Water Quality

Ambient Water Quality Objectives For The Similkameen River Sub-Basin Okanagan Area

Overview Report

Resource Quality Section
Water Management Branch
Ministry Of Environment

Prepared Pursuant To Section 2(E) Of The Environment Management Act, 1981

Original Signed By Ben Marr
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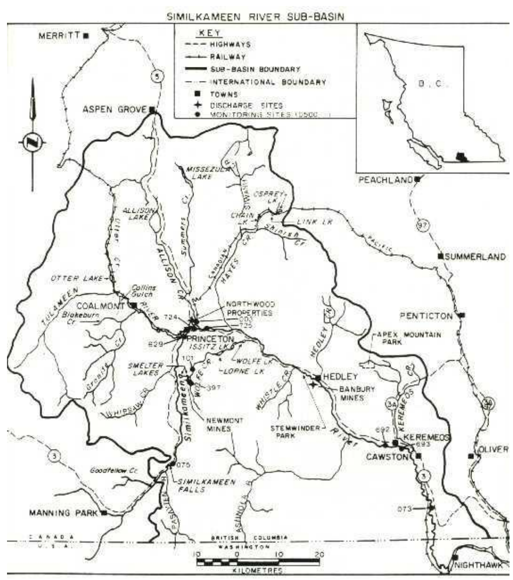
Figure 1. Similkameen River sub-basin



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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

The water quality of the Similkameen River and some of its selected tributaries, was assessed by examining water quality data and effluent quality data collected from about 1965 to December 1982. The purpose was to develop water quality objectives in areas where designated water uses may be threatened. 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 population centers along its length from west to east include Princeton, Hedley, Keremeos and Cawston.

Tributaries examined in this report were the Tulameen River which flows westerly and joins the Similkameen River at Princeton; Allison and Hayes Creeks which flow southerly and join the Similkameen just downstream from Princeton; Wolfe Creek which flows from south of Princeton and Hedley in a easterly direction before meeting the Similkameen about half-way between Princeton and Hedley; and Hedley and Keremeos Creeks which flow southerly and meet the Similkameen at Hedley and Keremeos, respectively.

Lakes examined in this report and which are located on these tributaries include Lorne and Smelter Lakes in the Wolfe Creek watershed; Allison and Missezula Lakes in the Allison Creek Watershed; and Chain, Link and Osprey Lakes in the Hayes Creek Watershed.

HYDROLOGY

The Similkameen River has an average non-freshet base flow which increases from 2 m^3/s above Goodfellow Creek near the eastern boundary of Manning Provincial Park, to 6 m^3/s above the Tulameen River confluence, 10.5 m^3/s near Hedley and 11 m^3/s at Cawston. Freshet occurs from April through

August, with average flows increasing to 40 m^3/s at Hedley and 300 m^3/s at Cawston. Major tributaries to the Similkameen River in terms of flow are the Pasayten and the Tulameen Rivers.

Average base and freshet flows in tributaries with water quality data were: 2 m^3/s and 110 m^3/s respectively for the Tulameen River, and 0.8 m^3/s and 8 m^3/s respectively for Allison Creek.

WATER USES

The Similkameen watershed contains some high quality fisheries values. Rainbow trout and whitefish can be found in the Tulameen and Similkameen Rivers, rainbow and cutthroat trout are in the Ashnola River, eastern brook and rainbow trout are in Hayes Creek, while Kokanee, rainbow trout, Grammarus shrimp and Mysis relicta are in the Allison Creek system. Wolfe Creek contains rainbow trout as well as the rare northern mountain sucker.

Consumptive water uses are 12,917 dam^3/year irrigation, 175 dam^3/year mining and 785 m^3/d drinking water in the Similkameen River; 9.3 dam^3/year irrigation and 9600 m^3/d drinking water in the Tulameen River; 2000 dam^3/year irrigation and 108 m^3/d drinking water in Allison Creek; 1296 dam^3/year irrigation and 267 m^3/d drinking water in Hayes Creek; 388 dam^3/year irrigation and 4.5 m^3/d livestock watering in Wolfe Creek; 6.8 dam^3/year mining, 222 dam^3/year irrigation and 680 m^3/d drinking water in Hedley Creek, 2276 dam^3/year irrigation and 82 m^3/d drinking water in Keremeos Creek and 1388 dam^3/year and 41 m^3/d drinking water in Ashnola Creek.

