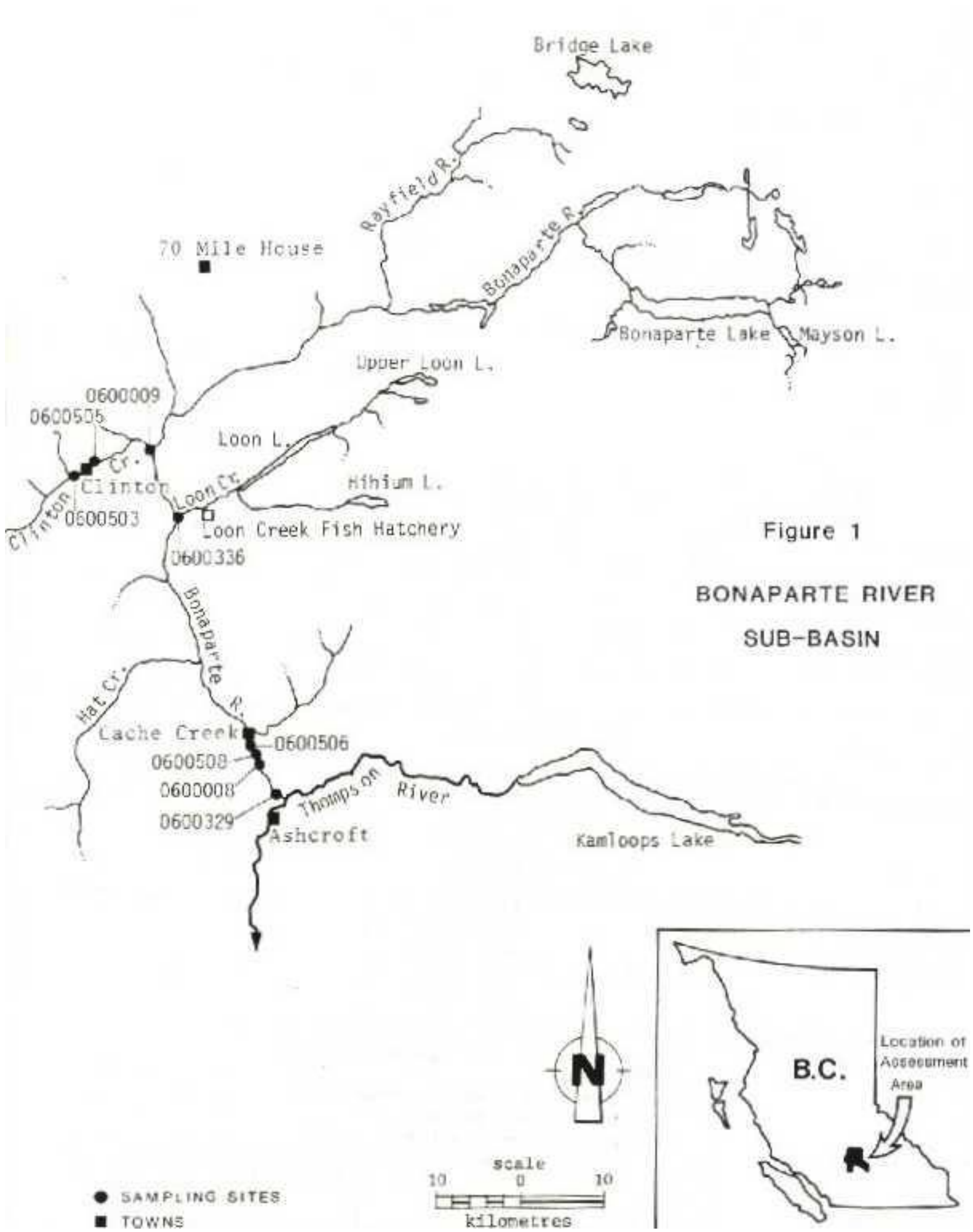
**Figure 1. Bonaparte River Location Map**



**PREFACE**
**Purpose of Water Quality Objectives**

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

**How Objectives Are Determined**

Water quality objectives are based the BC approved and working criteria as well as national water quality guidelines. Water quality criteria and guidelines are safe limits of the physical, chemical, or biological characteristics of water, biota (plant and animal life) or sediment which protect water use. Objectives are established in British Columbia for waterbodies on a site-specific basis. They are derived from the criteria by considering local water quality, water uses, water movement, waste discharges, and socio-economic factors.

