Water Quality

Water Quality Assessment And Objectives For The Fraser River From Hope To Sturgeon And Roberts Banks

Summary Report-First Update

Water Management Branch
Environment And Resource Division
Ministry Of Environment, Lands And Parks

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

Original Approved And Signed By:
D. Fast
Assistant Deputy Minister
Environment And Lands Hq Division
And
J. O'riordan
Assistant Deputy Minister
Environment And Lands Regions Division
September And October, 1998, Respectively.

DISCLAIMER

Canadian Cataloguing in Publication Data
Swain, L. G. (Leslie Grant), 1950-
Water quality assessment and objectives, for the Fraser River from Hope to Sturgeon and Roberts Banks

Written by L. G. Swain. cf. Overview p. 14.
Consists of two parts: An overview and a report,
of which the overview is also available as a separate document.

Includes bibliographical references: p.
ISBN 0-7726-3706-7

1. Water quality - British Columbia - Fraser River.
2. Water Quality - British Columbia - Lower Mainland.
I. British Columbia. Ministry of Environment, Lands and Parks.
II. Title

TD227.F7S92 1998 363.739'42'097113 C98-960298-2

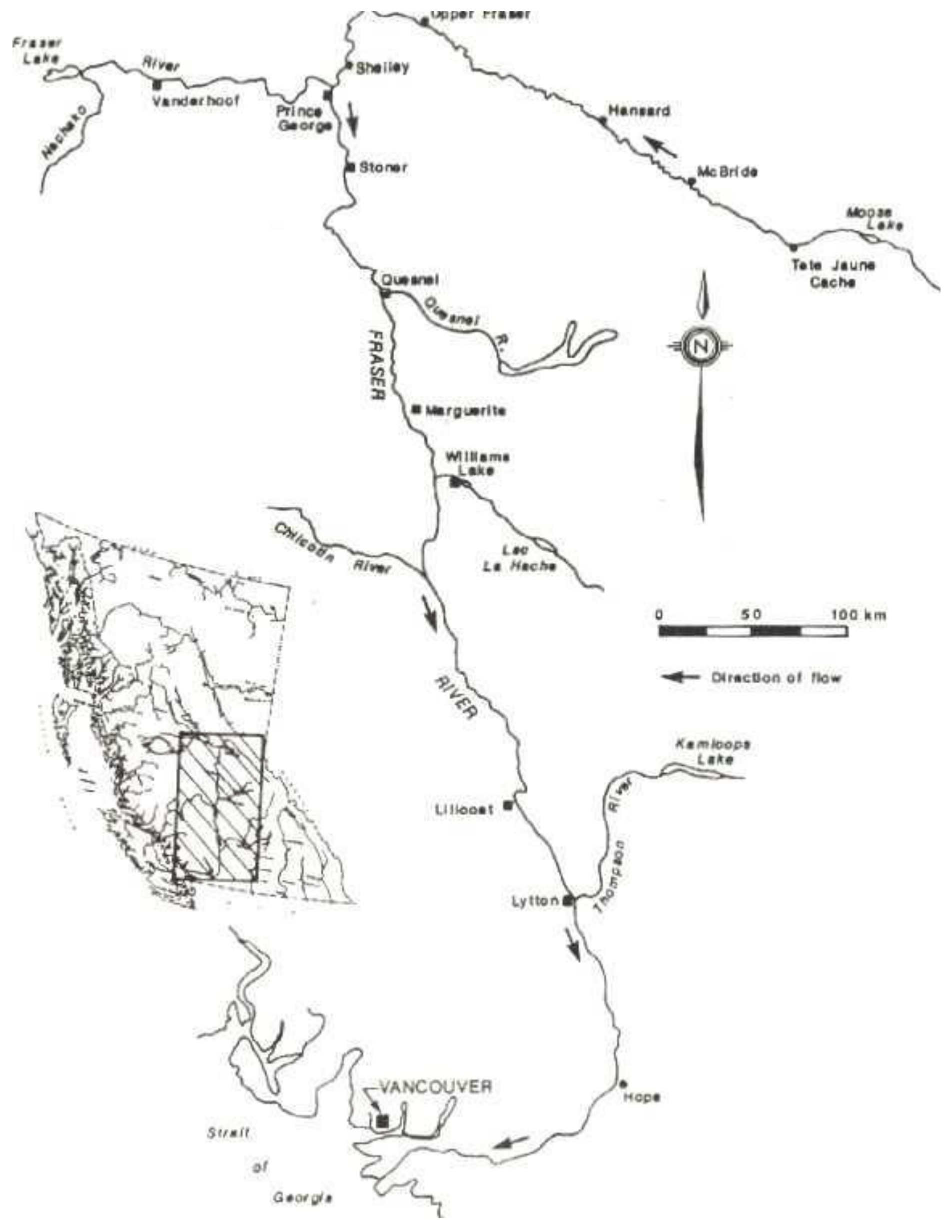
SUMMARY
This document is one in a series that describes ambient Water Quality Objectives for British Columbia. It has two parts: the following overview and a technical appendix which is available as a separate document. The overview provides general information about water quality on Sturgeon and Roberts Banks, and in the Fraser River in five main river reaches: from Hope to Chilliwack, Chilliwack to Kanaka Creek, the Main Stem from Kanaka Creek to the New Westminster trifurcation, and both the North Arm and the Main Arm, to the mouth. The technical appendix presents the details of the water quality assessment for these reaches, and forms the basis of the recommendations and objectives presented in the overview. The overview is intended for both technical readers and for readers who may not be familiar with the process of setting Water Quality Objectives. Tables listing Water Quality Objectives and monitoring recommendations are included for those readers requiring data about these water bodies.