WASTE DISCHARGES

Several operations discharge wastewater to the environment within this basin. These include a considerable number of mining operations, the largest number of which are small placer old mines located on both the Tulameen and the Similkameen Rivers near Princeton. These are not likely to affect ambient water quality as long as present management techniques are maintained.

Exfiltration ponds are the most frequently used means of disposing of wastewater from placer mines. Seepages from these facilities impact water quality only minimally, if at all, since their flows are insignificant relative to even the lowest recorded river flows.

Wastewater flows from the Town of Princeton to the Similkameen River are not significant relative to river flows. A portion of the wastewater is currently spray irrigated from May through September and exfiltration ponds are used for the remainder of the flow and for the entire flow during other months. No appreciable impact has been noted on the river water quality near this exfiltration facility located just downstream from the Tulameen River confluence.

An industrial landfill operated by Northwood Properties on the bank of the Similkameen, just downstream from Princeton, appears to have increased dissolved ammonia, total Kjeldahl nitrogen, total phosphorus and tannin and lignin in ground water wells according to limited data. An increase in total phosphorus in the Similkameen River near this site was noted. Any increases downstream in the river have not affected water uses.

The largest industrial operation in the watershed is the copper mine and concentrator of Newmont Mines, located about 12 km upstream from Princeton. Seepage from the Newmont Mines tailings impoundment, up to and including 2880 m^3/d is required to be recycled. Some seepage probably enters the Similkameen River and Wolfe Creek. Impacts noted on the Similkameen River, comparing values upstream to those downstream from this operation, have been associated with dissolved zinc and possibly phosphorus values. Limited data on fish muscle collected from a pond near the west tailings dam of the mine indicated low metal values compared to other areas in the Province. Thus water uses in the Similkameen would not be affected.

On Wolfe Creek, impacts near the mine have been decreased pH and buffering capacities and increased concentrations of copper, iron, manganese, molybdenum, zinc, phosphorus, ammonia and nitrate oxygen, dissolved solids, sodium and sulphate. Increased molybdenum values can affect herbage irrigated with this water, which is subsequently used as feed for ruminants. Increased dissolved solids can affect livestock watering supplies. Increases in sodium and sulphate could affect the use of the water as a drinking water supply, however, there presently are no such users. Increases in metals other than molybdenum can affect aquatic life.

The current waste management techniques undertaken within the Similkameen watershed generally appear to be successful in reducing the impacts of wastewater on ambient quality. These waste management techniques are reflected in tertiary treatment facilities being approved for sewage treatment at Allison Lake and Keremeos. As well, Banbury Mines, a proposed gold mine and processing plant near Hedley, plans to have no discharge to the Similkameen River.

A coal mining project near Coalmont in the Tulameen watershed has been mentioned as a possible development for the watershed. However, company representatives were skeptical that it will proceed in the foreseeable future. Consequently, no predictions about the effects of this project on water quality were made.

It is suspected that diffuse sources of pollution along Allison, Hayes and Keremeos Creeks may be raising values of phosphorus and fecal coliforms. This potentially can increase algal growth, while the fecal coliforms can necessitate more elaborate water treatment. These sources are suspected to be cattle wastes on Allison and Hayes Creeks and cattle wastes and/or septic tanks along Keremeos Creek.

AMBIENT WATER QUALITY

The buffering capacity to acid was generally high, increasing about 50% along the Similkameen River through the basin. For this reason, operations which could discharge acidic effluents near or to the river should be situated at or downstream from Princeton if possible. Dissolved oxygen levels generally were also high throughout the basin.

Metal and nutrient concentrations were generally low. Nitrogen increased only slightly in a downstream direction throughout the water basin while total phosphorous concentrations approximately tripled.