Water quality objectives are set to protect the most sensitive designated water use at a specific location. A designated water use is one that is protected in a given location and is one of the following:

- raw drinking water, public water supply, and food processing
- 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 routinely provide policy direction for resource managers for the protection of water uses in specific waterbodies. Objectives guide the evaluation of water quality, the issuing of permits, licences 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. While water quality objectives have no legal standing and are not directly enforced, these objectives become legally enforceable when included as a requirement of a permit, licence, order, or regulation, such as the Forest Practices Code Act, Water Act regulations or Waste Management Act regulations.

## Objectives and Monitoring

Water quality objectives are established to protect all uses which may take place in a waterbody. Monitoring (sometimes called sampling) is undertaken to determine if all the designated water uses are being protected. The 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 waterbodies, 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)

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## INTRODUCTION

The water quality of the Bonaparte River and some of its tributaries in the Thompson-Bonaparte area (Figure 1) was assessed by examining water quality data and effluent quality data collected to about December 1983. The watershed is important habitat for rainbow trout and has good potential for salmon spawning and rearing. In addition to the usual developments, cattle create major problems for water quality. Water quality objectives therefore were developed in reaches where designated water uses may be threatened, either now or in the foreseeable future. A detailed technical appendix was prepared and forms the basis for the conclusions presented here and in the Thompson-Bonaparte Sub-Regional Environmental Management Plan.

The Bonaparte River originates at Bonaparte Lake, about 100 km north from Kamloops, from where it flows south-westerly towards the Village of Clinton. At its confluence with Clinton Creek, just east from Clinton, it flows south-easterly, passing though the Town of Cache Creek. It meets the Thompson River just north from the Town of Ashcroft.

Two tributaries which are also discussed in this document are Clinton Creek which drains forom the west side and Loon Creek which drains from Loon Lake on the east side.

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## HYDROLOGY

The Bonaparte River has a drainage area of 5100 $km^2$ and a 7-day average low flow of 1.64 $m^3/s$ near Cache Creek. Mean annual flows increased from 3 $m^3/s$ just dpwnstream from Bonaparte Lake to nearly 6 $m^3/s$ near its confluence with the Thompson River.

Flows in Loon Creek (480 $km^2$ drainage area), near its confluence with the Bonaparte River, have ranged from 0.014 $m^3/s$ to 1.27 $m^3/s$ (mean monthly figures). The annual mean flow is 0.54 $m^3/s$. Loon Lake, situated about 15 kilometers upstream from the confluence, has a retention time of about 15 years.

Clinton Creek (250 $km^2$ drainage area) has a mean flow of 0.34 $m^3/s$ as measured near its confluence with the Bonaparte River.

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## WATER USES

The Bonaparte River and its tributaries are important rainbow trout habitat. A dam, located three kilometers upstream from the Thopmpson River confluence, prevents all species of salmon from reaching the upper 140 kilometers of mainstem and tributary Bonaparte drainage to spawn. Before the now unused dam was built, the Bonaparte River had salmon populations in its upper reaches.

Major primary-contact recreational use in the watershed is made of Loon Lake, which has a Provincial Park situated on its shores. The lake has about 250 cottages and eight resorts along its northern shore.

Water in Clinton Creek, Loon Lake and the Bonaparte River is used for irrigation and domestic water supplies. For irrigation on a yearly basis, approximately 7560 $dam^3$ is licensed from the Bonaparte River, 1000 $dam^3$ is licensed from Clinton Creek and 1265 $dam^3$is licensed from Loon Creek. For domestic water supplies, approximately 9135 $m^3/d$ is licensed from the Bonaparte River, 1570 $m^3/d$ is licensed from Clinton Creek and 175 $m^3/d$ from Loon Creek.

