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CYANIDE CONCENTRATION, WATER QUALITY CRITERIA AND ANNOTATED BIBLIOGRAPHY

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ABSTRACT

The toxicological and environmental significance of cyanide in the Similkameen River, British Columbia, is discussed. The source of cyanide in this system is mainly from gold mining via the cyanide heap-leaching operation along the river. The diversity of chemical forms of this pollutant has a direct effect on its degree of toxicity and the analytical method used to measure it. The terminologies used in various studies include free cyanide (the summation of HCN and CN^-), simple cyanide or weak-acid dissociable cyanide, complex cyanides, total cyanide, and thiocyanate.

Most of the experiments leading to the determination of the tolerance limits for aquatic life are based on the toxicity of free cyanide. The median sublethal effects concentrations of this cyanide form can range from 0.001 to 0.025 mg/L and the median lethal threshold concentrations are between 0.02 and 0.30 mg/L. Free cyanide cannot be measured in mine wastes because no approved analytical method of this form exists. Weak-acid dissociable (simple) cyanide is considered to be a reasonable estimate of the toxic components of cyanide. Total cyanide encompasses all of the cyanides including metallocyanide complexes. These are not themselves toxic, but their photodecomposition can yield the highly toxic HCN. Photolysis of iron-cyanide complexes and their potential toxicity to aquatic life is of particular environmental concern in waters affected by gold mine wastes.

Descriptive statistical methods were used to analyse concentrations of cyanide observed in the Similkameen River from 1984 to 1988. Mean concentrations (and ranges) of simple cyanide and total cyanide were 0.0008 (0.0005 - 0.015) mg/L and 0.0011 (0.0005 - 0.0157) mg/L, respectively, at the sampling site near the Canada-United States boundary during the 5 year sampling period. All observations obtained during low flow and high flow conditions were compared with various criteria for the protection of aquatic life. Approximately 2% of simple cyanide observations were above the level of 0.01 mg/L set by the British Columbia Ministry of Environment as a provisional maximum Water Quality Objective for weak-acid dissociable cyanide in the Similkameen River. About 3% of simple cyanide observations exceeded the limit of 0.005 mg/L of the Canadian Water Quality Guidelines. Also, 3% and 4% of simple cyanide observations were above the criteria for continuous exposure of 0.0042 mg/L and 0.0026 mg/L for freshwater aquatic life and rainbow trout, respectively, recommended by the United States Environmental Protection Agency for free cyanide.

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INTRODUCTION

The Similkameen River is a transboundary river between Canada and the United States. This river supports a variety of water uses, including diverse and important sport fisheries. The examination of existing water quality criteria and the formulation of water quality objectives for the transboundary reach of the Similkameen River is necessary because of the continuing intensification of land and water uses in the area. The main concerns focus upon the environmental impact of gold mining via the cyanide heap-leaching operations along the river, and the drainage of toxic elements from agricultural land near the Canada-United States boundary. A number of papers describing developments affecting water uses in the basin, seasonal variations of heavy metal concentrations in the river and their comparison with water quality guidelines have been published by Zeman and Slaymaker (1987, 1988, and 1989).

CHEMISTRY AND FATE OF CYANIDE IN THE AQUATIC ENVIRONMENT

Cyanides comprise a group of organic and inorganic compounds composed of nitrogen bonded to carbon. These compounds occur in water as: a) free hydrocyanic acid (HCN), b) simple cyanides (alkali and alkaline earth cyanides), c) easily decomposable complex cyanides such as $Zn(CN)_2$, and d) relatively stable complex cyanides such as $[Fe(CN)_6]^{-3}$, $[Fe(CN)_6]^{-4}$, and $Co(CN)_4$ (APHA, 1985). The complex nickel and copper cyanides assume an intermediate position between the easily decomposable and relatively stable compounds (Towill et al.,1978). Thiocyanates (SCN^- radical) are compounds which are formed from cyanides and sulfur-containing materials (Conn, 1981).