Phosphorus could have originated from diffuse sources or mining wastes. Total solids also increased slightly in a downstream direction throughout the basin, probably because of increased dissolved solids from Princeton to Stemwinder Park. Water uses are unaffected by these increases.

According to available data, the flows of the Tulameen River and Similkameen River at Princeton were approximately equal and water quality was are of equal and water quality was approximately the same in each river above the confluence. Therefore both rivers were of equal importance in determining the water quality of the Similkameen River downstream from Princeton. The Tulameen River did however have slightly high pH, alkalinity and total phosphorus than the Similkameen River. This does not affect water uses downstream from the confluence.

Other direct or indirect tributaries evaluated include Hayes Creek and Allison Creek, which are tributaries to the Similkameen River, Blakeburn Creek, Collins Gulch and Granite Creek in the Tulameen basin. All were characterized by good buffering capacities to acidic inputs, low trace metal and nutrient values and generally high dissolved oxygen concentrations.

Studies conducted on Chain, Link and Osprey Lakes found that Link and Osprey Lakes were eutrophic, while Chain Lake was mesotrophic, but tending to be eutrophic. Phosphorus was found to be the limiting nutrient in the lakes, its major source likely being the internal release from lake sediments. Recreational use of the lakes for swimming, due to algal growth in the lakes, is probably restricted.

PROVISIONAL WATER QUALITY OBJECTIVES

Provisional water quality objectives proposed for the Similkameen River sub-basin are summarized in Table 1. The objectives are based on preliminary working criteria for water quality and on available data on ambient water quality, waste discharges, water 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 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 water bodies and for water quality characteristics which may be affected by man's activity, now and in the foreseeable future.

In the Similkameen River from Manning Park to the International Boundary, the Tulameen River, Allison Creek and Hayes Creek, designated water uses include protection of aquatic life, use of water for drinking, irrigation, livestock watering, wildlife and recreation. From Manning Park to Princeton, another designated sue is for industrial use (mining). In Wolfe Creek, designated water uses are irrigation, livestock watering, wildlife and the protection of aquatic life. Decisions have not yet been made on whether to aerate Allison and Missezula Lakes, which drain to the Similkameen River via Allison Creek. Aeration will tend to improve aesthetic values for recreational use, whereas the lack of aeration will tend to enhance the fishery.

More than one maximum and mean value are proposed for copper and zinc objectives in the Similkameen River for three reasons. First, there are two distinct hardness regimes in the river which affect the toxicity of metals to aquatic life. One regime with values greater than 50 mg/L usually occurs from August through April and a second with values from 20 to 50 mg/L usually occurs from May through July. Secondly. there are short time periods when values for most contaminants rise above an average value without causing acutely toxic effects to aquatic life. Thirdly, there are higher values naturally occurring upstream which occasionally exceed the proposed objectives. Consequently, maximum and mean copper and zinc objectives are based on the hardness present in the river. When upstream copper or zinc values meet or exceed these objectives, the objective is set at a value which is not to exceed the upstream value by more than 20%. This percentage allows for differences between measurements arising from random sampling or analytical errors while still protecting aquatic life.

No distinct regime for hardness existed in Wolfe Creek. Therefore a hardness of 100 mg/L was assumed to set copper, lead and zinc objectives. The hardness value of 100 mg/L is less than the minimum ever recorded, which was 120 mg/L. Since higher hardness values will lower metal toxicities to aquatic life, the proposed objectives are slightly conservative.

Since Wolfe Creek water is used to irrigate forage crops, maximum and mean molybdenum values are proposed for the irrigation season to protect ruminant animals, such as cattle, from molybdenosis. This is necessary since values in Wolfe Creek downstream from the Newmont mine can increase three to ten times above background and approach or at times possibly exceed the proposed objectives under a worst case situation. Molybdenosis is associated with forage crops with high molybdenum values. Sulphate and copper affect the molybdenum levels at which molybdenosis occurs. High sulphate levels, which are present in Wolfe Creek, can help prevent molybdenosis.

