Water Quality

Ambient Water Quality Objectives For The Similkameen River Okanagan Area

First Update

Overview Report

Resource Quality Section
Water Management Branch
Ministry Of Environment

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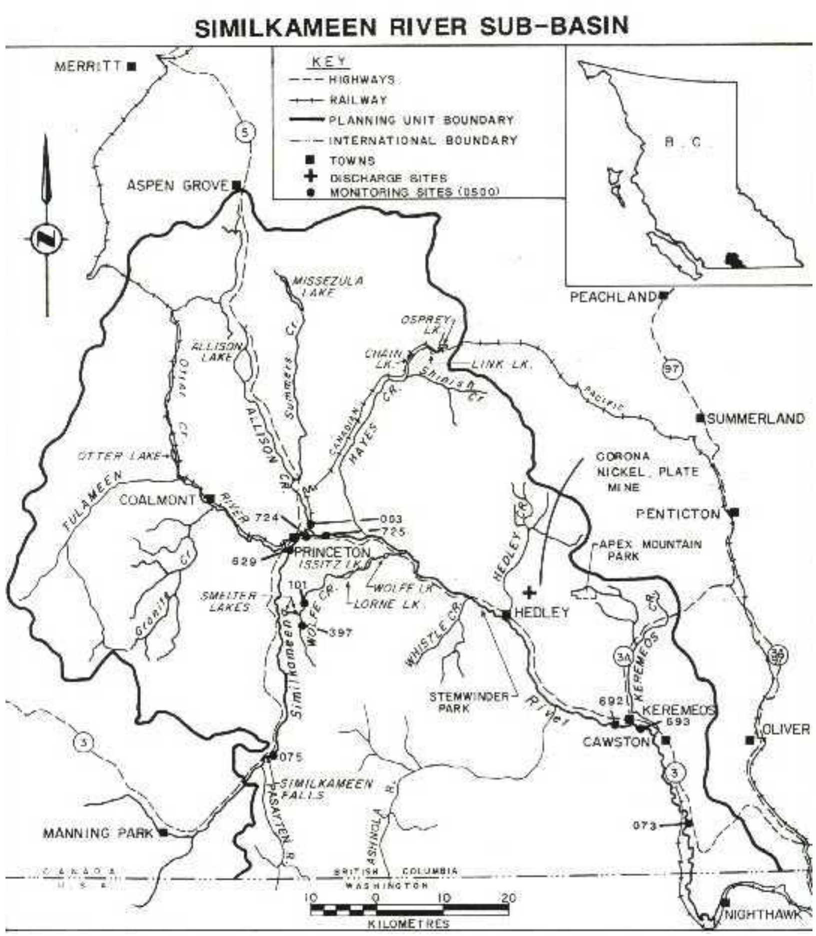
SUMMARY
Provisional water quality objectives were issued in 1985 for the Similkameen River and its major tributaries. Recent mining developments have prompted the present extension to this work and an update of provisional water quality objectives approved by the Ministry for this part of the sub-basin.

The Similkameen River and the mouth of Hedley Creek are important rainbow trout habitat. Several other fish species, including whitefish are also important to the Similkameen River.

Most of the water contamination comes from diffuse agricultural sources, although there are treated municipal sewage discharges from Princeton and Keremeos. Mining developments are designed for "zero-discharge", but there is evidence of ground water contamination from past mining operations. As a result, the contaminants of most concern in this update, which were not addressed in the previous assessment, are metals, metalloids and cyanide compounds.

Provisional water quality objectives have been set for nutrients, metals, solids, bacteriological indicators, cyanide compounds, dissolved oxygen and pH. Attainment of these objectives will protect aquatic life and irrigation supplies.

Figure 1. Similkameen River sub-basin 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).

INTRODUCTION

Provisional water quality objectives issued in 1985 for the Similkameen River and its major tributaries, based on water quality data collected up to December 1982. Recent mining developments have prompted the present extension to this work. The water quality of Hedley Creek and the Similkameen River between Stemwinder Park (just upstream from Hedley Creek) and the International Boundary was assessed by examining water quality data and effluent quality data from January 1983 to about May 1988. The purpose was to develop water quality objectives in areas where designated water uses may be threatened by a number of mining and milling operations proposed for the sub-basin. There is also a review and update of provisional water quality objectives approved by the Ministry for this part of the sub-basin in 1985. A detailed technical appendix was prepared and forms the basis for the conclusions presented in this report.

