

## Water Quality Objectives for Mill Bay and Tributary Streams



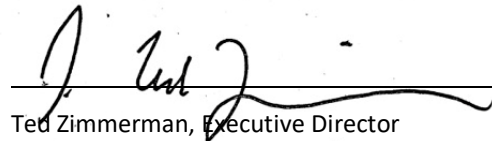
The Water Quality Objectives (WQOs) for Mill Bay represent a collaborative effort of the Cowichan Valley Regional District, Malahat First Nation, Shawnigan Watershed Roundtable, Shawnigan Research Group, Shawnigan Basin Society, Cowichan Land Trust, Environment Canada (Canadian Shellfish Sanitation Program), the many volunteers and concerned and engaged citizens of Mill Bay, Malahat and Shawnigan Lake, Mosaic Forest Management (Island Timberlands and Timberwest), Island Health, Department of Fisheries and Oceans with the Province of British Columbia (B.C.). The WQOs represent benchmarks to inform the management of water quality in Mill Bay and protect the water values for the benefit of all.

The Mill Bay WQO Policy Report may be updated as more information becomes available.

While efforts will be made to continue monitoring the water quality of Mill Bay, approval of the Mill Bay WQOs does not imply any obligation to conduct monitoring by either B.C., or partners listed above.

Once approved, the Mill Bay WQOs constitute formal provincial policy and must be considered in any decision affecting water quality made within the Ministry of Environment and Climate Change Strategy. The policy may also be used by other agencies to inform resource management or land use decisions.

Signed on behalf of the Province of British Columbia:



Ted Zimmerman, Executive Director

Date:

March 7, 2023

Water Protection and Sustainability Branch

The **Water Quality Objective Series** is a collection of British Columbia (B.C.) water quality objectives reports. Water quality objectives are developed for specific waterbodies to promote the protection and stewardship of provincially significant water resources. Once approved, water quality objectives constitute Provincial policy and are considered in resource management decisions affecting water quality. For additional information visit: <https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-objectives>.

**ISBN:** 978-1-0399-0009-7

**Citation:**

Province of British Columbia. 2023. Water Quality Objectives for Mill Bay and Tributary Streams. Water Quality Objective Series, WQO-08. Prov. B.C., Victoria B.C.

**Cover Photo:** Rosie Barlak, B.C. Ministry of Environment and Climate Change Strategy.

**Acknowledgements**

The Water Quality Objectives presented are based on the report *Cowichan Bay and Tributaries: Water Quality Assessment and Recommended Objectives*. Special thanks are extended to those who contributed to that work including: the Cowichan Valley Regional District, Malahat First Nation, Shawnigan Watershed Roundtable, Shawnigan Research Group, Shawnigan Basin Society, Cowichan Land Trust, Environment Canada (Canadian Shellfish Sanitation Program), the many volunteers and concerned and engaged citizens of Mill Bay, Malahat and Shawnigan Lake, Mosaic Forest Management (Island Timberlands and Timberwest), Island Health, Department of Fisheries and Oceans, and the groundwater and mapping staff from the Ministry of Forests, Lands and Natural Resource Operations and Ministry of Environment and Climate Change Strategy.

© Copyright 2023

## **EXECUTIVE SUMMARY**

Water quality objectives were developed to promote the protection of water quality values associated with the marine waters of Mill Bay and its freshwater tributaries. The marine waters are to be protected for recreational and cultural uses with an additional goal of improving water quality to allow for shellfish harvesting in the future. In the freshwater tributaries, provisional water quality objectives are provided to ensure protection of source drinking water, aquatic life, wildlife, irrigation, and recreational and cultural uses. The water quality objectives are summarized in the following tables.

**Water Quality Objectives for Mill Bay**

<b>Variable</b>	<b>Objective Value</b>	<b>Notes</b>
Enterococci – recreational and cultural uses	≤35 CFU <u>or</u> MPN/100 mL	Geometric mean of at least 5 weekly samples collected in a 30-day period.
	≤70 CFU <u>or</u> MPN/100 mL	Single sample maximum allowable concentration.
Fecal coliforms – bivalve shellfish harvesting	≤14 MPN/100 mL	Median or geometric mean of at least 5 weekly samples collected in a 30-day period.
	≤43 MPN/100 mL	Maximum allowable concentration for 90% of results within a sampling period. Sampling periods require a minimum of 10 results.