A number of analytical methods have been developed for cyanide measurements (Leduc et al., 1982). For example, in the automated method for the analysis of total cyanide, ultra-violet light is used to dissociate the complex cyanides. Without this irradiation step, only the simple cyanides are measured (Kelada et al., 1984). In the manual method, described by ASTM (1985), the technique of weak-acid dissociable cyanide may be employed. In free cyanide determination the aim is to measure only the HCN and CN^- present in the sample at the time of analysis (APHA, 1985; U.S. EPA, 1985). Although it is desirable to determine the free cyanide concentration directly, no commonly used methods for free cyanide are available (U.S. EPA, 1985). According to Etheridge (1989), the Ontario Ministry of the Environment considers free cyanide and weak-acid dissociable cyanide to be the same. In the laboratories of Environmental Protection (EP) and the Water Quality Branch of Inland Waters (IW), Vancouver B.C., two different methods were used for the analysis of cyanide compounds in effluents and receiving waters. Effluent samples, in the EP laboratory, were analysed

for total cyanide and weak-acid dissociable cyanide by a method described in Conn (1981). The totals cyanide analysis included all forms of cyanide except the extremely strong complexes such as cobalt-cyanide. The weak-acid dissociable cyanide analysis measured all cyanide forms except the iron-cyanide and cobalt-cyanide complexes. Receiving water samples were analysed in the IW laboratory according to a method described in Golden et al.(1972) and Environment Canada (1988 b). Complex cyanides were converted to hydrocyanic acid (HCN) with irradiation by ultraviolet light, and distilled from a phosphoric acid medium into a phosphate buffer solution for analysis of total cyanide. The simple cyanide analysis was the same except that samples were not irradiated. Comparison of the analytical methods used by these two laboratories (Ferguson 1985) indicated that the IW simple cyanide test measured the same cyanide complexes as the EP weak-acid dissociable analysis. However, the IW total cyanide method included the measurements of thiocyanate and the cobalt-cyanide complex, whereas the EP method did not. In the laboratory of the British Columbia Ministry of Environment a strong-acid dissociable method was used to measure the total cyanide. This method did not measure thiocyanate (Singleton 1986).

Cyanide ion in the aquatic environment can react with a variety of metals to form metal cyanides. If the metals become more prevalent, formation of simple metal cyanides is favored. These compounds are insoluble and can accumulate in bed sediments (Cruz et al., 1974). If cyanide ion is present in excess, complex metallocyanides may be formed. These compounds are quite soluble and can be transported in solution (Towill et al., 1978).

In biological systems, hydrogen cyanide interferes with the enzymes associated with cellular oxidation. It is either quickly metabolized or the organism dies. Thus, there is little potential for bioaccumulation of hydrogen cyanide (Broderius, 1973). Information in the literature exists on the degradation of hydrogen cyanide and metallocyanide complexes during anaerobic and aerobic sewage treatment (Raef et al., 1977), but few data are available on biodegradation of these compounds in surface water.

ENVIRONMENTAL IMPACT

The chemical form of cyanide determines its toxicity to aquatic life. The toxicity of most tested solutions of cyanides to fish is attributable mainly to the molecular HCN resulting from dissociation of the complexes. Cyanides that are strongly bound to their metals, such as ferro- and ferricyanides, have very low toxicity because the cyanide is not free to combine with hydrogen ions to form HCN, even at low pH. However, when iron cyanides are exposed to ultraviolet light they do decompose slowly, making the cyanide ion available to form HCN, and hence have an evironmental impact. On the other hand, sodium and potassium cyanides are

toxic because they dissociate completely in water; at or below pH 8 the cyanide then recombines with the hydrogen ions present to form molecular HCN (Burdick and Lipschuetz, 1948; APHA, 1985).

The influence of pH and temperature on the acute toxicity to fish of free cyanide and the relative contributions of the molecular HCN and the ionic CN^- was investigated by Broderius and Smith (1979). Their findings indicate that when pH is below 8 and temperature is below 25°C, at least 94 percent of the free cyanide exists as HCN. When pH and/or temperature are higher, a smaller percentage of free cyanide exists as HCN and more as CN^-.

The cyanide data in the literature are usually published in terms of free cyanide expressed as CN^-. When free cyanide is expressed as HCN, the results can be adjusted using the molecular weights of the compound and CN^- (U.S. EPA, 1985). Measurements of total cyanide in receiving waters are desirable for the assessment of potential cyanide release from metallic complexes contained in gold mill effluents into the aquatic environment. A state-of-the-art review of the technology being applied at gold mills for the removal of contaminants from waste is described in Ingles and Scott (1987). Removal of these contaminants is required to protect receiving waters from undesirable environmental impacts.