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## WASTE DISCHARGES

Two refuse sites are located in this sub-basin, as well as one fish hatchery and two municipal sewage treatment facilities. The municipal sewage facilities discharge secondary-treated effluent, while the fish hatchery has a settling basin (*i.e.* primary treatment). Diffuse sources of contaminants, mainly cattle wastes, can cause degradation of nearby watercourses.

The refuse site operated by the Village of Ashcroft is well removed from watercourses, therefore its leachate is not a major concern. The refuse site near Clinton is over one kilometer from Clinton Creek. Due to the small volumes of waste, the arid climate and the distance to the creek, leachate is not a problem for the creek.

The fish hatchery, located adjacent to Loon Creek, discharges flow-through water to the creek following treatment in a setling basin. No significant problems related to this operation have been apparent according to monitoring since the settling basin was installed.

The Village of Clinton uses a lagoon system to provide secondary treatment to domestic wastewater before discharge to Clinton Creek. Calculations based upon effluent flows and quality, and measurements going from upstream to downstream in Clinton Creek, have shown that values of fecal coliforms, ammonia, suspended solids and total phosphorus can increase appreciably in the creek. These increases can affect downstream water users. Modifications to the existing lagoon system are being considered.

The Village of Cache Creek uses an activated sludge plant to provide secondary-treatment to domestic wastewater which is then discharged to the Bonaparte River. Calculations based upon effluent flows and quality, and measurements going in a downstream direction in the Bonaparte River, have shown increased values of fecal coliforms, ammonia and total phosphorus in the river. These increases could affect downstream water users. The Village of Ascroft, which takes its water from the Thompson RIver downstream from the Bonaparte River, and the South Central Health Unit, both have expressed concern over a proposal to stop effluent disinfection at Cache Creek. The proposal to stop effluent disinfection arose from concerns expressed by the BC Fisheries Branch about residual chlorine in the effluent and it potential toxicity to fish in the Bonaparte River.

Cattle located in the Bonaparte basin can influence phosphorus, ammonia, $BOD_5$ and fecal coliform concentrations in the Bonaparte River and its tributaries. Increases in these characteristics have been measured in the basin where no point discharges occur, but where cattle are located.

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**WATER QUALITY**

The Bonaparte River was moderately to well buffered to acidic discharges, was of moderate hardness and had some high values of total copper, iron, lead and total phosphorus. High metal values here and throughout the watershed are believed to be natural. Ammonia values increased along the length of the river but did not affect aquatic life. Dissolved oxygen and percent saturation values varied over a wide range, possibly causing stress to aquatic life. Some suspended solids values, suspected to be naturally occurring, were so high at times that they exceeded certain general criteria for protection of aquatic life.

Clinton Creek was highly buffered to acidic discharges, would be classed as having hard water and historically had some high total copper, iron, lead and total phosphorus values. Dissolved oxygen values generally have met criteria for the protection of aquatic life. The suspended solids in the creek were within most general criteria for protection of aquatic life. Some fecal coliform values in the creek were so high that drinking water supplies likely would require complete treatment.

Loon Lake was mesotrophic or possibly eutrophic. It had high phosphorus and nitrogen values. It was highly buffered to acidic discharges, had hard water which is classified as being poor for a domestic water supply, but had low metal levels. Dissolved oxygen levels met criteria for protection of aquatic life, except in deeper parts of the hypolimnion.

Downstream from Loon Lake, Loon Creek was highly buffered to acidic discharges. The creek would be classified as having hard water, but slightly less hard than in Loon Lake. Some values for total aluminum and iron were high and exceeded working water quality criteria to protect aquatic life. Phosphorus and nitrogen were higher in Loon Creek, downstream from Loon Lake, than in the lake itself, suggesting a source of these nutrients downstream from the lake. These higher values are not believed to have caused algal blooms, possibly due to the river velocity in this area. Dissolved oxygen and un-ionized ammonia nitrogen did not exceed criteria for the protection of aquatic life. Suspended solids levels were so low that aquatic life was afforded a moderate to high level of protection from the abrasive action of the solids. Fecal coliform values appeared to be at levels which would require at least partial treatment of the raw water before drinking, but were low enough to permit irrigation.