The Similkameen River flows from Manning Park, northeasterly to Princeton and then southeasterly until it crosses the International Boundary just south from Cawston (see attached Figure). Major populations centers along its length from west to east include Princeton, Hedley, Keremeos and Cawston. Hedley Creek flows southerly and meets the Similkameen River at Hedley.

HYDROLOGY

The Similkameen River has an average non-freshet base flow which increases from $2m^3/s$ above Goodfellow Creek near the eastern boundary of Manning Provincial Park, to $6m^3/s$ above the Tulameen River confluence, $10.5m^3/s$ near Hedley and $11m^3/s$ at Cawston. Freshet occurs from April through September, with average flows increasing to $40m^3/s$ above Goodfellow Creek, $130m^3/s$ at Princeton, 260 m^3/s at Hedley and 300 m^3/s at Cawston. Major tributaries to the Similkameen River in terms of low are the Pasayten and the Tulameen Rivers.

Seven day average low flows ranged from $3.11m^3/s$ to $8.34m^3/s$ in the Similkameen River at Stemwinder Park Seven-day low flows with two-and-ten-year return periods were $5.7m^3/s$ and $3.16m^3/s$, respectively. In Hedley Creek, seven-day low flows near the mouth ranged from $0.076m^3/s$ to $0.359m^3/s$, with flows for two-and-ten-year return periods of $0.176m^3.s$ and $0.078m^3/s$.

WATER USES

Fish species which occur in the Similkameen River downstream from Stemwinder Park include Rainbow trout, whitefish, prickly sculpin, longnose dace, bridgelip sucker, northern mountain sucker4, peamouth chub, northern squawfish, crappie and redside shiner. Rainbow trout use the river section form Hedley to the International boundary and the mouths of creeks as spawning areas. In Hedley Creek, the greatest density of rainbow trout is within 250 m from the mouth, In the Similkameen River, the greatest density of northern squawfish was found at the mouth of Hedley Creek.

Hedley Creek is not used for primary-contact recreation, but the Similkameen River is used for swimming (primary contact) and for canoeing, rafting, kayaking (secondary contact).

As reported in the 1985 report on this sub-basin, consumptive uses are 12917 $dam^3/year$ irrigation, 175 $dam^3/year$ mining and $785m^3/d$ drinking water in the Similkameen River and 222 $dam^3/year$ irrigation, 6.8 $dam^3/year$ mining and 680 m^3/d drinking water in Hedley Creek.

WASTE DISCHARGES

The operations within the river basin from Stemwinder Park to the International Boundary with the potential to impact the river are mining, milling or tailings reprocessing operations. The largest operation of this type, the Corona Nickel Plate Mine, is located near the headwaters of Cahill Creek, a tributary to the Similkameen. Water quality objectives were issued for Cahill creek in February 1987. These objectives should ensure that the Similkameen River, in turn, will be protected from impacts from this operation.

Three cyanide-leaching operations have been proposed along this river reach, all planning for no liquid discharge. Two of the leaching operations are to reprocess tailings currently located along the banks of Hedley Creek and the Similkameen River. Other than the inherent concern of operation using cyanide near sensitive water courses, there are concerns about the disturbances to the tailing pipes and the potential release to the watercourses of metals and solids.

The other major waste discharge along this river reach is that of tertiary-treated sewage from the Village of Keremeos to the ground about 300 m from the river. The facility has experienced maintenance problems which are being rectified.

The major input from diffuse sources of nutrient pollution has been calculated to be from cattle wastes. Specifically, increased phosphorus levels may result in algal growths, while increased fecal coliform concentrations could necessitate more elaborate water treatment for uses of drinking water.

AMBIENT WATER QUALITY

Hedley Creek had soft water with moderate buffering potential for acidic inputs while the Similkameen River water was harder and was well buffered to acidic inputs. Concentrations of metals in both waterbodies generally met water quality criteria to protect designated uses, although there were occasional higher levels in both waterbodies.

This pattern was also true for arsenic concentrations in the Similkameen River, but values in Hedley Creek met the criteria. Some thiocynate levels exceed criteria to protect raw drinking water. It is suspected that these high levels are associated with scouring of the tailings piles.