**Provisional Water Quality Objectives for the Freshwater Tributaries to Mill Bay**

<b>Variable</b>	<b>Objective Value</b>	<b>Notes</b>
Dissolved oxygen – aquatic life	≥8 mg/L	Average of 5 weekly samples collected in a 30-day period.
	≥5 mg/L	Minimum concentration measured at any given time.
Turbidity – drinking water	<5 NTU	Maximum, October 1 – April 30.
	<2 NTU	Maximum, May 1 – September 30.
Total suspended solids	≤7 mg/L	Average of 5 weekly samples collected in a 30-day period.
	≤27 mg/L	Maximum concentration measured at any given time.
Total phosphorus – aquatic life	≤5 µg/L	Average of 5 monthly measurements, May – September. No more than 20% of results to exceed this value.
	≤10 µg/L	Maximum allowable concentration.
Total arsenic	≤5 µg/L	Maximum concentration measured at any given time.
Total copper	≤2 µg/L	Average of 5 weekly samples collected in a 30-day period.
	≤4 µg/L	Minimum concentration measured at any given time.
Total iron	1 mg/L	Maximum concentration measured at any given time.
Total zinc	≤7.5 µg/L	Average of 5 weekly samples collected in a 30-day period.
	≤33 µg/L	Maximum concentration measured at any given time.
<i>Escherichia coli</i>	≤10 CFU/100 mL	90 <sup>th</sup> percentile of 5 weekly samples collected in a 30-day period.

## **CONTENTS**

EXECUTIVE SUMMARY .....	III
1. INTRODUCTION .....	1
2. SITE DESCRIPTION .....	1
3. WATER USES AND VALUES .....	1
4. WATER QUALITY OBJECTIVES .....	2
4.1 Mill Bay .....	2
4.1.1 Microbiological Indicators .....	2
4.2 Tributary Streams .....	3
4.2.1 Dissolved Oxygen .....	3
4.2.2 Turbidity .....	3
4.2.3 Total Suspended Solids .....	3
4.2.4 Total Phosphorus .....	4
4.2.5 Total Arsenic .....	4
4.2.6 Total Copper .....	4
4.2.7 Total Iron .....	4
4.2.8 Total Zinc .....	4
4.2.9 Microbiological Indicators .....	5
5. MONITORING RECOMMENDATIONS .....	5
6. REFERENCES .....	7

## **FIGURES**

Figure 1: Map of Mill Bay and surrounding area .....	2
--	---

## **TABLES**

Table 1. Recommended water quality monitoring program for Mill Bay .....	6
--	---

## **1. INTRODUCTION**

Water quality objectives (WQO) are developed as Provincial policy statements for specific waterbodies to promote the protection and stewardship of B.C.'s water resources. WQOs define conditions that represent levels of low risk to water values. They formalize expectations with respect to water quality for a given waterbody and are used to inform resource management decisions in the natural resource sector.

WQOs are established on a priority basis for waterbodies (fresh, estuarine, marine) of regional, provincial, inter-provincial, and international significance to protect, manage, and conserve B.C.'s water resources. WQOs are set with the goal of protecting water values by maintaining existing water quality, improving existing water quality, or protecting water quality for a specific use.

WQOs are based on water quality guidelines, or similar information, and water quality assessments which consider the characteristics of the waterbody. These characteristics include: the ambient water quality and its assimilative capacity; the aquatic life and wildlife, and its habitat; the hydrology; the sediments; the potential contaminant loadings from point and non-point source waste discharges; and the cultural and social values associated with a waterbody.

Once approved, WQOs are considered Provincial policy and are considered in decisions affecting water quality. This document presents WQOs for the marine waters of Mill Bay and its freshwater tributary streams. These WQOs are based on the document *Mill Bay and Tributaries: Water Quality Assessment and Recommended Objectives* (Smorong and Phippen 2021); readers should refer to this report for detailed water quality information on this area.

## **2. SITE DESCRIPTION**

Mill Bay is located approximately 20 km south of Duncan, B.C., on Vancouver Island and is part of the traditional lands of the Malahat First Nation. Shawnigan Creek is the main tributary to Mill Bay and its watershed includes Shawnigan Lake, a drinking water source with high recreational and fisheries values. The marine waters of Mill Bay contain shellfish beds, which are closed for harvest due to fecal contamination, and recreational fishing and swimming/diving areas. Mill Bay is also used for boating, with a marina located within the Bay and the Mill Bay Nature Park located on the northern end of the Bay.

The Shawnigan community watershed makes up a significant portion of the total drainage area in the watershed and provides drinking water to local communities near Shawnigan Lake. The Shawnigan community watershed was designated as a community watershed in 2000, as defined under the *Forest Practices Code of British Columbia Act*. This designation was grand-parented and continued under the *Forest and Range Practices Act* (FRPA) in 2004.