LETHAL AND SUBLETHAL TOXICITY OF FREE CYANIDE

Literature on the toxicity of cyanides to fish contains a large number of data on acute, lethal tests of cyanide (e.g. Leduc and Chan, 1975) but fewer data on the sublethal effects of chronic cyanide poisoning. Two types of acute toxicity tests are utilized: a) static and/or static renewal tests, and b) flow- through tests. The advantages and disadvantages of static tests are described, for example, by Stephan (1982) and Sergy (1987).

The flow-through tests are described by Buikema *et al.* (1980) and Benoit *et al.* (1982). Most of the experiments leading to the determination of the tolerance limits for fish were performed with a flow-through apparatus for continuous renewal of the cyanide solution (Doudoroff, 1976). The concentrations are reported as molecular HCN or free cyanide (HCN and CN^-) expressed as CN^-.

Smith *et al.* (1979) and Cardwell *et al.* (1976) performed numerous tests on the acute toxicity of free cyanide to the young and adults of several kinds of fish, using the continuous-flow technique. Most of the estimated 96-hour median lethal concentrations (LC50) and lethal threshold concentrations (LTC) of HCN or of free cyanide expressed as CN^- range between 0.02 and 0.30 mg/L at temperatures of 6 to 25°C and dissolved oxygen levels not less than 5.0 mg/L. The lethal threshold levels are lowest at low temperatures and decrease with decreasing oxygen concentrations, particularly

below 5 mg/L. According to the experiments of Smith et al. (1979), the fish embryo is not usually the most susceptible life-history stage; it can be very resistant to cyanide poisoning compared with the adult stage. Kimball et al. (1978) found that the susceptibility of adult fish to cyanide poisoning can increase markedly during the spawning period. Koenst et al. (1977) observed the death of one out of five or six adult brook trout during the spawning period at each of the three highest HCN levels tested (about 0.054, 0.065, and 0.075 mg/L). The deaths occurred after the temperature was reduced from 12° to 9°C near the time spawning began.

Sublethal effects of free cyanide observed at concentrations near 0.005 mg/L were impairment of swimming ability, some reduction of fat, and dry weight gains of rainbow trout (Kovacs, 1979) . Kimball et al.(1978) observed a failure of bluegills to spawn after 289 days of exposure to 0.005 mg/L of HCN concentration. Reduction of fecundity and histopathological changes in the liver and gonads have been observed in some experiments (Leduc and Chan, 1975) with juvenile rainbow trout, subjected to chronic poisoning with free cyanide at concentrations as low as 0.01 mg/L. Various other physiological changes in fish have been reported after exposure to cyanide concentrations above 0.03 mg/L (McCracken, 1978).

Examination of data on the toxicity of cyanides to fresh-water invertebrates (Becker and Thatcher 1973) revealed that fish-food organisms were more resistant to cyanide poisoning than the sensitive fishes.

Interaction of free cyanide with other substances was studied by various investigators (EIFAC, 1987). Results from experiments by Broderius and Smith (1979) revealed decidely less-than-additive toxic action of HCN and chromium, possibly due to complexation, and more-than-additive toxicity of HCN with zinc and with ammonia. Negilski and Davies (1973) found that chronic exposure to sublethal concentrations of pentachlorophenol, cyanide and zinc in combination was more harmful to the growth and production of juvenile salmon than the toxicants were individually.

WATER QUALITY CRITERIA FOR FRESHWATER AQUATIC LIFE

Findings from a number of studies indicate that free cyanide concentration limits appropriate for different fresh waters where fisheries are to be protected to varying degrees can range from 0.001 to 0.025 mg/L, (Doudoroff et al. 1976, and Smith et al. 1979).

The approach published in the document by the National Academy of Sciences and National Academy of Engineering (1973), consists of a complex water quality criterion that prescribes free cyanide concentration limits varying with the determined 96-hour median lethal concentrations for the particular species to be protected. According to that publication, a concentration of free cyanide (CN^-) which is safe to aquatic life can be estimated by multiplying the

96-hour LC50 by an application factor of 0.05. No concentration greater than 0.005 mg/L is recommended at any time.