Ammonia, nitrate and nitrite concentrations in both waterbodies. met aquatic life criteria. Total phosphorus values in both Hedley Creek and the Similkameen River were high enough to cause algal growths if phosphorus were the limiting factor and bio-available. No record exists of nuisance algal growths although studies of periphyton growth are recommended.

Dissolved solids concentrations were well below water quality criteria and in both waterbodies, suspended solids concentrations were occasionally high enough to be considered a possible threat to aquatic life.

Criteria used in this assessment for dissolved oxygen were more stringent than those proposed by the Canadian Council of Resource and Environment Ministers (CCREM). the CCREM criteria allow for some impairment to fisheries resources which was deemed undesirable in these watercourses. A few dissolved oxygen concentrations in both water bodies were slightly lower than the former criteria. In Hedley Creek, fecal coliforms were low enough to permit use as a drinking water supply with disinfection alone. Levels in the Similkameen were higher, necessitating partial treatment plus disinfection.

PROVISIONAL WATER QUALITY OBJECTIVES

Provisional water quality objectives are proposed for Hedley Creek and the Similkameen River between Princeton and the International Boundary. The objectives for this stretch of the Similkameen are a blend of new values and previous values issued in 1985. The objectives are summarized in Table 1. Water quality objectives for other parts of the Similkameen River basin, which were issued in 1985, are summarized in Table 2 for the convenience of the reader.

Objectives based on working and approved criteria for water quality and on available data on ambient water quality, waste discharges, eater uses and river flows. The objectives will remain provisional until receiving water monitoring programs provide adequate data and the Ministry has established approved water quality criteria for all the characteristics of concern.

Water quality objectives have no legal standing and would not be directly enforced. The objectives are policy guidelines for resource managers to protect water uses in the specified water bodies. They will guide the evaluation of water quality, the issuing of permits, licences and orders and the management of the fisheries of the Province's land base. They also provide a reference against which the state of water quality in a particular water body can be checked and serve to make decisions on whether to initiate basin-wide quality studies.

Depending on the circumstance, 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 foreseeable future.

Both Hedley Creek and the Similkameen River are used as drinking water supplies. A water quality objective for bacteriological quality has been proposed to protect this use only for the Similkameen River since there are no anthrpogenic sources of pathogens to Hedley Creek. Related to this, an objective is proposed to protect aquatic life from excess chlorine.

Water quality objectives are proposed for suspended solids to protect gills of fish, for substrate sedimentation to protect spawning grounds and for turbidity to ensure good drinking water supplies. These characteristics may be affected by disturbance to the tailings piles.

Some residual cyanide may be present in the tailings piles. It may be released when the piles are disturbed. Cyanide will also be used in the leaching process. For these reasons, objectives are proposed for weak-acid dissociable cyanide, strong-acid dissociable cyanide plus thiocyanate and cyanates.

Several metals or metal-solids are present in high concentration in the tailings piles. It is suspected that these could be increased in both waterbodies when the tailings piles are disturbed. For these reasons, water quality objectives have been proposed for arsenic, aluminum, chromium, copper, iron, lead, manganese, mercury, molybdenum, nickel, uranium and zinc.

These are existing sewage discharges to the ground near the Similkameen River, non-point sources of nutrients and BOD located near the Similkameen River and potential inputs of nutrients from the tailings piles. Therefore water quality objectives are proposed for ammonia and periphyton in Hedley Creek and the Similkameen River and for dissolved oxygen in the Similkameen River only. An objective is proposed for pH in both waterbodies since alkaline solutions may be caused.

MONITORING RECOMMENDATIONS

We recommend that monitoring be carried out for at least three years to check how well the objectives are being met. The extent of monitoring after that will depend on results as well as on regional priorities and available funding.