The Fraser River is home to both resident and anadromous species of fish. There are 20 species of resident fish documented in the Fraser River below Hope, and five Pacific salmon species which migrate up the river to spawn. The salmon runs are among the largest in the world, representing major commercial catches of all five Pacific species, important native food fisheries, and a significant sport fishery. Consistent achievement of Water Quality Objectives is critical for the sustainability and success of the Fraser's salmon resource.

The main sources of water contamination downstream from Hope are treated municipal-type discharges, discharges from various industrial operations, and non-point source discharges. Although the number of direct discharges to the river is greatest in the Main Arm, the contamination from such discharges is more severe in the North Arm due to its smaller river flow.

Water Quality Objectives have been recommended to protect aquatic life, wildlife, livestock watering, irrigation water supplies, and recreation, in all five reaches from Hope to the Sturgeon and Roberts Banks. As water uses change from one reach to another, Objectives and recommendations are based on the most sensitive use in that particular reach.

Figure 1. The Fraser River from Hope to Sturgeon and Roberts Banks: Location Map



PREFACE

Purpose of Water Quality Objectives

Water quality objectives are tools that support the effective management of water resources. They describe conditions that water managers have agreed should be met in order to protect the most sensitive designated uses of freshwater, estuarine, and coastal marine ecosystems. They are used in conjunction with other management tools, such as effluent controls, best management practices, and best available or best practicable wastewater treatment technology (BAT/BPT), to achieve high standards of water quality.

Water quality objectives are being jointly prepared by Environment Canada and the Ministry of Environment, Lands, and Parks, as part of their respective mandates for responsible water resource management. Objectives are prepared only for those waterbodies and water quality characteristics that may be affected by human activity, either now or in the future.

How Objectives Are Determined
Water quality objectives are based on water quality guidelines and criteria. The Canadian water quality guidelines, which are developed by the Canadian Council of Ministers of the Environment (CCME), are numerical concentrations or narrative statements for chemical, physical, radiological, and biological variables that are recommended to support and maintain designated water uses. Like water quality guidelines, water quality criteria also relate the physical, chemical, or biological characteristics of water, biota (plant and animal life) or sediment to their effects on water use, but differ in that they are developed by the Ministry of Environment, Lands and Parks.

Water quality objectives are numerical concentrations or narrative statements which have been established to support and protect the most sensitive designated use of water at a specified site (BCMOELP 1986; CCREM 1987). They are derived from the guidelines and criteria by considering local water quality, water uses, water movement, waste discharges and other factors.

Water quality objectives are based on the best scientific information available at the time the objectives are developed. When insufficient information exists, provisional water quality objectives may be applied until the data required to develop permanent water quality objectives are available. Provisional objectives are deliberately conservative. To facilitate the establishment of permanent objectives, a monitoring or study program is usually recommended to fill any data gaps that are identified.

Water quality objectives are set to protect the most sensitive designated water use at a specific location. Designated uses of water include the following:

- raw drinking water, public water supply, and food processing;
- fish, other aquatic life, and wildlife;
- agriculture (livestock watering and irrigation);
- recreation and aesthetics; and,
- 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 have no legal standing at this time and, therefore, cannot be directly enforced. In British Columbia, water management objectives are achieved through the issuance of permits for effluent discharges, monitoring of the volumes and concentrations of contaminants discharged, inspection of

farms, streambank restoration, erosion control, and enforcement of environmental legislation when violations occur. The limits on effluent discharges are generally based upon the best available technology for wastewater treatment; however, the objectives have also been used to support the permitting process in recent years.

Water quality objectives are important water management tools because they provide policy direction for resource managers with respect to the protection of water uses in specific waterbodies. Objectives provide benchmarks for evaluating water quality, issuing wastewater discharge permits, dispersing water withdrawal licences and orders, and managing fisheries and the province's land base. They also provide reference points against which the state of water quality can be checked and help to determine whether additional management actions are needed to protect and/or restore the designated water uses in a particular waterbody.

Objectives and Monitoring

Water quality objectives are established to protect all the uses which take place in a water body. To determine if the objectives are being met and if the water uses are being protected, monitoring programs are usually specified along with the objectives. Monitoring should take place at critical times 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 critical times, then they will also be protected at other times when the threat is less severe. The monitoring usually takes place during a five week period, which allows the specialists to measure the worst, as well as average, conditions in the water. For some water bodies, the monitoring period and frequency will vary with the nature of the problem, the severity of threats to designated water uses, and the way the objectives are expressed (*i.e.*, mean value, maximum value, etc.).

