Water Quality

Ambient Water Quality Objectives For The Fraser River Sub-Basin From Hope To Kanaka Creek

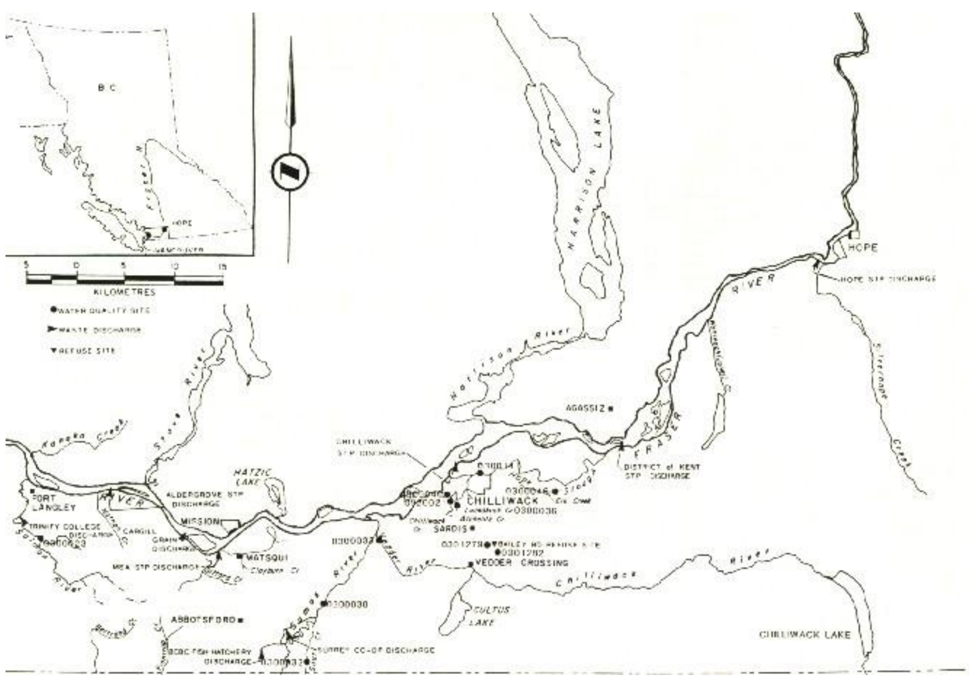
Overview Report

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
Deputy Minister
Ministry Of Environment
November 25, 1985.

Figure 1. Fraser River sub-basin from Hope to Kanaka Creek



Ministry of Environment & Climate Change Strategy

Water Protection and Sustainability Branch
Environmental Sustainability and Strategic Policy Division

Mailing Address:
PO Box 9362
Stn Prov Govt
Victoria BC V8W 9M2

Telephone: 250 387-9481
Facsimile: 250 356-1202
Website: www.gov.bc.ca/water

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

This report examines water quality in the Fraser-Delta area, incorporating the Fraser River from Hope to Kanaka Creek and all areas to the south from the river, including such tributaries as the Salmon River and the Vedder/Chilliwack River (see attached figure). Two additional reports form part of the assessment: one dealing with water quality in the Fraser River From Kanaka Creek to Sturgeon and Roberts Banks, and the other dealing with water quality in the Serpentine, Nicomekl and Campbell Rivers and Boundary Bay. The purpose of the assessments is to develop water quality objective in areas where designated water uses may be threatened.

Tributaries entering the Fraser River from the north are not examined specifically, but their effect on Fraser River water quality is considered. Similarly, only waster discharges along the north shore discharging directly into the river are discussed. A more detailed examination of watercourses and waste discharges in the area to the north from the Fraser River will be undertaken when water quality assessments and objectives are prepared for the Coquitlam-Pitt and Harrison-Lillooet areas. A detailed technical appendix was prepared and forms the basis for the conclusions presented here.

The Fraser River flows westerly for Hope to Kanaka Creek and subsequently to its confluence with the Strait of Georgia. The reach from Hope to Chilliwack is about 55 km in length, as is the reach from Chilliwack to Kanaka Creek.