The U.S. EPA criteria, described in the Guidelines for Deriving Numerical National Water Quality Criterion for the Protection of Aquatic Organisms and Their Uses (Stephan et. al.,1985), are expressed as the two following numbers: a) criteria continuous concentration (CCC), which is the water quality criterion recommendation for the highest instream concentration of a toxicant to which organisms can be exposed indefinitely without causing unacceptable effects, and b) criteria maximum concentration (CMC), which is the water quality criterion recommendation representing the highest instream concentration of a toxicant or an effluent to which organisms can be exposed for a brief period of time without causing mortality. The criterion for free cyanide, presented by the U.S. EPA (1985) to protect aquatic life, is 0.0042 mg/L for the CCC and 0.0313 mg/L for CMC. Similarly, the criterion for rainbow trout is 0.0026 mg/L for the CCC and 0.0224 mg/L for the CMC. If a single value must be specified for general application, the U.S. EPA (1987) specify that, except possibly where a locally important species is very sensitive, freshwater aquatic organisms and their uses should not be affected unacceptably if the concentration of cyanide does not exceed criteria for acute and chronic exposures of 0.0052 and 0.022 mg/L, respectively. The criteria were developed for free cyanide, but at this time no approved analytical methods for such a measurement are available. Therefore, U.S. EPA (1987) recommends applying the criteria using the total cyanide method. However, evidence has been presented elsewhere that the total cyanide concentration is not toxicologically meaningful (e.g. Doudoroff, 1976). Weak-acid dissociable cyanide is recommended by Singleton (1986), and Swain (1988) as the water quality criterion in water polluted with waste water cyanide.

Canadian Water Quality Guidelines were prepared by the Canadian Council of Resource and Environment Ministers (CCREM, 1987) and continue to be published as Canadian Council of Ministers of the Environment (CCME) Guidelines. The numerical limit of 0.005 mg/L as free cyanide (CN-) is recommended. Also, it is recognized that sample preservation and analytical problems may make monitoring for free cyanide unreliable (CCREM, 1987). The measurements of weak-acid dissociable cyanide are also recommended in waters affected by mine wastes CCREM (1987). The Similkameen River basin is one of the geographic units in the Province for which provisional water quality objectives were issued by the British Columbia Ministry of Environment (BC MOE). These objectives (Swain, 1988) are: a) that the 30 - day average value and maximum value for weak-acid dissociable cyanide should not exceed 0.005 mg/L and 0.01 mg/L, respectively, and b) that the maximum concentration of strong-acid dissociable cyanide plus thiocyanate should not exceed 0.20 mg/L in drinking water.

SITE-SPECIFIC MEASUREMENTS

Chemical water quality measurements in the Similkameen River were taken at the federal-provincial station OOBCO8NL005 (Environment Canada 1988a) during the period from 1984 to 1988. This station is located approximately 9 km (5.6 miles) north of the Canada-U.S. boundary. Sampling for chemical analysis were conducted by the Water Quality Branch, Inland Waters, Environment Canada, Vancouver, B.C.

The analytical method and preservation of samples used to analyse cyanides in the laboratory of the Water Quality Branch, IW, Environment Canada, Vancouver, B.C. are described in Golden et al. This automated method has a number 0660L (Environment Canada 1988b). This method determines both total cyanide and simple cyanide simultaneously, in the range of 0.0005 to 0.050 mg/L HCN. The methods used to analyse concentrations of selected constituents in water are described in the NAQUADAT Dictionary of Parameter Codes (Environment Canada, 1988b). These constituents were: colour (02011L) rel. units, hardness (10603L) mg/L, pH laboratory (10301L) pH units, turbidity (02013) NIU, cadmium total (48002P) mg/L, copper total (29005P) mg/L, iron total (26005P) mg/L, lead total (02005P) mg/L, manganese total (25005P) mg/L, and zinc total (30005P) mg/L. Discharge data measured at the international gauging station number 08NL022 near Nighthawk, Washington, were provided by the Water Resources Branch, Inland Waters, (Environment Canada, 1986).

DATA ANALYSIS AND COMPARISON WITH GUIDELINES

The measured cyanide concentrations were graphically displayed in a preliminary analysis according to: a) time of the sampling period, b) variation of discharge, and c) distribution pattern. Two major clusters of the data were observed, one in the low flow and the other in the high flow discharge period. Therefore, these observations were divided with respect to the discharge into two distinct groups: a) low flow period (annual mean discharge $\leq 55 m^3/s$), b) high flow period (annual mean discharge $> 55 m^3/s$). The vast majority of cyanide concentrations tend to be low relative to a small, although substantial, number of high concentrations observed during the 5-year period. Plots on probability graph paper showed that the cyanide data were not from a normal distribution and the lognormal distribution was considered as an alternative model for transformation of the data in the regression analysis.