INTRODUCTION

The Fraser River drains about one-quarter of the Province of British Columbia, and extends from near the Alberta-British Columbia border in the north and east, to the estuary at the River confluence with the Strait of Georgia in the south and west of the Province (see Figure 1). The purpose of this report is to develop Water Quality Objectives for resource and environmental managers, providing them with updated policy direction for the protection of designated uses of the Fraser River from Hope to Sturgeon and Roberts Banks. The reason that the existing Water Quality Objectives have to be updated is because of a number of advances in treatment such as upgrading treatment of Annacis and Lulu STP effluents to secondary, and the shutdown of several industrial operations such as Western Canada Steel and Chatterton Chemicals.

Others that may find the information useful include habitat biologists, and environmental and water quality specialists. The public will also find the Water Quality Objectives useful for assessing the health of their environment, articulating concerns about existing uses of resources in their environment, and monitoring the performance of various government agencies cooperating in maintaining acceptable high levels of water quality in the Fraser River Basin.

Profile of the Fraser River from Hope to Sturgeon and Roberts Banks

HYDROLOGY

The Fraser River exhibits a classic perpetual annual snow melt hydrograph pattern due to its extensive snow pack and its massive basin storage. High flows take place from May to August, with 64% of the annual volume runoff at Hope taking place during this time. Low flow months are consistently between November and April. The lowest tenth percentile low mean monthly flows were 610 m^3/s at Hope (March), 977 m^3/s at Mission (February), and 1178 m^3/s at Port Mann (February).

At the New Westminster trifurcation, the river flow divides, with about 15% entering the North Arm, 79% entering the Main Arm and the remaining 6% entering Annacis Channel. In the North Arm itself, 45% of the flow enters the Middle Arm.

Tidal action influences water movement and residence times in the lower reaches of the Fraser River. Tidal mixing and salinity intrusions change on seasonal and daily time schedules. Tides in the estuary are semi-diurnal. Furthermore, during freshet conditions from May to August, a distinct salt wedge is confined to the outer 10 km of the estuary. When runoff conditions are moderate to low, salt wedge intrusion can extend as far as 15 to 30 km inland. Tidal mixing and salinity intrusions are important factors in the fate, behaviour, and distribution of contaminants in the lower Fraser River. Water Quality Objectives must be developed in view of such influences in order to be sufficiently protective of all designated resource uses.

WATER USES

The most common human uses of the Fraser River from Hope to the Banks were determined through water withdrawal licences and from over 150 respondents to an informational survey issued to stakeholders along the Fraser. There are no direct raw drinking water withdrawals from the Fraser from Hope to the mouth of the river. From Chilliwack to the trifurcation area, the most popular recreational water uses tend to be non-contact, shoreline activities such as hiking, walking, fishing, and bird-watching. Primary-contact recreation such as swimming does not commonly occur along the Fraser River itself; instead, it is more likely to take place in the aesthetically "cleaner", warmer, and more accessible tributaries, or towards the mouth of the river.

Due to the variances in the economic land use of the Fraser River area, agricultural water use (*i.e.* irrigation or livestock watering) is more common from Hope to the trifurcation, while industrial water use is more prevalent along the North and Main Arms.

Aquatic use of the Fraser River from Hope to the Banks is apparent and evidenced by fish and benthic invertebrate fauna. In addition to salmon, the Fraser River supports a great diversity of resident and migratory fish populations as well benthic invertebrates. Because aquatic life is generally the most sensitive water use along the length of the Fraser from Hope to the Banks, it forms the basis for most of the Objectives which are set.

WASTE WATER DISCHARGES

The main sources of water contamination downstream from Hope are treated municipal-type discharges, cooling water from various industrial operations, and non-point and point source discharges from landfill leachate and infiltration ponds. There are eight municipal sewage treatment plants servicing the various municipalities along the river, as well as many smaller, privately-owned primary and secondary treatment facilities with outfalls to the river.

Although not covered by permits, there are many non-point agricultural discharges along the more rural areas of the river between Hope and the trifurcation. These generate increased nutrient and bacteriological loadings to the river. Other non-point discharges occur as leachate from more than 30 industrial and domestic-type landfills adjacent to, or at some distances from, the banks of the river. The larger landfills often have leachate collection and treatment facilities before discharging to the river. However, surface water is usually allowed to flow untreated. Potential contamination from landfills covers a broad spectrum from metals to toxic substances and various organic and inorganic chemicals. Another non-point discharge discussed in this report is the leachate from over 22 infiltration ponds and septic tanks permitted along the river from Hope to the Banks. The contamination from these sources is usually minor but the actual impact will depend on the nature of the discharge and the degree of treatment prior to discharge to the land.