The area to the south from the river, to the International Boundary was also examined in detail. This area comprises several tributaries including Hope Slough (and its tributary Elk Creek), Chilliwack Creek (and its tributaries Luckakuck and Atchelitz Creeks), The Salmon River, Chilliwack River, Gifford Creek, Clayburn Creek, Nathan Creek, a small length of Silverhope Creek and Wahleach (Jones) Creek. As well, Bertrand and Fishtrap Creeks which flow in a southerly direction into the United States were examined. Urban centers in this area include Abbottsford, Aldergrove, Vedder Crossing, Sardis, Chilliwack and Hope.

HYDROLOGY

The Fraser River near Hope has a 10 year, 1 day average low flow of 450 m^3/s. This low flow increases to nearly 800 m^3/s at Mission. Mean annual flows are 2700 m^3/s at Hope and 3600 m^3/s at Mission. Over one half the increase in the mean annual flow between Hope and Mission is from the Harrison River which enters from the north.

Low flows on the Fraser River occur from January through mid-April. Freshet commence at approximately that time and peaks in the late June.

Several smaller tributaries are discussed in this document. Those for which historical mean annual flows are available include Silverhope Creek near Hope (14 m^3/s), Jones (Wahleach) Creek (9.5 m^3/s), Hope Slough (up to 2 m^3/s), the Chilliwack River (70 m^3/s), the Sumas River (3.5 m^3/s) And the Salmon River (1.5 m^3/s).

WATER USES

The Fraser River is one of the most important migratory routes in British Columbia for adult and juvenile salmonids. Several tributaries to the south from the river, including but not limited to Silverhope Creek, Wahleach Creek, Hope Slough, Elk Creek and the Chilliwack River provide important rearing habitat. The Chilliwack River is the most productive system in the Fraser-Delta area.

Extensive recreational use is made of water bodies in the Fraser-Delta area, including boating and angling in the Fraser River and canoeing, kayaking and angling in the Chilliwack River. Chilliwack sand Cultus Lakes are used extensively for recreation for beaches, angling, swimming and parks.

Very little consumptive use is made of Fraser River water. Only 51.8 dam^3/year is licences to be withdrawn for irrigation and 4.5 m^3/d for drinking water. However, extensive use of water from tributaries is made for irrigation. Annually, this amounts to 5.6 dam^3 from Silverhope Creek, 749 dam^3 from Hope Slough, 92.6 dam^3 from Elk Creek, 125 dam^3 from the Chilliwack River, 679 dam^3 from Sumas River, 231 dam^3 from the Salmon River, 326 dam^3 from Chilliwack Creek, 324 dam^3 from Atchelitz Creek, 390 dam^3 from Luckakuck Creek, 438 dam^3 from Clayburn Creek, 125 dam^3 from Gifford Creek and 254 dam^3 from Fishtrap Creek. Drinking water requirements amount to 2.3 m^3/d from Cultus Lake, 9 m^3/d from the Salmon River, 702 m^3/d from Clayburn Creek, 30 m^3/d from Gifford Creek and 6.8 m^3/d from Nathan Creek.

WASTE DISCHARGES

Many small operations use disposal to ground or recycle as means to reduce the impact of their wastes. These procedures, in combination with the extremely small quantities of wastewater involved, make these discharges of little significance to surface water quality. Larger operations, such as sewage treatment plants, discharge treated wastewater directly to nearby watercourses.

Major discharges to the Fraser River of secondary treated domestic sewage occur from the Hope sewage treatment plant (STP), the Kent STP, the Chilliwack STP, the MSA (also known as James or Abbotsford) STP, the Aldergrove STP. Permitted discharge volumes are 6800 m^3/d from the Hope STP after treatment in an aerated lagoon system, 2730 m^3/d from the Kent STP after treatment in an extended aeration system, 12,700 m^3/d from the Chilliwack STP after treatment in an activated sludge plant, 20,500 m^3/d from the MSA STP after treatment in a physical-chemical plant and 4546 m^3/d from the Aldergrove STP following treatment in an activated sludge plant. Raw sewage bypasses to the Fraser River can occur from the Kent STP and the Chilliwack STP, while bypasses from the Aldergrove STP enter Bertrand Creek.