TABLES

Table 1 Provisional Water Quality Objectives for Hedley Creek and the Similkameen River Downstream from Princeton

Water Bodies	Similkameen River from Princeton to the International Border	Hedly Creek
Designated Water Uses	drinking water, aquatic life, wildlife, recreation, livestock, irrigation	drinking water, aquatic life, wildlife, livestock, irrigation
fecal coliforms	less than or equal to 10/100 mL 90th percentile	not applicable
Escherichia coli	less than or equal to 10/100 mL 90th percentile	not applicable
enterococci	less than or equal to 3/100 mL 90th percentile	not applicable
total chlorine residual	0.002 mg/L maximum	not applicable
weak acid dissociable cyanide	less than or equal to 0.005 mg/L average 0.010 mg/L maximum	less than 0.005 mg/L average 0.010 mg/L maximum or no significant increase from u/s if u/s is greater
strong acid dissociable cyanide plus thiocyanate	0.20 mg/L maximum	0.20 mg/L maximum or no significant increase from u/s if u/s is greater
cyanates	0.45 mg/L maximum	0.45 mg/L maximum or no significant increase from u/s if u/s is greater
total arsenic	0.05 mg/L maximum or no significant increase from	0.05 mg/L maximum

	u/s if u/s is greater	
periphyton chlorophyll-*a*	less than or equal to 50 mg/m^2 average	less than or equal to 100 mg/m^2 average
dissolved oxygen	8.0 mg/L minimum (July to March) 11.0 mg/L minimum (April to June)	not applicable
suspended solids	10 mg/L maximum increase when u/s is less than or equal to 100 mg/L 10 % maximum increase when u/s is greater than 100 mg/L	
substrate sedimentation	no significant increase by weight in particulate matter for particles less than 3 mm in diameter	
turbidity	1 NTU maximum increase when u/s is less than or equal to 5 NTU 5 NTU maximum increase when u/s is less than or equal to 50 NTU 10 % maximum increase when u/s is greater than 50 mg/L	
pH	6.5 to 8.5 maximum or 0.2 unit change if background is outside this range	
dissolved aluminum	less than or equal to 0.05 mg/L average 0.10 mg/L maximum no significant increase over u/s if u/s is greater	
total chromium	less than or equal to 0.002 mg/L average 0.02 mg/L maximum no significant increase over u/s if u/s is greater	
total copper	less than or equal to 0.04 (hardness in mg/L) micrograms/L average or 2 micrograms/L if the hardness is greater than or equal to 50 (0.094 [hardness in mg/L] + 2) micrograms/L maximum no significant increase over u/s if u/s is greater	
total iron	0.3 mg/L maximum or	

	no significant increase over u/s if u/s is greater
total manganese	0.05 mg/L maximum or no significant increase over u/s if u/s is greater
total lead	less than or equal to 3.31 + exp (1.273 ln [mean hardness in mg/L] - 4.705) micrograms/L average exp (1.273 ln [mean hardness in mg/L] - 1.460) micrograms/L maximum or no significant increase over u/s if u/s is greater 0.8 microgram/g wet weight in fish muscle
total mercury	less than or equal to 0.02 micrograms/L average and 0.1 micrograms/L maximum in water 0.8 microgram/g wet weight in fish muscle
total molybdenum	less than or equal to 0.01 mg/L average and 0.05 mg/L maximum May to September
total nickel	0.025 mg/L average when hardness is less than or equal to 65 mg/L 0.065 mg/L maximum when hardness exceeds 65 mg/L or no significant increase over background
total uranium	less than or equal to 0.01 mg/L average 0.10 mg/L maximum or no significant increase over background
total zinc	less than or equal to 0.01 mg/L average 0.03 mg/L maximum or no significant increase over background

Note: The objectives apply to discrete samples from all parts of the water body except from initial dilution zones of effluents or, in the case of the tailings piles, along their length. These excluded dilution zones are defined as extending up to 100 m downstream from the discharge point and no more than 50 percent across the width of the stream, from the surface to the bottom. This exclusion does not apply to objectives for fish.

1. The fecal coliform, enterococci, Escherichia coli, weak acid dissociable cyanide, dissolved aluminum and total chromium, copper, lead, mercury, molybdenum, uranium and zinc averages and 90th percentiles are calculated from at least 5 samples taken weekly in a period of 30 days.
2. The increase (in NTU, mg/L or %) for turbidity and suspended solids, is over levels measured at a site u/s from a discharge or series of discharges and as close to them as possible, and applies to d/s levels.
3. The periphyton chlorophyl-a and substrate sedimentation averages are calculated from at least 5 randomly located samples taken from natural substrates at each site on any one sampling date.
4. pH measurements may be made in-situ but must be confirmed in the laboratory if the objective is exceeded.
5. 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 loadings and stream flow. The objective applies only if the sewage effluent is chlorinated.
6. For substrate sedimentation, weak and strong acid dissociable cyanide, cyanates, thiocyanate, dissolved aluminum, total chromium, copper, iron, lead, manganese, nickel, uranium and zinc the term no significant increase is defined as a maximum of 20% increase from upstream values and applies to paired values or average values.
7. If strong acid dissociable cyanide values are greater than the objective for weak acid disociable cyanide, further sampling is recommended at the same site and at sites further d/s.