Water quality of Loon Creek upstream from Loon Lake could not be assessed due to only one monitoring site having been established and a paucity of data.

## PROVISIONAL WATER QUALITY OBJECTIVES

Provisional water quality objectives are proposed for Clinton Creek, Loon Creek, Loon Lake and the Bonaparte River. The objectives are based on working criteria for water quality and on available data on ambient water quality, waste discharges, water uses, river flows and limnological characteristics. The objectives will remain provisional until receiving water monitoring programs provide adequate data and the Ministry has established approved water quality criteria for the characteristics of concern.

The objectives can be considered as policy guidelines for resource managers to protect water uses in the specified water bodies. For example, they can be used to draw up waste management permits and plans, regulate water use or plan fisheries management. They can also provide a reference against which the state of water quality in a particular water body can be checked.

Water quality objectives have no legal standing and their direct enforcement would not be practical. This would be due to the difficulty of accurately measuring contaminants in receiving water and attributing the contamination exceeding the objective to particular sources for legal purposes, and thus of proving violations and their causes. Hence, although water quality objectives should be used when determining effluent permit limits, they should not be incorporated as part of the conditions in a waste management permit.

Depending on the circumstances, water quality objectives may already be met in a water body, 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 man's activity, now and in the future.

Designated water uses include aquatic life, wildlife, livestock, irrigation and drinking water supply. These uses apply to Clinton Creek, the Bonaparte River and Loon Creek between Loon Lake and its confluence with the Bonaparte River. These same uses are designated for Loon Creek between Loon Lake and Upper Loon Lake, with the exception of drinking water. In addition, recreation is designated as a use in the Bonaparte River. The designated uses for Loon Lake are primary-contact recreation, drinking water, aquatic life and wildlife. Where drinking water is a designated use, the level of treatment required prior to use may vary, according to the water body.

Three different objectives are proposed for dissolved oxygen in streams, to protect spawning and rearing habitats for trout and salmon. Each objective is dependent upon the life stage (*e.g.* egg, alevin or fry) of the affected fish. Dissolved oxygen levels have occasionally not met the proposed objectives in Clinton Creek, Loon Lake or the Bonaparte River.

An objective for dissolved oxygen for Loon Lake is also proposed. This is a long-term objective, which presently is not always achieved. It has been proposed on the assumption that some efforts will be made to control the upstream source of nutrients to the lake, and that management options within the lake itself, such as aeration, may also be undertaken. A complementary objective for phosphorus has not been proposed. Data are needed on phosphorus concentrations at spring overturn to delineate the trophic status of the lake, and to help in recommending future lake management strategies.

Where treated sewage is discharged, objectives have been proposed for pH, total chlorine residual, suspended solids, turbidity, un-ionized ammonia nitrogen, nitrite nitrogen, periphyton chlorophyll-*a* and fecal coliforms. The pH objective is proposed to help control the amount of un-ionized ammonia (and resulting toxicity) potentially present at any temperature. Total chlorine residual objectives are proposed to prevent toxicity to fish in the receiving water, following chlorination to to reduce fecal coliform concentrations. These proposed objectives are presently met. Fecal coliform objectives are proposed to protect the health of downstream water users. These are not always met in Clinton Creek, Loon Creek or the Bonaparte River. Toxicity due to un-ionized ammonia or nitrite can be a concern downstream from sewage treatment works. However, toxicity due to un-ionized ammonia, nitrite or chlorine residual has not been a reported problem in Clinton Creek or the Bonaparte River. Periphyton chlorophyll-*a* objectives have been proposed as a measure of algal growth, so that excessive growth will not occur which would impair use. These proposed objectives are generally met, although they are a long-term goal in Clinton Creek.