Other major discharges are Cargill Grain, a hog raising operation which uses a combined anaerobic/aerated lagoon system prior to discharging 250 m^3/d to an exfiltration basin and Trinity Junior College, which is located near the Salmon River. The College provides secondary treatment to domestic sewage in two aerated lagoons and is allowed to discharge 282 m^3/d to the Salmon River from October through May 15. However, the sewage also exfiltrates to the river.

Changes have been noted downstream from sewage treatment plants in the Fraser River at Hope, Kent and Chilliwack. These changes, which could affect water use by a aquatic life and humans if they persisted throughout the river, were reflected in reduced dissolved oxygen and increased phosphorus, ammonia, organic nitrogen, suspended solids and fecal coliforms. Complete mixing of effluents and river water probably had not occurred where samples were collected since calculations have indicated that with complete mixing may require changes in treatment or changes to the outfall systems used at these treatment plants. Some possible options include extending existing outfalls and/or adding diffusers. Localized effects of discharges are not always well defined, requiring that further data be collected.

Impacts from cattle operations could be important during low flows in several tributaries. These include Hope Slough, Elk Creek and the Salmon River.

WATER QUALITY

The Harrison River on the north side is a major tributary of the Fraser River between Hope and Kanaka Creek. The Harrison River, the outlet from Hatzic Lake (also on the north side) and tributaries from the south including a short length of Silverhope and Wahleach (Jones) Creeks, the Vedder /Chilliwack River, Luckakuck Creek and the Salmon River had good water quality. The Fraser River from Hope to Kanaka Creek (including Hope Slough) had good water quality, although fecal coliform values probably would preclude primary water-contact recreation (*i.e.* swimming) in the river.

Elk Creek, a tributary to Hope Slough had some high iron and manganese levels relative to those recommended for drinking, high phosphorous and fecal coliform values and low dissolved oxygen levels. Use of the water for drinking and by aquatic life potentially could be affected.

The Sumas River, a tributary to the Vedder River, had good water quality except for phosphorus, fecal coliforms and asbestos. Although phosphorus values in its lower reaches were typical of low productivity streams, higher phosphorus values and likely higher productivity existed in its upper reaches. In addition, fecal coliform values were generally high throughout the Sumas River, exceeding working water quality criteria for primary contact recreation. Naturally occurring asbestos values in the river were higher than found in most other water in North America. These high levels have been associated with high metal-levels, as well as toxicity problems to plants in flooded areas where sediments had been deposited.

There were some notable water quality problems evident in both Atchelitz and Chilliwack Creeks. These problems were low dissolved oxygen values and high phosphorus and fecal coliform values, High phosphorus values may have promoted algal growths which in turn caused the wide ranges of dissolved oxygen values noted. Additional sampling of the creeks has been recommended to check these possibilities. Algal growths can cause taste and odour problems in drinking water, as well as lead to fluctuating dissolved oxygen levels which can stress aquatic life.

Both Cultus and Chilliwack Lakes are oligotrophic. Cultus Lake has been affected by Eurasian water milfoil (*Myriophyllum spicatum*) since 1977. Approximately 5 ha of an affected area 18.7 ha area is managed by rotavating or the installation of bottom barriers. The milfoil has spread into valuable shore-based sockeye spawning grounds at the south end of the lake

---

PROVISIONAL WATER QUALITY OBJECTIVES

Provisional water quality objectives are proposed for the Fraser River from Hope to Kanaka Creek, several of its tributaries along this reach and to the south from the river, Cultus and Chilliwack Lakes and Bertrand Creek which flows southerly into the United States. 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/or limnological characteristics in the case of lakes. 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 o 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 waster management permits and plans, regulate water use of 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 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.

Water uses including protection of aquatic life, wildlife, livestock and irrigation are designated for the Fraser River from Hope to Kanaka Creek, Hope Slough, Luckakuck Creek, Atchelitz Creek, Clayburn Creek and the Sumas River.