Low soil pH, which generally is less than 7.0 in soils along Wolfe Creek, helps to minimize the uptake of applied molybdenum. Soils, other than those directly adjacent to the creek itself, are generally well-drained. This also helps to prevent molybdenum uptake.

The proposed molybdenum objectives are site-specific and are to protect forage crops produced on poorly-drained soils (since some such soils are irrigated) and low-pH soils, when there is a high sulphate content in the irrigation water. These objectives should not be taken as a precedent for other areas in the region, since factors such as the type of crops irrigated, soil pH and drainage and sulphate present would have to be examined on a site-specific basis.

Objective are proposed for phosphorus in three lakes. These are 0.002 mg/L in Osprey Lake where aeration is not used, thereby enhancing the lake fishery and 0.01 mg/L or 0.02 mg/L in Allison and Missezula Lakes, depending upon whether aeration is used to improve aesthetic values or not used to favour fish productivity.

Objectives are proposed for fecal coliforms in the Similkameen River from Manning Park to the International Boundary, to allow water to be used for drinking water after only disinfection. However, coliform data are sparse and this objective may have to be reviewed following further data collection.

In the Similkameen River downstream from Princeton to the International Boundary, objectives are proposed for pH, un-ionized ammonia and chlorine residual. These objectives are proposed because municipal sewage plants at Princeton and Keremeos might increase these constituents in the rivers, although no such effects have been noted. Residual chlorine and un-ionized ammonia can be reduced by preventing pH increases.

MONITORING RECOMMENDATIONS

A summary of recommended routine water quality monitoring is given in Table 2. Recommended monitoring is the minimum required to check that water quality objectives are being met, to finalize provisional objectives that have been proposed, or to increase the accuracy of the information collected.

The recommended monitoring program is based upon technical considerations. Regional priorities and available funding are factors which could either limit or expand the program.

TABLES

Table 1a Provisional Water Quality Objectives for the Similkameen Sub-Basin

Water Bodies	Similkameen River from Manning Park to Princeton	Similkameen River from Princeton to the USA border	Allison Creek
Designated water uses	drinking water, aquatic life, wildlife, recreation, livestock watering, irrigation, industrial (mining)	drinking water, aquatic life, wildlife, recreation, livestock watering, irrigation	drinking water, aquatic life, wildlife, recreation, livestock watering, irrigation
fecal coliforms	less than or equal to 10 MPN/100mL 90th percentile		
dissolved solids	not applicable		

total chlorine residual	not applicable	0.002 mg/L maximum	not applicable
un-ionized ammonia	not applicable	less than or equal to 0.007 mg/L average 0.030 mg/L maximum	not applicable
total phosphorus	not applicable		
dissolved oxygen	not applicable		5.25 mg/L minimum April to September, inclusive
pH	not applicable	6.5 to 8.5	not applicable
dissolved copper	for hardness 20 to 50 (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 for hardness over 50 (usually August to April): less than or equal to 0.006 mg/L average, 0.008 mg/L maximum or 20% maximum increase, whichever is greater	not applicable	
dissolved zinc	for hardness 20 to 50 (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	not applicable	

	greater for hardness over 50 (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	
dissolved molybdenum	not applicable	
dissolved iron	not applicable	
dissolved manganese	not applicable	

Table 1b Provisional Water Quality Objectives for the Similkameen Sub-Basin

Water Bodies	Osprey Lake	Allison and Missezula Lakes	Wolfe Creek
Designated water uses	drinking water, aquatic life, wildlife, recreation, livestock watering	drinking water, aquatic life, wildlife, recreation	aquatic life, wildlife, livestock watering, irrigation
fecal coliforms	less than or equal to 10 MPN/100mL 90th percentile		not applicable
dissolved solids	not applicable		less than or equal to 500 mg/L average
total chlorine residual	not applicable		