Non-point source discharges downstream from Kanaka Creek are usually typical of the urban setting. There are well over 100 storm water discharges and combined sewer overflows to the river. These discharges transport metals from tire wear and polycyclic aromatic hydrocarbons (PAHs) from unburned fossil fuels, as well as lesser amounts of other contaminants.

Most of the industrial-type discharges are concentrated in the Main and North Arms, with the contamination most severe in the North Arm. Some sources of these industrial-type discharges are fish processing plants which discharge very high concentrations of nutrients directly to the river, foundries which may be releasing dissolved metals and suspended solids, and paper mills which often have effluents containing inorganics and organics.

The largest loading of contaminants to Sturgeon and Roberts Banks potentially comes form the contaminants carried by the Fraser River itself which can be deposited under certain situations on the Banks. In the past, the largest discharge was from the Iona STP; however, a long sea outfall now carries these primary treated wastes into deeper waters of the Strait of Georgia. Presently, the Roberts Bank Coal Port is the source for some non-point source contaminants, especially PAHs associated with coal.

There are many other sources of effluent discharges to the river, with varying degrees of contamination potential. Some of these include wash down water from petroleum bulk storage facilities and concrete plants, backwash water from a gas compressor station, tank filtration water from fish farms and storm water runoff from limestone plants. All of these effluent sources must be analyzed and considered when setting objectives for a particular reach, in order to specify their potential threat to the specific water uses of the reach and to develop Water Quality Objectives for appropriate water bodies.

Since 1985 when the first Water Quality Objectives for this area of the Fraser River were established, several significant changes have taken place with respect to waste discharges. The deep sea outfall from the Iona STP was newly established at that time; however, little information was yet available about its effects. We now know that effects are minor, if any and concentrated very close to the discharge pipes themselves. The Annacis and Lulu STP discharges are being upgraded to secondary treatment levels from primary. Several industrial operations which discharged to the river have subsequently closed, including Western Canada Steel, Chatterton Chemicals, and Doman Forest Products. As well, lead has been eliminated as an additive to gasoline (replaced by manganese) while a Regulation under the Waste Management Act has greatly reduced the discharge of chlorophenols to the river. Many contaminated sites have also been rehabilitated, including those at Noranda (PCB's) and White Pine (creosote). There has also been a great increase in the urbanized area resulting in greater flows from the sewage treatment facilities and stormwater.

Water Quality Assessment and Objectives

WATER QUALITY ASSESSMENT

The water quality assessment of the Fraser River includes data regarding water and sediment quality, as well as fish tissue chemistry and benthos abundance, diversity, community structure, and tissue chemistry. The river is generally well buffered to acidic inputs, with moderate water hardness. Metal concentrations generally meet the guidelines for the protection of aquatic life; however, aluminum and copper concentrations are high in some areas. These metals appear to be at high levels in the upper river as well. On some occasions in backwater areas and sloughs, dissolved oxygen concentrations are below guidelines to protect aquatic life. Fecal coliform concentrations are high throughout the Fraser River below Hope.

Tidal influences play an important role in the distribution of contaminated sediments in the Fraser River. Reduced flows allow finer-sized sediment particles, which adsorb higher concentrations of organics, to settle out. The highest concentrations of organochlorine compounds in sediments from upstream pulp and paper operations are found at sites downstream from Hope, likely due to slower river velocities in this area.

Fish tissue analyses indicated some high arsenic and cadmium concentrations. There are no guidelines for human consumption so that it cannot be determined if these high levels are a concern. Lead concentrations seem to be decreasing due to the elimination of leaded gasoline. Manganese concentrations were higher in fish from the Main Arm than in those from other reaches while chromium concentrations were higher in fish from the North Arm. The data indicated that the elimination of mercury is faster than any uptake, resulting in no accumulation. Some PCBs were measurable in fish from the North Arm where historic discharges have taken place, but the concentrations were not of concern.

Benthic fauna analyses indicated that both abundance and biodiversity were greater downstream toward the urban and industrial centres of the North and Middle Arms. In contrast, the number of sensitive taxa of benthos decreased significantly toward these centres. This change means that some impacts from human activities are being measured in the downstream reaches. Because there are no federal guidelines or provincial guidelines for the interpretation of most contaminant concentrations in tissues, tissue chemistry was simply reported but not evaluated for effects on designated water uses.

WATER QUALITY OBJECTIVES

Water Quality Objectives proposed for the five reaches of the Fraser River from Hope to the Sturgeon and Roberts Banks are listed in Table 1. The Objectives are based on BC approved guidelines for water quality, the Canadian Water Quality Guidelines developed by the Canadian Council of Ministers of the Environment for water quality, and on available data on ambient water quality, waste discharges, water uses, and stream flows.

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 currently being prepared only for water bodies and for water quality characteristics which may be affected by human activity now and in the foreseeable future.

Designated water uses for all five reaches of the Fraser River from Hope to the Sturgeon and Roberts Banks are for the protection of aquatic life, wildlife, recreation, livestock watering, and irrigation. On Sturgeon and Roberts Banks, designated water uses are protection of aquatic life and wildlife, and primary-contact recreation.