Table 2 Provisional Water Quality Objectives for other parts of the Similkameen sub-basin (approved 1985)

Water Bodies	**Similkameen River from Manning Park to Princeton**	**Allison Creek**	**Osprey Lake**	**Allison and Missezula Lakes**	**Wolfe Creek**
Designated Water Uses	**drinking water, aquatic life, wildlife, recreation, livestock, irrigation, industrial (mining)**	**drinking water, aquatic life, wildlife, recreation, livestock, irrigation**	**drinking water, aquatic life, wildlife, recreation, livestock**	**drinking water, aquatic life, wildlife, recreation**	**aquatic life, wildlife, livestock, irrigation**

fecal coliforms	less than or equal to 10 MPN/100 mL 90th percentile				not applicable
dissolved solids	not applicable				less than or equal to 500 mg/L average
total phosphorus	not applicable		less than or equal to 0.02 mg/L avaerage	less than or equal to 0.02 mg/L average with aeration less than or equal to 0.02 mg/L average with no aeration	not applicable
dissolved oxygen	not applicable	5.25 mg/L minimum April to September, inclusive	not applicable		
pH	not applicable				6.5 to 8.5
dissolved iron	not applicable				0.3 mg/L maximum or 20% maximum increase, whichever is greater
dissolved manganese	not applicable				0.20 mg/L maximum or 20% maximum increase, whichever is greater

dissolved molybdenum	not applicable		0.02 mg/L average, 0.05 mg/L maximum or 20% maximum increase, whichever is greater applies only during the irrigation season, May to September, inclusive
dissolved copper	when hardness is 20 to 50 mg/L, usually May to July: Less than or equal to 0.002 mg/L average, 0.004 mg/L maximum or 20% maximum increase whichever is greater when hardness is over 50 mg/L, usually August to April: Less than or equal to 0.006 mg/L average, 0.008 mg/L maximum or	not applicable	when hardness is greater than or equal to 100 mg/L: Less than or equal to 0.010 mg/L average, 0.015 mg/L maximum or 20% maximum increase whichever is greater when hardness is less than 100 mg/L: Less than or equal to 0.006 mg/L average, 0.008 mg/L maximum or 20% maximum increase whichever

	20% maximum increase whichever is greater		is greater
dissolved zinc	when hardness is 20 to 50 mg/L, usually May to July: Less than or equal to 0.05 mg/L average, 0.08 mg/L maximum or 20% maximum increase whichever is greater when hardness is over 50 mg/L, usually August to April: Less than or equal to 0.05 mg/L average, 0.18 mg/L maximum or 20% maximum increase whichever is greater	not applicable	when hardness is greater than or equal to 100 mg/L: Less than or equal to 0.05 mg/L average, 0.32 mg/L maximum or 20% maximum increase whichever is greater when hardness is less than 100 mg/L: Less than or equal to 0.05 mg/L average, 0.18 mg/L maximum or 20% maximum increase whichever is greater

Note: The objectives apply to discrete samples from all parts of the water body except from initial dilution zones of effluents. These excluded dilution zones are defined as extending up to 100 m downstream from the discharge point and no more than 50 percent across the width of the stream, from the surface to the bottom.
1. The dissolved zinc, molybdenum and solids average is calculated from at least 5 weekly samples taken in a period of 30 days.
2. The fecal coliform 90th percentile is calculated from at least 5 weekly samples taken in a period of 30 days.
3. The dissolved zinc, molybdenum, manganese, iron and copper increase in % is over levels measured at a site u/s from a discharge or a series of discharges and as close to them as possible and applies to d/s average or maximum levels.
4. pH measurements may be made in-situ but must be confirmed in the laboratory if the objective is exceeded.
5. The total phosphorus average is calculated from a set of at least 3 samples, including near the surface, at mid-depth and near the bottom, all at mid-lake during spring overturn.

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