The summary statistics of a large set of data on discharge and cyanide concentrations are shown in Table 1 (Appendix A). The arithmetic mean and standard error are used for interpretation and comparison with previous studies. The overall concentration range for simple cyanide ranged from 0.0005 to 0.015 mg/L and for total cyanide from 0.0005 to 0.0157 mg/L. Maximum concentration of these cyanide forms was

observed during low flow conditions. Multiple linear regression analysis (SPSS, 1988) was used to express total cyanide, the response variable, as a function of several other water quality variables in the regression equation. The procedure sequentially removed less significant variables and indentified those that were significantly associated with total cyanide during low flow and high flow conditions. The t-statistics in Table 2 (Appendix A) indicate the significance levels of these variables. Total cyanide was associated with discharge, hardness, lead, phosphorus, mercury and water temperature during low flow periods. In contrast, during high flow total cyanide was associated with discharge, silica, sodium and chloride. The linear relationship between cyanide and selected variables was confirmed by the F statistic and the R^2 coefficient.

Descriptive statistical methods were used to analyse concentrations of cyanide and the associated variables obtained during low flow and high flow conditions (Appendices B and C). Tables in these appendices indicate the number of observations taken during the sampling period, ranges, arithmetic means with their standard errors, and median concentrations. These statistics are summarized in four groups showing temporal variation during the sampling period in the following terms: a) overall, b) yearly, c) monthly, and d) yearly-monthly.

The concentrations of simple and total cyanides from the Similkameen River were compared with various criteria and guidelines for the protection of aquatic life. Separate comparisons were made to effects levels for rainbow trout, which are of site-specific significance as sport fish in the Similkameen River. The exceedences measured during the 5-year period, compared to the different criteria and guidelines, are illustrated in Table 13. Approximately 2% of simple cyanide observations were above the level of 0.01 mg/L set by the British Columbia Ministry of Environment as a provisional Maximum Water Quality Objective for weak-acid dissociable cyanide (Swain, 1988). About 3% of both simple cyanide and total cyanide observations exceeded the limit of 0.005 mg/L as the Canadian Water Quality Guideline for free cyanide (CCREM, 1987). Also, 3% and 4% of observations of both cyanide forms were above the Concentration Criteria for Continuous Exposure of 0.0042 mg/L and 0.0026 mg/L for freshwater aquatic life and rainbow trout, respectively, recommended for free cyanide (U.S. EPA, 1985).

SUMMARY AND CONCLUSIONS

The diversity of the chemical form of the cyanide anion has a direct effect on its degree of toxicity and the analytical methods used to measure it. The terminology used in various studies includes mainly free cyanide (the summation of HCN and CN^-), simple cyanide or weak-acid dissociable cyanide, complex cyanides, total cyanide, and thiocyanide.

Although free cyanide provides a scientific basis for deriving literature criteria for this constituent, no approved methods for analysis of this cyanide form are available. Weak-acid dissociable cyanide provides a reasonable estimate of toxic components in mine wastes and it is more scientifically defensible as a criterion than total cyanide. The term total cyanide encompasses all the cyanides including metallocyanide complexes. These complexes are not themselves toxic, but their photodecomposition can yield highly toxic HCN. Photolysis of iron-cyanide complexes and their potential toxicity to aquatic life is of particular environmental concern in waters affected by gold mine wastes. Therefore, if iron - cyanides are suspected to be present in the aquatic ecosystem, B.C. Ministry of Environment (Singleton, 1986) recommends site-specific studies such as bioassays using sensitive local species. Such studies would lead to appropriate modification of water quality criteria for cyanide.

The literature data which are based on the toxicity of free cyanide to freshwater fish indicate that the median lethal threshold concentrations are between 0.02 and 0.30 mg/L. Sublethal effects of free cyanide above 0.001 mg/L can be harmful to some fish, especially at low temperatures. Continuous exposure to levels above 0.025 mg/L has been found to impair the growth of most fish species.