Water Quality Objectives which are based on approved or draft BC water quality guidelines include those for suspended solids, dissolved oxygen, chromium, copper, lead, manganese, zinc, PCBs, PAHs, dioxins and furans, chlorophenols, microbiological indicators, ammonia, nitrite and pH. The objectives are required to ensure that inputs from non-point source discharges, and point sources such as pulp and paper mills and sewage treatment plants do not impair water uses. An objective is proposed for pH as a range of values. The upper value will control the formation of toxic quantities of ammonia. In the estuary area, the Objectives for some PAHs in sediments are based on the likely presence of salt water in the pores of the sediment.

Water Quality Objectives which came into effect in 1985 for the tributaries to the Fraser River between Hope and Kanaka Creek are included as Table 6 in this document. No effort has been made in the technical appendix to rationalize these; however, values have been revised to reflect new guidelines which have been developed for the contaminants of concern.

MONITORING RECOMMENDATIONS

Monitoring programs should be designed and coordinated to determine the degree to which Water Quality Objectives are being met. Monitoring of ecosystem responses will provide a means of identifying situations where more restrictive effluent standards are required or where Water Quality Objectives need to be adjusted to meet water management goals. A suggested monitoring program design is in Table 5. The actual monitoring undertaken will depend on regional resources and will be coordinated with activities of other groups such as the GVRD. Should the Objectives be exceeded, it will mean that some water uses may be threatened at some time in the future.

WATER QUALITY OBJECTIVES AND MONITORING TABLES

The following tables provide a summary of the objectives data and monitoring recommendations.

To protect water uses in a waterbody, objectives specify a range of values for characteristics (variables) that may affect these uses. These values are maximum and/or minimum values that are not to be exceeded.

Some readers may be unfamiliar with terms such as: maximum concentration, 30-day average concentration, 90th percentile, and not applicable (NA). Maximum concentration means that a value for a specific variable should not be exceeded; 30-day average concentration means that a value should not be exceeded during a period of 30 days, when five or more samples are collected at approximately equal time intervals. The term 90th percentile indicates that 9 out of 10 values should be less than a particular value. Not applicable (NA) means that water uses are not threatened for that particular variable.

Table 1. Water Quality Objectives for the Fraser River Hope to Sturgeon and Roberts Banks.

Characteristics	Hope to Chilliwack	Chilliwack to Kanaka Creek	Kanaka Creek to the trifurcation	North and Middle Arms	Main Arm	Sturgeon and Roberts Banks
Designated Water uses	aquatic life, wildlife, livestock watering, irrigation, secondary contact recreation					
Designated Water Uses	not applicable			primary contact recreation		
fecal coliforms	less than or equal to 200 CFU/100 mL geometric mean, April to October					
enterococci	less than or equal to 20 CFU/100 mL geometric mean, April to October					
Escherichia coli	less than or equal to 77 CFU/100 mL geometric mean, April to October					
Pseudomonas aeruginosa	less than or equal to 10 CFU/100 mL 75th percentile, April to October		less than or equal to 10 CFU/100 mL geometric mean, April to October			
suspended solids	not applicable		less than or equal to 10 mg/L increase when the u/s background is less than100			not applicabl

		mg/L or ..... less than or equal to 110% of the u/s background when the background is greater than 100 mg/L		e
total ammonia nitrogen	**AMMONIA TABLES**			not applicable
total nitrite nitrogen	**NITRITE TABLE**			not applicable
pH	6.5 to 8.5			not applicable
dissolved oxygen	greater than or equal to 5 mg/L instantaneous minimum 30-day mean greater than or equal to 8.0 mg/L or 80% saturation whichever is higher from May to October ..... greater than or equal to 9 mg/L instantaneous minimum ..... 30-day mean greater than or equal to 11.0 mg/L from November to April			greater than or equal to 5 mg/L instantaneous minimum ..... 30-day mean greater than or equal to 8.0 mg/L or 80% saturation whichever is higher
total chromium	not applicable		less than or equal to 26 micrograms/g dry	not applicable

			weight of sediment, long-term	
total copper	not applicable	less than or equal to 2 micrograms/L mean when hardness is less than 50 mg/L ..... less than or equal to [0.04 (mean hardness)] micrograms/L when hardness is greater than 50 mg/L ..... less than [0.094(hardness) + 2] micrograms/L maximum		not applicable
total lead	not applicable	less than or equal to 3.31 + exp(1.273(ln(mean hardness) - 4.705) micrograms/L mean and ..... less than exp(1.273(ln(hardness) - 1.460) micrograms/L maximum	For Freshwater: less than or equal to 3.31 + exp(1.273(ln(mean hardness) - 4.705) micrograms/L mean and less than exp(1.273(ln(hardness) - 1.460) micrograms/L maximum ..... For Estuarine and Marine Water: less than or equal to 2 micrograms/L mean with 80% of values less than or equal to 3 micrograms/L ..... less than 140 micrograms/L maximum	not applicable
total manganese	not applicable	less than 100 micrograms/L maximum		not applicable
total zinc	not applicable	less than or equal to 14 micrograms/L mean		not applicabl