The primary concerns with respect to water quality include contamination associated with urban and rural development and agricultural activities (such as runoff, treated sewage, septic fields, fertilizers, and pesticides), commercial and industrial land use, and recreational uses.

## **3. WATER USES AND VALUES**

The water uses and values to be protected in Mill Bay include aquatic life, wildlife, recreational and cultural uses, and shellfish harvesting. The harvest of shellfish in the bay is currently closed due to sanitary contamination. Indigenous nations have expressed a desire to improve water quality to regain their traditional community practice of harvesting shellfish for sustenance and cultural purposes within their territory.

The water uses and values to be protected in the freshwater tributaries to Mill Bay are drinking water, aquatic life, irrigation, recreational uses, and wildlife.

Given the current level of development in this area, and the potential for future development, the goal of these WQOs is to protect current water values and uses and improve water quality to allow the desired uses in the future, where appropriate (e.g., bivalve shellfish harvesting).



Figure 1: Map of Mill Bay and surrounding area.

## 4. WATER QUALITY OBJECTIVES

The assessment of water quality in Mill Bay and its freshwater tributaries (Smorong and Phippen 2021) found that the water quality is generally good. Bacteriological contamination was identified as a concern in both in the marine waters and the freshwater tributaries. Water temperature occasionally exceeded the water quality guidelines (WQGs) at the outlet of Shawnigan Lake, while the freshwater tributaries to Mill Bay occasionally had elevated levels of turbidity, total suspended solids, and metals.

### 4.1 Mill Bay

#### 4.1.1 Microbiological Indicators

Fecal contamination of Mill Bay is a primary water quality concern. The very limited data available showed the potential for fecal contamination in Mill Bay. WQOs for microbiological indicators are established to ensure protection of human health in Mill Bay with respect to primary contact (full immersion with likelihood of swallowing water) and secondary contact (only limbs immersed with low risk of swallowing water) through recreational and cultural activities. As the area is currently closed to bivalve shellfish harvest (Closure 19.3 West Saanich Inlet), a long-term WQO is also provided with the goal of eventually removing this closure.

The preferred indicator organism for the protection of recreational uses in marine waters is enterococci. **The WQO for enterococci is a geometric mean of  $\leq 35$  CFU or MPN/100 mL, based on 5 weekly samples collected over a 30-day period. The single sample maximum allowable concentration is 70 CFU or MPN/100 mL.** The units reported, either colony-forming units (CFU) or most probable number (MPN),

depends on the analytical method used (membrane filtration or multiple tube fermentation, respectively). Either method is acceptable.

To support the long-term goal of allowing bivalve shellfish harvesting in Mill Bay, a WQO for fecal coliforms is defined based on the requirements of the Canadian Shellfish Sanitation Program (CSSP) (Canadian Food Inspection Agency 2012). **The WQO for fecal coliforms is a median or geometric mean concentration of  $\leq 14$  MPN/100 mL, based on 5 weekly samples collected over a 30-day period, with a 90<sup>th</sup> percentile concentration of  $\leq 43$  MPN/100 mL.** Note that the CSSP specifies that multiple-tube fermentation is the analytical method to be used with results reported as MPN.

## **4.2 Tributary Streams**

Provisional WQOs are provided for the freshwater tributaries to Mill Bay to protect the water values of both the tributaries themselves and Mill Bay. These WQOs are provisional given the limited data available and may be revised in the future. The WQOs apply to all freshwater tributaries and are largely based on the WQOs for the Cowichan River and Koksilah River (see Obee and Epps 2011).

### **4.2.1 Dissolved Oxygen**

Dissolved oxygen (DO) is an important characteristic of aquatic habitats and crucial to the survival of aquatic life. The limited data available met the B.C. aquatic life WQGs and to help ensure conditions remain healthy, a provisional WQO for DO is defined. **The provisional WQO for DO is an average concentration  $\geq 8$  mg/L based on a minimum of 5 weekly samples collected over a 30-day period, with an instantaneous minimum of 5 mg/L DO at any given time.**

### **4.2.2 Turbidity**

Turbidity is a concern with respect to drinking water quality and risks to human health. Turbidity can interfere with disinfection, provide a medium for microbial growth, and indicate the presence of pathogens. The freshwater tributaries to Mill Bay have occasionally exceeded the Cowichan/Koksilah River WQO levels in the past.

To protect water quality entering Mill Bay, the Mill Bay tributaries should be assessed relative to the objectives developed for the Cowichan and Koksilah Rivers. **The provisional WQO for turbidity is a maximum of 5 NTU from October through April, and a maximum of 2 NTU from May through September.** The need for a WQO emphasizes the importance of adequate treatment of source water to minimize risks to human health.