The actual data collected in the Similkameen River near the Canada-United States boundary indicate that the overall concentration range for simple (weak-acid dissociable) cyanide was from 0.0005 to 0.015 mg/l during the sampling period from 1984 to 1988. All cyanide concentration data were compared with published water quality criteria pertaining to the protection of freshwater aquatic life. Concentrations of cyanide which exceeded water quality criteria were observed in the late summer and fall seasons characterized by low flow. Extreme values occurred in October 1987 and also in May and August 1988 after the start of active gold mining on the Nickel Plate Mountain and gold extraction from the old tailings at Hedley. In view of the observed high values, additional work would be required to define potential sources such as cyanide heap-leaching operations along the river, seepage waters from tailings ponds, and to study cyanide attenuation potential of soil between the tailings and groundwater in the area of Cahill Creek, and the impact on water in the Similkameen River.

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APPENDIX A

TABLE 1. Statistical Summary of Discharge and Cyanide Concentrations Observed in the Similkameen River Near the Canada-United States Boundary during 1984-1988.

Discharge Conditions	Minimum	Maximum	Arithmetic Mean	Standard Error	Coefficient of Variation	Median	Percentiles 95%	Percentiles 99%	Number of Observations
				Discharge m^3/sec					
Low Flow	4.5	51	17.8	1.0	63.9	14.4	44.5	50.1	127
High Flow	53.8	430	156.4	14.5	64.0	109	368	430	47
Overall	4.5	430	55.2	6.1	146.7	17.5	278	385	174
				Simple Cyanide (mg/L)					
Low Flow	0.0005	0.015	0.0009	0.0002	221.0	0.0005	0.0015	0.014	117
High Flow	0.0005	0.0085	0.0007	0.0002	175.9	0.0005	0.0005	0.0085	45
Overall	0.0005	0.015	0.0008	0.0001	215.4	0.0005	0.001	0.014	162
				Total Cyanide (mg/L)					
Low Flow	0.0005	0.0157	0.0011	0.0002	189.3	0.0005	0.0022	0.015	116
High Flow	0.0005	0.011	0.0008	0.0002	185.7	0.0005	0.0012	0.011	45
Overall	0.0005	0.0157	0.0010	0.0002	189.9	0.0005	0.002	0.015	161

TABLE 2. Regression Analysis determining the Relationship between Total Cyanide and a Set of Physical and Chemical Variables under different Discharge Conditions in the Similkameen River during 1984-1988.

	Statistics for Variables in the Regression Equation						
Variable	Slope	t Statistics	Significance	F Statistic	Significance	Number of Observations	R^2
			Low Flow				
Discharge	-1.74484	-4.844	0.00005	9.253	0.00005	68	0.738
Hardness	-5.44038	-4.704	0.00005				
Lead Total	-0.50492	-4.066	0.0001				
Phosphorus Total	-0.30419	-2.718	0.0086				
Selenium Total	0.43816	2.649	0.0103				
Mercury Total	-0.47036	-2.385	0.0202				
Water Temperature	0.21364	2.314	0.0241				
Intercept	7.99867	3.073	0.0032				
			High Flow				
Discharge	1.33207	5.136	0.00005	13.4259	0.00005	31	0.821
Silica Reactive	-6.70887	-6.845	0.00005				
Sodium Dissolved	6.01379	5.855	0.00005				
Chloride	-0.92388	-2.825	0.0090				
Intercept	-1.58817	-1.849	0.0759				

TABLE 1.1. Summary Statistics for Water Quality Measurements in the Similkameen River near the Canada-United States Bounday. Cyanide Simple (mg/L).

84-8	N	Minimum	Maximum	Mean	Std.Error	Median
	162	0.0005	0.0150	0.00083	0.00014	0.0005

---------- STATION=near the Canada-United States Boundary ----------

YEAR	N	Minimum	Maximum	Mean	Std.Error	Median
1984	50	0.0005	0.0005	0.00050	0.00000	0.0005
1985	33	0.0005	0.0007	0.00051	0.00001	0.0005
1986	26	0.0005	0.0005	0.00050	0.00000	0.0005
1987	27	0.0005	0.0150	0.00181	0.00072	0.0005
1988	26	0.0005	0.0085	0.00121	0.00041	0.0005