		..... less than 30 micrograms/L maximum	e
total PCBs	not applicable	In sediments: less than or equal to 0.02 micrograms/g dry weight of sediments normalized to 1% organic carbon ..... In Whole Fish less than or equal to 0.1 micrograms/g wet weight	not applicabl e
total chlorophenols	In sediments: less than or equal to 0.01 micrograms/g dry weight of sediment ..... In Fish Muscle less than or equal to 0.2 micrograms/g wet weight		not applicabl e
2,3,4,6-TTCP	not applicable	less than or equal to 0.04 microgra ms/L when pH is less than 7.1 ..... less than or equal to 0.3 microgra ms/L when pH is greater than 7.1	not applicable
2,3,5,6-TTCP	not applicable	less than or equal to 0.02 microgra ms/L when pH is less than 7.1	not applicable

		less than or equal to 0.1 micrograms/L when pH is between 7.1 and 8.1 ..... less than or equal to 0.25 micrograms/L when pH is greater than 8.1	
PCP	not applicable	less than or equal to 0.02 micrograms/L when pH is less than 6.9 ..... less than or equal to 0.1 micrograms/L when pH is greater than 6.9 and less than 7.9	not applicable

Dioxins and Furans 2,3,7,8-T_4CDD TEQ's	In sediments: less than or equal to 0.25 pg TEQ/g sediment normalized to 1% organic carbon ..... In Fish Muscle: less than or equal to 50 pg/g wet weight in fish muscle or egg	In Sediment: less than or equal to 0.25 pg

	tissue			TEQ/g sediment normalized to 1% organic carbon
PAHs acridine	not applicable	In Sediment: less than or equal to 1 microgram/g dry weight normalized to 1% organic carbon		not applicable
PAHs acenaphthene	not applicable	In Sediment: less than or equal to 0.15 microgram/g dry weight normalized to 1% organic carbon		
PAHs acenaphthylene	not applicable	In Sediment: less than or equal to 0.66 microgram/g dry weight normalized to 1% organic carbon	In Sediment: less than or equal to 0.01 microgram/g dry weight normalized to 1% organic carbon in May to August ..... In Sediment: less than or equal to 0.66 microgram/g dry weight normalized to 1% organic carbon in September to April	not applicable
PAHs anthracene	not applicable	In Sediment: less than or equal to 0.6 microgram/g dry weight normalized to 1% organic carbon		not applicable
PAHs benzo(a)anthracene	not applicable	In Sediment: less than or equal to 0.2 microgram/g dry weight normalized to 1% organic carbon		not applicable
PAHs benzo(a)pyrene	not applicable	In Sediment: less than or equal to 0.06 microgram/g dry weight normalized to 1% organic carbon ..... In Fish Muscle: less than or equal to 4 micrograms/kg wet weight when consumers eat less than or		In Sediment: less than or equal to 0.06 microgra

		equal to 50 g/week ..... less than or equal to 2 micrograms/kg wet weight when consumers eat more than 50 and less than or equal to 100 g/week ..... less than or equal to 1 micrograms/kg wet weight when consumers eat more than 100 and less than or equal to 200 g/week		m/g dry weight normalize d to 1% organic carbon
PAHs chrysene	not applicable	In Sediment: less than or equal to 0.2 microgram/g dry weight normalized to 1% organic carbon		
PAHs di-benzo(a,h)anth racene	not applicable	In Sediment: less than or equal to 0.005 microgram/g dry weight normalized to 1% organic carbon		not applicabl e
PAHs fluoranthene	not applicable	In Sediment: less than or equal to 2 microgram/g dry weight normalized to 1% organic carbon		not applicabl e
PAHs fluorene	not applicable	In Sediment: less than or equal to 0.2 microgram/g dry weight normalized to 1% organic carbon		
PAHs naphthalene	not applicable	In Sediment: less than or equal to 0.01 microgram/g dry weight normalized to 1% organic carbon		
PAHs phenanthrene	not applicable	In Sediment: less than or equal to 0.0867 microgram/g dry weight normalized to 1% organic carbon	In Sediment: less than or equal to 0.04 microgram/g dry weight normalized to 1% organic carbon in May to August ..... In Sediment: less than or equal to 0.0867 microgram/g dry weight normalized to 1% organic carbon in September to April	not applicabl e