### **4.2.3 Total Suspended Solids**

Total suspended solids (TSS) are typically correlated with turbidity; the TSS WQO for the Cowichan and Koksilah rivers (Obee and Epps 2011) is an average concentration of 7 mg/L and a maximum concentration of 27 mg/L. These WQOs were based on the observation that high concentrations of TSS occur occasionally and are meant to apply to situations which may have been triggered by human activities (Obee and Epps 2011).

The average TSS concentrations exceeded the Cowichan/Koksilah WQO at most locations during fall sampling periods. For this reason, a provisional TSS WQO for the Mill Bay tributaries is provided. **The provisional WQO is an average TSS concentration of  $\leq 7$  mg/L, based on a minimum of 5 weekly samples collected in a 30-day period, and a maximum concentration of 27 mg/L at any one time.**



#### **4.2.4 Total Phosphorus**

On Vancouver Island, phosphorus concentrations are a concern during summer low flow periods when elevated levels are most likely to lead to the deterioration of aquatic habitats and the quality of source drinking water. The limited data available showed elevated total phosphorus levels in the tributaries to Mill Bay which exceeded guidance developed specifically for Vancouver Island streams (British Columbia Ministry of Environment, 2014). A provisional WQO is therefore defined to protect the values of the Mill Bay tributary streams. **The provisional WQO is an average total phosphorus concentration of  $\leq 5 \mu\text{g/L}$ , based on a minimum of 5 monthly measurements from May through September, and a maximum concentration of  $10 \mu\text{g/L}$  at any time.** No more than 20% of individual measurements should exceed  $5 \mu\text{g/L}$ .

#### **4.2.5 Total Arsenic**

The B.C. total arsenic WQG for the protection of aquatic life is a maximum concentration of  $5 \mu\text{g/L}$  at any time. This level was exceeded once in the available data and coincided with very high values for several parameters that were not consistent with other results (see Smorong and Phippen 2021). All other results were well below the WQG value. Despite this, **a provisional WQO for total arsenic of  $5 \mu\text{g/L}$ , maximum concentration at any time**, is proposed and additional monitoring should be conducted to confirm the need for this WQO.

#### **4.2.6 Total Copper**

The total copper WQO for the Cowichan and Koksilah rivers is an average concentration of  $2 \mu\text{g/L}$ , based on 5 weekly measurements collected in a 30-day period, and a maximum of  $4 \mu\text{g/L}$  at any one time (Obee and Epps 2011).

Total copper concentrations in the freshwater tributaries to Mill Bay occasionally exceeded both the mean and maximum WQOs for the Cowichan and Koksilah rivers, based on samples collected during the fall months. Some exceedances were influenced by very high results measured on one sampling date that were not consistent with other data (see Smorong and Phippen 2021), and additional data should be collected to confirm this assessment. **The provisional WQO for total copper is an average concentration of  $\leq 2 \mu\text{g/L}$ , based on a minimum of 5 weekly measurements, and a maximum concentration of  $10 \mu\text{g/L}$  at any time.** It should be noted that the current B.C. approved copper WQG is based on the dissolved fraction and this WQO may be revised on the future.

#### **4.2.7 Total Iron**

The B.C. total iron WQG for the protection of aquatic life is a maximum concentration of  $1 \text{ mg/L}$  at any time. This level was exceeded once in the available data and coincided with very high values for several parameters that were not consistent with other results (see Smorong and Phippen 2021). All other results were well below the WQG value. Despite this, **a provisional WQO for total iron of  $1 \text{ mg/L}$ , maximum concentration at any time**, is proposed and additional monitoring should be conducted to confirm the need for this WQO.

#### **4.2.8 Total Zinc**

The total zinc WQO for the Cowichan and Koksilah rivers is an average concentration of  $7.5 \mu\text{g/L}$ , based on 5 weekly samples in 30 days, and a maximum concentration of  $33 \mu\text{g/L}$  at any time (Obee and Epps 2011).

Total zinc concentrations in the tributaries to Mill Bay were below the maximum WQO, but the average WQO was exceeded at some sites. **Therefore, the following provisional WQO for total zinc is proposed:**

an average concentration of  $\leq 7.5 \mu\text{g/L}$ , based on a minimum of 5 weekly measurements, and a maximum concentration of  $33 \mu\text{g/L}$  at any time. Additional monitoring should be conducted to confirm the results presented in Smorong and Phippen (2021).