Objectives have been proposed for suspended solids to prevent possible physical damage to aquatic life. Objectives for turbidity are meant to protect drinking water use and address the effect of light attenuation on aquatic life. The Clinton lagoons, due to low dilution and significant algal growths, can, under certain conditions, increase suspended solids concentrations in Clinton Creek by nearly the objective level. No such increases in suspended solids have been noted downstream from the Cache Creek STP discharge in the Bonaparte River. However, upsets can occur in activated sludge sewage treatment plants which can result in the discharge of excessive quantities of suspended solids. Therefore objectives for suspended solids are proposed to address these possibilities. An objective for suspended solids also has been proposed for Loon Creek, due to the possible input of solids from the fish hatchery settling basin. These objectives presently are met.

An objective has been proposed for dissolved solids in Clinton Creek, since the creek has high background values which could be increased considerably due to the lack of dilution available in the creek. The proposed objective has always been achieved in the past.

Provisional objectives for fecal coliforms vary according to whether irrigation, recreation or drinking water is the most sensitive designated use. Objectives may appear as a geometrical mean, a 90th percentile value or a maximum value, depending on water use and the degree of treatment required by the water user.

Should a development be proposed in the future for a watershed where provisional objectives do not exist for the characteristics of concern, the designated water uses should be protected while objectives are developed for those characteristics. Table 1 summarizes designated water uses and provisional water quality objectives for water courses where these have been proposed.

**MONITORING RECOMMENDATIONS**

Several monitoring programs have been proposed ( Table 2), some dealing with verifying the proposed water quality objectives and others to aid ion the development of further objectives. Appropriate monitoring of waste discharges should be conducted at the same time as receiving water monitoring. The recommended monitoring is based upon technical considerations. and actual programs will depend on budget allocations and project priorities.

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**TABLES**

**Table 1. Provisional Water Quality Objectives for the Bonaparte sub-basin**

<table>
<tr><th>Water bodies</th><th>Bonaparte River</th><th>Clinton Creek</th><th>Loon Creek</th><th>Loon Lake</th></tr>
<tr><td rowspan="2">Designated water uses</td><td>Recreation</td><td colspan="2">not applicable</td><td rowspan="2">drinking water, aquatic life, wildlife, recreation</td></tr>
<tr><td colspan="3">drinking water (complete treatment), aquatic life, wildlife, livestock, irrigation</td></tr>
<tr><td>fecal coliforms near water intakes</td><td colspan="3">not applicable</td><td>less than or equal to 10 MPN/100 mL, 90th percentile</td></tr>
<tr><td>fecal coliforms at bathing beaches</td><td colspan="3">not applicable</td><td>less than or equal to 200 MPN/100 mL, geometric mean<br>less than or equal to 400 MPN/100 mL, 90th percentile</td></tr>
<tr><td>fecal coliforms elsewhere</td><td colspan="3">less than or equal to 100 MPN/100 mL, 90th percentile</td><td>not applicable</td></tr>
<tr><td>suspended solids</td><td colspan="3">10 mg/L maximum increase when upstream is less than or equal to 100 mg/L</td><td>not applicable</td></tr>
</table>

| | | | | |
|---|---|---|---|---|
| | 10% maximum increase when upstream is greater than 100 mg/L | | | |
| turbidity | 5 NTU maximum increase when upstream is less than or equal to 50 NTU<br>10% maximum increase when upstream is greater than 50 NTU | | | |
| dissolved solids | not applicable | 500 mg/L maximum | not applicable | |
| total chlorine residual | 0.002 mg/L maximum | | not applicable | |
| un-ionized ammonia | less than or equal to 0.007 mg/L average<br>0.03 mg/L maximum | | | not applicable |
| nitrite | less than or equal to 0.02 mg/L maximum<br>0.06 mg/L maximum | | not applicable | |
| periphyton chlorophyll-*a* | less than 50 $mg/m^2$ average | less than 100 $mg/m^2$ or 20% maximum increase, whichever is greater | not applicable | |
| pH | 6.5 to 8.5 except 6.5 to 9.0 below Cache Creek | 6.5 to 8.5 | 6.5 to 9.0 | not applicable |
| dissolved oxygen | 11.2 mg/L minimum when eggs are in 'eye' to hatch stage | | | 5.0 mg/L minimum in hypolimnion (minimum 5 m above sediment-water interface) |
| | 8.0 mg/L minimum when fish eggs and/or larvae or alevin are present | | | |
| | 7.75 mg/L minimum at all other times | | | |