Note: While water quality objectives do not apply in initial dilution zones where acutely toxic conditions are not permitted, they do apply to discrete samples of water and sediment from all other parts of the Fraser River from Moose Lake to Hope. In practice, the extent of the initial dilution zone is defined on a site specific basis, with due regard to water uses, aquatic life, including migratory fish, and other waste discharges. However, where sufficient site-specific data is not available for defining initial dilution zones for the objectives established, provisional initial dilution zones will be defined as extending up to 100 metres downstream from a discharge, and occupying no more than 25% of the stream width around the discharge point, from the bed of the stream to the surface. It is also important to note that objectives for fish apply to all parts of the river, including fish in the initial dilution zone.
-Not Applicable means no water quality objective is recommended.
-For fecal coliforms and enterococci the 90th percentiles are calculated from at least five weekly samples collected in a period of thirty days. For values recorded as less than the detection limit, the detection limit itself should be used in calculating the statistic. The 90th percentile can be extrapolated by graphical methods when fewer than ten samples are collected.
-For turbidity and suspended solids the increase in mg/L or NTU is over levels measured at a site upstream from a discharge or series of discharges and as close to them as possible, and applies to downstream values.
-The maximum chlorophyll-a is based on an average calculated from at least five randomly located samples from natural substrates at each site on any sampling date.
-For pH measurements may be made in situ but must be confirmed in the laboratory if the objective is not achieved.

Table 5. Recommended Water Quality Monitoring for the Fraser River from Hope to the Sturgeon and Roberts Banks.

Site and Location	Sampling Frequency and Dates	Variables
E206581 Fraser River at Hope	5 times weekly in 30 days ..... January to March	In Water: fecal coliforms, enterococci, *Escherichia coli*, *Pseudomonas aeruginosa*, dissolved oxygen, ammonia-N, nitrite-N, pH, chloride
E207603 Fraser River d/s of Kent STP		

E207602 Fraser River d/s of MSA STP		
0300005 Fraser River main stem d/s of Pattullo Bridge		
0300002 Fraser River North Arm d/s of Oak Street Bridge		
0301311 Fraser River Main Arm d/s of Annacis STP		
E207407 Fraser River Main Arm d/s of Lulu STP		
0300005 Fraser River Main Stem d/s Pattullo Bridge 0300002 Fraser River North Arm d/s of Oak Street Bridge 0301311 Fraser River Main Arm d/s Annacis STP	5 times weekly in 30 days ..... January to March	In Water: suspended solids
0300005 Fraser River Main Stem d/s of Pattullo Bridge 0300002 Fraser River North Arm d/s of Oak Street Bridge 0301311 Fraser River Main Arm d/s	5 times weekly in 30 days ..... January to March	In Water: copper, lead, manganese, zinc

Annacis STP		
0300002 Fraser River North Arm d/s of Oak Street Bridge	5 times weekly in 30 days ..... January to March	In Water: 2,3,4,5,6-PCP; 2,3,4,5-TTCP; 2,3,4,6-TTCP; 2,3,5,6-TTCP
E207600 Fraser River Middle Arm		
E206965 Fraser River Main Stem at Barnston Island	once, composite at each site of 3 replicates ..... January to March	In Sediments: organic carbon, moisture content, PCBs, PAHs (acridine, acenaphthene, acenaphthylene, anthracene, benzo(a)pyrene, benzo(a)anthacene, chrysene, dibenzo(a,h)anthacene, fluoranthene, fluorene, naphthalene, phenanthrene)
E206967 Fraser River North Arm at Tree Island Slough		
E206968 Fraser River North Arm at MacDonald Slough		
E206969 Fraser River Main Arm at Annieville Channel		
E206970 Fraser River Main Arm at Ewen Slough		
new site Fraser River near Hope	once, composite at each site of 3 replicates ..... January to March	In Sediments: organic carbon, moisture content, total chlorophenols, dixins and furans ..... In Fish Muscle: moisture content, total chlorophenols, dixins and furans
E207931 Fraser River u/s MSA STP		
E206968 Fraser River North Arm at MacDonald Slough		
E206965 Fraser River Main Arm at		

Barnston Island		
E206970 **Fraser River Main Arm at Ewen Slough**		
E206969 **Fraser River Main Arm at Annieville Channel**	**once, composite at each site of 3 replicates** **.....** **January to March**	**In Sediments:** **chromium, moisture content**
E206970 **Fraser River Main Arm at Ewen Slough**		
new site **Roberts Bank between Coal port and Tsawwassen jetty**	**5 times weekly in 30 days** **.....** **January to March**	**In Water:** **fecal coliforms, enterococci, *Escherichia coli*, *Pseudomonas aeruginosa*, pH, dissolved oxygen**
new site **Sturgeon Bank between Iona jetty and Main Arm jetty**		
new site **Roberts Bank between Coal port and Tsawwassen jetty**	**once, composite at each site of 3 replicates** **.....** **January to March**	**In Sediments:** **organic carbon, moisture content, Dioxins and Furans, PAHs (acenaphthene, benzo(a)pyrene, chrysene, fluorene, naphthalene, phenanthrene)**
new site **Sturgeon Bank between Iona jetty and Main Arm jetty**		

Table 6. Water Quality Objectives for Tributaries to the Fraser River from Hope to Kanaka Creek.

Table 6a. Water Quality Objectives for Tributaries to the Fraser River from Hope to Kanaka Creek.