#### 4.2.9 Microbiological Indicators

Smorong and Phippen (2021) identified issues with microbiological contamination in the freshwater tributaries to Mill Bay and concluded these streams are contributing microbiological indicators at concentrations above the shellfish harvesting guidelines to the marine waters. The available data exceeded the Cowichan and Koksilah rivers WQO for *Escherichia coli* (90<sup>th</sup> percentile  $\leq 10/100 \text{ mL}$ ) at all sites. Recreational water users should also use caution given the extensive recreation guideline exceedances. The presence of domestic water licenses on these tributaries emphasizes the need for consideration of drinking water guidelines and the need for disinfection prior to consumption, where applicable. For these reasons, a provisional WQO for *E. coli* is recommended. **The WQO is a 90<sup>th</sup> percentile for *E. coli* of  $\leq 10/100 \text{ mL}$  (MPN or CFU), based on a minimum of 5 weekly samples collected within a 30-day period.**

### 5. MONITORING RECOMMENDATIONS

Regular water quality monitoring is essential for assessing the attainment of WQOs. The recommended water quality monitoring program for Mill Bay and its tributaries is summarized in Table 1. Monitoring should occur, at a minimum, once every 5 years depending on available resources and changes to land use.

Monitoring efforts are to consist of at least 5 samples collected within a 30-day period during the summer dry period (between August and September) and the fall first-flush period (October and November) at all sites. In this way, the two critical periods (minimum dilution during low-flow and maximum turbidity during the first fall rains) will be monitored. Samples collected during the winter months should coincide with rain events whenever possible. An additional 5-in-30 monitoring period in the tributaries during spring manure spreading (March/April) may provide useful information on nutrient sources to the streams. The samples collected in the marine areas should be analyzed for microbiological parameters (enterococci and fecal coliforms) although additional analyses (e.g., metals) may be desirable if resources allow. Water samples from the tributaries should be analyzed for total and dissolved metals, water hardness, nutrients, conventional parameters, and *E. coli*.

Monthly field sampling should occur during the growing season of the freshwater tributaries to measure total phosphorous and chlorophyll *a*. Chlorophyll *a* should be measured as the biomass of *naturally growing* periphytic algae to allow direct comparison to the Cowichan and Koksilah Rivers WQO.

It is recommended that sediment sampling be included during future attainment monitoring efforts at key sites (see Smorong and Phippen 2021). Sediments provide sinks for many contaminants and may serve as a source of pollutants to the water column (MacDonald and Ingersoll 2003).

Finally, it is recommended that microbial source tracking (MST) sampling occur during future attainment monitoring, to identify sources of microbiological contaminants.

Monitoring data collected by other parties should be included to support future water quality assessments in Mill Bay and its tributaries. Any group or agency planning to monitor water quality in the Mill Bay watershed is advised to contact ENV discuss coordination with existing initiatives.

Table 1. Recommended water quality monitoring program for Mill Bay and its freshwater tributaries.

Sampling area	Timing	Parameters
Mill Bay marine areas	5-in-30 sampling summer and fall	Enterococci, fecal coliforms
Freshwater streams	5-in-30 sampling summer and fall	<b>Metals:</b> Total and dissolved metals <b>Nutrients:</b> Total P, total N, total nitrate, total nitrite <b>Conventional parameters:</b> Turbidity, TSS, temperature, DO, pH, conductivity, hardness, dissolved organic carbon <b>Microbiological:</b> <i>E. coli</i>
Freshwater streams	Monthly (growing season only)	Total phosphorus, chlorophyll <i>a</i>

## 6. REFERENCES

- British Columbia Ministry of Environment. 2014. [Phosphorus Management in Vancouver Island Streams](#). Environmental Protection Division.
- Canadian Food Inspection Agency. 2012. [Canadian Shellfish Sanitation Program – Manual of Operations](#).
- MacDonald, D.D. and Ingersoll, C.G. 2003. A guidance manual to support the assessment of contaminated sediments in freshwater, estuarine, and marine ecosystems in British Columbia. Industrial Wastes and Hazardous Contaminants Branch, Ministry of Environment, Lands, and Parks. Victoria, B.C.
- Obee, N. and Epps, D. 2011. Water Quality Assessment and Objectives for the Cowichan and Koksilah rivers. Environmental Protection Division and Environmental Sustainability & Strategic Policy Division, British Columbia Ministry of Environment, Victoria, B.C. Available online at: [https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-objectives/wqo\\_cowichan\\_koksilah\\_update.pdf](https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-objectives/wqo_cowichan_koksilah_update.pdf)
- Smorong, D. and B. Phippen. 2021. Mill Bay and Tributaries: Water Quality Assessment and Recommended Objectives. Environmental Quality Series. Prov. B.C., Victoria B.C.