---------- STATION=near the Canada-United States Boundary ----------

MONTH	N	Minimum	Maximum	Mean	Std.Error	Median
Jan	11	0.0005	0.0010	0.00055	0.00005	0.0005
Feb	11	0.0005	0.0005	0.00050	0.00000	0.0005
Mar	13	0.0005	0.0005	0.00050	0.00000	0.0005
Apr	15	0.0005	0.0005	0.00050	0.00000	0.0005
May	15	0.0005	0.0085	0.00103	0.00053	0.0005
Jun	16	0.0005	0.0005	0.00050	0.00000	0.0005
Jul	13	0.0005	0.0035	0.00082	0.00024	0.0005
Aug	16	0.0005	0.0075	0.00097	0.00044	0.0005
Sep	11	0.0005	0.0010	0.00062	0.00006	0.0005
Oct	17	0.0005	0.0150	0.00215	0.00113	0.0005
Nov	12	0.0005	0.0050	0.00088	0.00038	0.0005
Dec	12	0.0005	0.0005	0.00050	0.00000	0.0005

TABLE 1.1 - Cont'd

YEAR	MONTH	N	Minimum	Maximum	Mean	Std.Error	Median
1984	Jan	0	.	.	.	.	.
1984	Feb	1	0.0005	0.0005	0.00050	.	0.0005
1984	Mar	1	0.0005	0.0005	0.00050	.	0.0005
1984	Apr	5	0.0005	0.0005	0.00050	0.00000	0.0005
1984	May	7	0.0005	0.0005	0.00050	0.00000	0.0005
1984	Jun	7	0.0005	0.0005	0.00050	0.00000	0.0005
1984	Jul	5	0.0005	0.0005	0.00050	0.00000	0.0005
1984	Aug	6	0.0005	0.0005	0.00050	0.00000	0.0005
1984	Sep	3	0.0005	0.0005	0.00050	0.00000	0.0005
1984	Oct	7	0.0005	0.0005	0.00050	0.00000	0.0005
1984	Nov	4	0.0005	0.0005	0.00050	0.00000	0.0005
1984	Dec	4	0.0005	0.0005	0.00050	0.00000	0.0005
1985	Jan	6	0.0005	0.0005	0.00050	0.00000	0.0005
1985	Feb	4	0.0005	0.0005	0.00050	0.00000	0.0005
1985	Mar	4	0.0005	0.0005	0.00050	0.00000	0.0005
1985	Apr	3	0.0005	0.0005	0.00050	0.00000	0.0005
1985	May	2	0.0005	0.0005	0.00050	0.00000	0.0005
1985	Jun	2	0.0005	0.0005	0.00050	0.00000	0.0005
1985	Jul	2	0.0005	0.0007	0.00060	0.00010	0.0006
1985	Aug	2	0.0005	0.0005	0.00050	0.00000	0.0005
1985	Sep	1	0.0005	0.0005	0.00050	.	0.0005
1985	Oct	3	0.0005	0.0005	0.00050	0.00000	0.0005
1985	Nov	2	0.0005	0.0005	0.00050	0.00000	0.0005
1985	Dec	2	0.0005	0.0005	0.00050	0.00000	0.0005
1986	Jan	2	0.0005	0.0005	0.00050	0.00000	0.0005
1986	Feb	2	0.0005	0.0005	0.00050	0.00000	0.0005
1986	Mar	2	0.0005	0.0005	0.00050	0.00000	0.0005
1986	Apr	3	0.0005	0.0005	0.00050	0.00000	0.0005
1986	May	2	0.0005	0.0005	0.00050	0.00000	0.0005
1986	Jun	2	0.0005	0.0005	0.00050	0.00000	0.0005
1986	Jul	2	0.0005	0.0005	0.00050	0.00000	0.0005
1986	Aug	2	0.0005	0.0005	0.00050	0.00000	0.0005
1986	Sep	2	0.0005	0.0005	0.00050	0.00000	0.0005
1986	Oct	3	0.0005	0.0005	0.00050	0.00000	0.0005
1986	Nov	2	0.0005	0.0005	0.00050	0.00000	0.0005
1986	Dec	2	0.0005	0.0005	0.00050	0.00000	0.0005
1987	Jan	1	0.0005	0.0005	0.00050	.	0.0005
1987	Feb	2	0.0005	0.0005	0.00050	0.00000	0.0005
1987	Mar	3	0.0005	0.0005	0.00050	0.00000	0.0005
1987	Apr	2	0.0005	0.0005	0.00050	0.00000	0.0005
1987	May	2	0.0005	0.0005	0.00050	0.00000	0.0005
1987	Jun	3	0.0005	0.0005	0.00050	0.00000	0.0005
1987	Jul	2	0.0005	0.0015	0.00100	0.00050	0.0010
1987	Aug	3	0.0005	0.0010	0.00067	0.00017	0.0005
1987	Sep	3	0.0008	0.0010	0.00093	0.00007	0.0010
1987	Oct	2	0.0140	0.0150	0.01450	0.00050	0.0145
1987	Nov	2	0.0005	0.0050	0.00275	0.00225	0.0027
1987	Dec	2	0.0005	0.0005	0.00050	0.00000	0.0005
1988	Jan	2	0.0005	0.0010	0.00075	0.00025	0.0008
1988	Feb	2	0.0005	0.0005	0.00050	0.00000	0.0005
1988	Mar	3	0.0005	0.0005	0.00050	0.00000	0.0005
1988	Apr	2	0.0005	0.0005	0.00050	0.00000	0.0005
1988	May	2	0.0005	0.0085	0.00450	0.00400	0.0045
1988	Jun	2	0.0005	0.0005	0.00050	0.00000	0.0005
1988	Jul	2	0.0005	0.0035	0.00200	0.00150	0.0020
1988	Aug	3	0.0005	0.0075	0.00283	0.00233	0.0005
1988	Sep	2	0.0005	0.0005	0.00050	0.00000	0.0005
1988	Oct	2	0.0005	0.0005	0.00050	0.00000	0.0005
1988	Nov	2	0.0005	0.0005	0.00050	0.00000	0.0005
1988	Dec	2	0.0005	0.0005	0.00050	0.00000	0.0005