Designated Water Uses:aquatic life, wildlife, livestock watering, irrigation-for all sites
addition of drinking water with complete treatment for Elk and Bertrand Creeks and Salmon River only

Water Bodies	**Hope Slough; Atchelitz, Luckakuck, Chilliwack, Elk, Bertrand and Saar Creeks; Salmon and Sumas Rivers**
Characteristics	**Objectives-except for dissolved oxygen all sampling is April to October**
fecal coliforms	**less than or equal to 200 CFU/100mL geometric mean**
enterococci	**less than or equal to 20 CFU/100mL geometric mean**
Escherichia coli	**less than or equal to 77 CFU/100mL geometric mean**
Pseudomonas aeruginosa	**less than or equal to 10 CFU/100mL 75th percentile**
dissolved oxygen	**greater than or equal to 5 mg/L instantaneous minimum 30-day mean greater than or equal to 8.0 mg/L or 80% saturation whichever is higher from May to October ..... greater than or equal to 9 mg/L instantaneous minimum 30-day mean greater than or equal to 11.0 mg/L from November to April**

Table 6b. Water Quality Objectives for Tributaries to the Fraser River from Hope to Kanaka Creek.

Designated Water Uses:aquatic life, wildlife, livestock watering, irrigation-for all sites
addition of drinking water with complete treatment for Elk and Bertrand Creeks and Salmon River only

Water Bodies	**Hope Slough; Atchelitz, Luckakuck, Chilliwack, Elk and Bertrand Creeks; Salmon River**
Characteristics	**Objectives-except for dissolved oxygen all sampling is April to October**
pH	**6.5 to 8.5**

ammonia nitrogen	AMMONIA TABLE

Table 6c. Water Quality Objectives for Tributaries to the Fraser River from Hope to Kanaka Creek.

Water Bodies	Chilliwack River Designated Uses: aquatic life, wildlife, recreation, livestock watering, irrigation, drinking water with partial treatment	Cultus Lake Designated uses: aquatic life, wildlife, primary contact recreation, drinking water with disinfection only
Characteristics	Objectives-except for dissolved oxygen all sampling is April to October	Objectives-all sampling is April to October
fecal coliforms	less than or equal to 100 CFU/100/mL 90th percentile	Near Water Intakes: less than or equal to 10 CFU/100/mL 90th percentile ..... At Bathing Beaches: less than or equal to 200 CFU/100/mL 90th geometric mean
enterococci	less than or equal to 100 CFU/100/mL 90th percentile	Near Water Intakes: less than or equal to 3 CFU/100/mL 90th percentile ..... At Bathing Beaches: less than or equal to 20 CFU/100/mL 90th geometric mean
Escherichia coli	less than or equal to 100 CFU/100/mL 90th percentile	Near Water Intakes: less than or equal to 10 CFU/100/mL 90th percentile ..... At Bathing Beaches:

		less than or equal to 77 CFU/100/mL 90th geometric mean
Pseudomonas aeruginosa	**not applicable**	**At Bathing Beaches:** **less than or equal to 2 CFU/100/mL 75th percentile**
total phosphorus	**not applicable**	**less than or equal to 10 micrograms/L mean at spring overturn**
dissolved oxygen	**greater than or equal to 5 mg/L instantaneous minimum** **30-day mean greater than or equal to 8.0 mg/L or 80% saturation whichever is higher from May to October** **.....** **greater than or equal to 9 mg/L instantaneous minimum** **30-day mean greater than or equal to 11.0 mg/L from November to April**	**greater than or equal to 5 mg/L instantaneous minimum in the hypolimnion**

Note: While water quality objectives do not apply in initial dilution zones where acutely toxic conditions are not permitted, they do apply to discrete samples of water and sediment from all other parts of the Fraser River from Moose Lake to Hope. In practice, the extent of the initial dilution zone is defined on a site specific basis, with due regard to water uses, aquatic life, including migratory fish, and other waste discharges. However, where sufficient site-specific data is not available for defining initial dilution zones for the objectives established, provisional initial dilution zones will be defined as extending up to 100 metres downstream from a discharge, and occupying no more than 25% of the stream width around the discharge point, from the bed of the stream to the surface. It is also important to note that objectives for fish apply to all parts of the river, including fish in the initial dilution zone.
-Not Applicable means no water quality objective is recommended.
-For fecal coliforms and enterococci the 90th percentiles are calculated from at least

five weekly samples collected in a period of thirty days. For values recorded as less than the detection limit, the detection limit itself should be used in calculating the statistic. The 90th percentile can be extrapolated by graphical methods when fewer than ten samples are collected.
-For turbidity and suspended solids the increase in mg/L or NTU is over levels measured at a site upstream from a discharge or series of discharges and as close to them as possible, and applies to downstream values.
-The total phosphorus mean is calculated from at least three samples taken at spring overturn, including near the surface, at mid-depth and near the bottom, all at mid-lake.
-For pH, measurements may be made in situ but must be confirmed in the laboratory if the objective is not achieved.

L. Swain
Water Quality Branch
Environmental Protection Department
Ministry of Environment, Lands and Parks
(250) 387-4227