***Note: The objectives apply to discrete samples from all parts of the waterbodies, except from initial dilution zones of effluents. These excluded initial dil;ution zones are defined as extending up to 100 m downstream from a discharge, and occupying no more than 50% of the stream width around the discharge point, from the bed of the stream to the surface. These excluded initial dilution zones in lakes are defined as extending up to 100 m horizontally in all directions, but not to exceed 25% of the width of the waterbody.***
***1. For fecal coliforms the geometric mean and the 90th percentile are calculated from at least five samples taken weekly in a period of 30 days. The recreation objectives (200-400/100 mL) apply during the recreation season and the drinking water objective (10/100 mL applies year round.***
***2. For suspended solids, turbidity and periphyton chlorophyll-a the increase (in mg/L, NTU or %) 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 levels.***
***3. Since the total chlorine residual objective is less than the minimum detectable concentration, it will be necessary to estimate the receiving water concentration using effluent load and stream flow.***
***4. The average ammonia and nitrite nitrogen levels are calculated from at least five weekly samples taken in a period of 30-days.***
***5. pH measurements can be made in-situ, but must be confirmed in the laboratory if the objective is exceeded. The objective of 6.5 to 8.5 applies to the Bonaparte River above Cache Creek, while the objective of 6.5 to 9.0 applies to the Bonaparte River downstream from Cach Creek.***
***6. The periphyton chlorophyll-a average is calculated from at least five randomly located samples from natural substrates at each site on any one sampling date.***

**Table 2. Recommended Water Quality Monitoring for the Bonaparte sub-basin**

| **Sites** | **Frequency and Timing** | **Characteristics to be Measured** |
|---|---|---|
| **Loon Lake (mid lake)** | **July and August, yearly spring overturn, for at least 3 years** | **dissolved oxygen and temperature profiles, total and orthophosphate phosphorus, secchi disc** |
| **Loon Lake (bathing beaches and water intakes)** | **five weekly samples in a 30-day period, for at least one year** | **fecal coliforms** |

| | | |
|---|---|---|
| Loon Creek (site 0600336) | March/April, July/August, October, yearly | dissolved oxygen, pH, temperature, total and dissolved aluminum, iron and manganese, nitrite and ammonia nitrogen, fecal coliforms |
| Loon Creek (u/s and d/s from the hatchery) | March/April, July/August, yearly | suspended solids, turbidity |
| Loon Creek (u/s from Loon Lake) | 3 times between April and October for at least 3 years | pH, ammonia, nitrite and nitrate nitrogen, temperature, fecal coliforms, dissolved oxygen, dissolved and suspended solids, turbidity, total and total dissolved phosphorus |
| Clinton Creek (sites 0600009, 0600505)<br>Bonaparte River (sites 0600008, 0600508) | five weekly samples in a 30-day period during each of freshet and low flow for at least one year, spot checks yearly thereafter | pH, ammonia, nitrite and nitrate nitrogen, temperature, fecal coliforms, dissolved oxygen, dissolved and suspended solids, turbidity, residual chlorine (estimated), periphyton chlorophyll-*a* |
| Clinton Creek (site 0600503)<br>Bonaparte River (site 0600506) | | suspended solids, turbidity |
| Bonaparte River (site 0600329) | monthly for at least 5 years | pH, temperature, fecal coliforms, dissolved and suspended solids, TAC colour, turbidity, dissolved oxygen, total hardness, total phosphorus, orthophosphate, periphyton chlorophyll-*a* (open water months), ammonia, nitrite and nitrate nitrogen |
| Clinton Creek, Loon Creek, Bonaparte River, Hat Creek (selected | weekly, April through mid-June for one year | special study on effects of cattle wastes, pH, temperature, dissolved oxygen, |

| | | |
|---|---|---|
| **sites)** | | **orthophosphate, total phosphorus, chlorophyll-*a*, nitrite, nitrate, ammonia and kjeldahl nitrogen, turbidity, suspended solids, fecal coliforms, flow** |

***Sampling may need to be increased to check objectives, depending on circumstances.***

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