Use for drinking water supplies and protection of aquatic life, wildlife, livestock and irrigation are the designated uses for Elk Creek, Salmon River, Fishtrap Creek, Gifford Creek and Bertrand Creek. Designated water uses on Saar Creek are for protection of aquatic life, wildlife,, livestock and irrigation. Designated uses for Nathan Creek include drinking water, use by wildlife and protection of aquatic life.

Drinking water supply, primary contact recreation, protection of aquatic life, wildlife, livestock and irrigation are the designated water uses for the Chilliwack River and Cultus Lake. Chilliwack Lake has the same uses except livestock watering and irrigation. The protection of aquatic life and wildlife are the designated uses for Wahleach and a short length of Silverhope Creeks.

Various values are proposed as objectives for dissolved oxygen. These arise because the Fraser River is a migratory route, while its tributaries provide spawning and rearing habitat for salmonids. For these reasons, a minimum 7.75 mg/L level is proposed for the Fraser River, while three different objectives are proposed in spawning and rearing habitats, each objective being dependent upon the life cycle stage (*e.g.*, egg, alevin or fry) of the affected fish.

Where treated sewage is discharged to the Fraser River, objectives have been proposed for pH, total chlorine residual, un-ionized nitrogen and fecal coliforms. The ph objective is proposed to help reduce the amount of un-ionized ammonia (and resulting toxicity) potentially present at any temperature. It also recognizes the sensitivity of the Fraser River to alkaline discharges. Total chlorine residual objectives are proposed to prevent toxicity in the receiving water, following chlorination to reduce fecal coliform concentration. Fecal coliform objectives are proposed to protect downstream water users. Toxicity due to un-ionized ammonia or chlorine residual has not been evident in the Fraser River.

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

Objectives to protect the quality of Cultus and Chilliwack Lakes have been proposed to protect the value of these lakes. It has been recommended that no increased phosphorus loading should occur to Cultus Lake and that further development on Chilliwack Lake be subject to strict control due to the sensitivity of the lake and the long water-retention-time.

Should a development be proposed in the future for a sub-basin 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 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 provisional water quality objectives and others investigating the localized impact of an effluent on water quality. The recommended monitoring is based on technical considerations and actual programs will depend on budget allocations and project priorities.

TABLES

Table 1a Provisional Water Quality Objectives for the Fraser River sub-basin from Hope to Kanaka Creek

Water Bodies	Fraser River, Hope to Kanaka Creek	Hope Slough, Atchelitz, Luckakuck and Chilliwack Creeks	Elk and Bertrand Creeks, Salmon River	Sumas River
Designated uses	aquatic life, wildlife, livestock, irrigation	aquatic life, wildlife, livestock, irrigation	drinking water (complete treatment), aquatic life, wildlife, livestock, irrigation	aquatic life, wildlife, livestock, irrigation
fecal coliforms	less than or equal to 1000 MPN/100 mL geometric mean, 4000 MPN/100mL maximum, April to October			
total chlorine residual	0.002 mg/L maximum	not applicable		
un-ionized ammonia-nitrogen	less than or equal to 0.007 mg/L average, 0.03 mg/L maximum			not applicable
total phosphorus	not applicable			
dissolved oxygen	7.75 mg/L minimum	11.2 mg/L minimum when fish eggs are in "eyed" to hatch stages		

		8.0 mg/L minimum when fish eggs, larvae or alevin are present 6.0 mg/L minimum at all other times		
pH	**6.5 to 8.5**			**not applicable**

Table 1b Provisional Water Quality Objectives for the Fraser River sub-basin from Hope to Kanaka Creek

Water Bodies	Saar Creek	Chilliwack River	Cultus Lake	Chilliwack Lake
Designated uses	**aquatic life, wildlife, livestock, irrigation**	**drinking water (partial treatment), aquatic life, wildlife, recreation, livestock, irrigation**	**drinking water (disinfection only), aquatic life, wildlife, recreation**	**drinking water (disinfection only), aquatic life, wildlife, recreation**
fecal coliforms	**less than or equal to 1000 MPN/100 mL geometric mean, 4000 MPN/100mL maximum, April to October**	**less than or equal to 100 MPN/100 mL 90th percentile**	**less than or equal to 10 MPN/100 mL 90th percentile near water intakes less than or equal to 200 MPN/100 mL geometric mean and less than or equal to 400 MPN/100 mL 90th percentile at bathing beaches**	**not applicable**
total chlorine residual	**not applicable**			