un-ionized ammonia	not applicable		
total phosphorus	less than or equal to 0.02 mg/L average	less than or equal to 0.01 mg/L average with aeration less than or equal to 0.02 mg/L average without aeration	not applicable
dissolved oxygen	not applicable		
pH	not applicable		6.5 to 8.5
dissolved copper	not applicable		for hardness greater than or equal to 100: less than or equal to 0.010 mg/L average, 0.015 mg/L maximum or 20% maximum increase, whichever is greater for hardness less than 100: less than or equal to 0.006 mg/L average, 0.008 mg/L maximum or 20% maximum increase, whichever is greater
dissolved zinc	not applicable		for hardness greater than or equal to 100: less than or equal to 0.05 mg/L average, 0.32 mg/L maximum or 20% maximum increase, whichever is greater

		for hardness less than 100: less than or equal to 0.05 mg/L average, 0.18 mg/L maximum or 20% maximum increase, whichever is greater
dissolved molybdenum	**not applicable**	**less than or equal to 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 iron	**not applicable**	**0.3 mg/L maximum or 20% maximum increase, whichever is greater**
dissolved manganese	**not applicable**	**0.2 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 in streams 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 fecal coliform 90th percentile is calculated from at least 5 weekly samples taken in a period of 30 days.
2. The increase in % for dissolved zinc, molybdenum, iron and copper, 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 dissolved zinc, molybdenum, iron and copper average is calculated from at least 5 weekly samples taken in a period of 30 days.
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 is less than the minimal 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. 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 three at mid-lake during spring overturn.

Table 2 Recommended Effluent and Water Quality Monitoring for the Similkameen Sub-Basin

Sites	Frequency and Timing	Characteristics to be Measured
Similkameen River at the falls, site 0500075	every second month, September to April	dissolved oxygen, copper, iron, lead and zinc; pH; fecal coliforms; dissolved and suspended solids; temperature; specific conductivity; hardness
Similkameen River u/s from Princeton and the Tulameen River, site 0500629		
Pasayten River at the mouth		
Siwash Creek at the mouth	4 times a year	
Similkameen River at Cawston near the international boundary, site 0500073	every second month, September to April	dissolved oxygen, copper, iron, lead and zinc; pH; fecal coliforms; dissolved and suspended solids; temperature; specific conductivity; hardness; true colour; orthophosphorus; ammonia, nitrite and nitrate-nitrogen; total alkalinity, cyanide,
Ashnola River at the mouth	12 time a year for the first year and 4 times a year subsequently	

		phosphorus, arsenic, cadmium, manganese, molybdenum and mercury; turbidity
Allison Creek at the mouth, site 0500003	every second month, April to October	dissolved oxygen, copper, iron, lead and zinc; pH; fecal coliforms; dissolved and suspended solids; temperature; specific conductivity; hardness; total and orthophosphorus
Summers Creek at the mouth		
Wolfe Creek d/s from Newmont mines, site 0500397	4 times per year at the same time as seepage	dissolved and suspended solids, pH, total nitrogen, dissolved sulphate, copper, iron, manganese, molybdenum, zinc and sodium, orthophosphorus, nitrate and ammonia-nitrogen, hardness
Wolfe Creek d/s from Newmont, site 0500101		
Wolfe Creek at the mouth		
Allison Lake	once per year at spring overturn (mid-lake near the surface, at mid-depth and near the bottom)	temperature and dissolved oxygen profiles, secchi depth, pH, kjeldahl, ammonia, nitrite and nitrate-nitrogen, total, total dissolved and orthophosphorus
Missezula Lake		
Osprey Lake		
Chain Lake, site 1100742		
Link Lake, site 1100721		
Similkameen River u/s from Princeton STP, site 0500724	twice per year when there is no irrigation, once per year when effluent is irrigated	dissolved oxygen, pH, fecal coliforms, total and orthophosphorus, ammonia-nitrogen, BOD_5, temperature, specific conductivity, total chlorine residual
Similkameen River d/s from Princeton STP, site 0500725		
Similkameen River u/s from Keremeos STP, site		

0500692 **Similkameen River d/s from Keremeos STP, site 0500693**		
Hayes Creek around cattle operations	**weekly mid-April to mid-June**	**special study of dissolved oxygen, fecal coliforms and nutrients to test effect of cattle**

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

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