un-ionized ammonia-nitrogen	not applicable			
total phosphorus	not applicable		less than or equal to 0.01 mg/L average at spring overturn	not applicable
dissolved oxygen	11.2 mg/L minimum when fish eggs are in "eyed" to hatch stages 8.0 mg/L minimum when fish eggs, larvae or alevin are present 6.0 mg/L minimum at all other times	11.2 mg/L minimum when fish eggs are in "eyed" to hatch stages 8.0 mg/L minimum when fish eggs, larvae or alevin are present 7.75 mg/L minimum at all other times	5.0 mg/L minimum in hypolimnion	not applicable

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 (25% in the case of the Fraser River), from the surface to the bottom.

1. Drinking water objectives (10, 100 and 1000-4000/100 mL) apply year round, the fecal coliform geometric mean, median and 90th percentile are calculated from at least 5 weekly samples taken in a period of 30 days. The recreation objective (200-400/100 mL) applies during the recreation season and the irrigation objective (1000-4000/100 mL) applies during the irrigation season.

2. 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 loading and streamflow. The objective applies only if sewage effluent is chlorinated.

3. The average un-ionized ammonia is calculated from at least 5 weekly samples taken in a period of 30 days.

4. The average total phosphorus is calculated from a set of at least 3 samples taken at spring overturn, including near the surface, at mid-depth and near the bottom, all at mid-lake.

5. pH measurements can be made in-situ but must be confirmed in the laboratory if the objecxtive is exceeded.

Table 2 Recommended Effluent and Water Quality Monitoring for the Fraser River sub-basin from Hope to Kanaka Creek

Sites	Frequency and Timing	Characteristics to be Measured
Fraser River: u/s, d/s and sample of effluent from MSA STP, KENT STP, Aldergrove STP, Chilliwack STP, Cargill Grain	1/month (December to April) for the first year 1/year (December to April) in subsequent years	dissolved oxygen, pH, ammonia-nitrogen, total phosphorus, suspended solids, fecal coliforms, temperature, total chlorine residual
Salmon River: u/s and d/s from Trinity Junior College	4 times (September and October) in the first year	dissolved oxygen, pH, ammonia-nitrogen, total phosphorus, temperature
Sumas River (site 0300030) Elk Creek (site 0300046) Saar Creekr (site 0300032) Chilliwack Creek (site 0300040) Luckakuck Creek (site 0300036) Atchelitz Creek (site 0920021) Hope Slough (site 0300141)	3 times (December to April) in the first year once (May to November) in the first year	dissolved oxygen
	5 times (July and August) annually	fecal coliforms
Vedder Canal (site 0300033)	5 times (August and September) yearly	dissolved oxygen, fecal coliforms
Cultus Lake	once between February 20 and March 10 yearly	total phosphorus
	5 times (July and August) annually	fecal coliforms, dissolved oxygen, chlorophyll-a

Salmon River (site 0300023) and headwaters	5 times at low flow and heavy rainfall for one year	total coliforms, fecal coliforms, fecal streptococci
Chilliwack Creek (site 0300040) and Atchelitz Creek (two sites)	monthly (May to Octember) for one year	dissolved oxygen, fecal coliforms
Saar Creek, Sumas River (two new sites), Hope Slough (two new sites), Elk Creek (two new sites)	6 times (August and September) for one year	dissolved oxygen, orthophosphorus, ammonia and nitrate-nitrogen
Lonzo Creek u/s and d/s from Surrey Cooperative	6 times for 1 year during rain events	dissolved oxygen, oil and grease
Lonzo Creek u/s and d/s from BCBC Hatchery	6 times for 1 year	dissolved oxygen, orthophosphorus
Unnamed creek u/s and d/s from Bailey Road refuse (Sites 0301279 and 0301282)	twice a year at low flow for three years	dissolved iron, nitrite, fecal coliforms

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

L. G. Swain, P. Eng.
G. B. Holms
Resource Quality Section
Water Management Branch
Ministry of Environment