TABLE 1.2. Summary Statistics for Water Quality Measurements in the Similkameen River near the Canada-United States Boundary. Cyanide Total 06606 (mg/L).

---------- STATION=near the Canada-United States Boundary ----------

84-8	N	Minimum	Maximum	Mean	Std.Error	Median
	161	0.0005	0.0157	0.00105	0.00016	0.0005

---------- STATION=near the Canada-United States Boundary ----------

YEAR	N	Minimum	Maximum	Mean	Std.Error	Median
1984	49	0.0005	0.0020	0.00056	0.00003	0.0005
1985	33	0.0005	0.0020	0.00077	0.00006	0.0007
1986	26	0.0005	0.0017	0.00060	0.00005	0.0005
1987	27	0.0005	0.0157	0.00224	0.00076	0.0007
1988	26	0.0005	0.0110	0.00153	0.00049	0.0007

---------- STATION=near the Canada-United States Boundary ----------

MONTH	N	Minimum	Maximum	Mean	Std.Error	Median
Jan	11	0.0005	0.0020	0.00078	0.00014	0.0005
Feb	11	0.0005	0.0007	0.00054	0.00002	0.0005
Mar	13	0.0005	0.0007	0.00053	0.00002	0.0005
Apr	15	0.0005	0.0012	0.00063	0.00006	0.0005
May	15	0.0005	0.0110	0.00132	0.00069	0.0005
Jun	16	0.0005	0.0010	0.00059	0.00004	0.0005
Jul	13	0.0005	0.0035	0.00097	0.00025	0.0005
Aug	15	0.0005	0.0083	0.00137	0.00052	0.0005
Sep	11	0.0005	0.0020	0.00091	0.00020	0.0005
Oct	17	0.0005	0.0157	0.00241	0.00119	0.0005
Nov	12	0.0005	0.0057	0.00122	0.00042	0.0008
Dec	12	0.0005	0.0020	0.00083	0.00013	0.0007

TABLE 1.2 - Cont'd

YEAR	MONTH	N	Minimum	Maximum	Mean	Std.Error	Median
1984	Jan	0	.	.	.	.	.
1984	Feb	1	0.0005	0.0005	0.00050	.	0.0005
1984	Mar	1	0.0005	0.0005	0.00050	.	0.0005
1984	Apr	5	0.0005	0.0005	0.00050	0.00000	0.0005
1984	May	7	0.0005	0.0008	0.00054	0.00004	0.0005
1984	Jun	7	0.0005	0.0007	0.00053	0.00003	0.0005
1984	Jul	5	0.0005	0.0005	0.00050	0.00000	0.0005
1984	Aug	5	0.0005	0.0005	0.00050	0.00000	0.0005
1984	Sep	3	0.0005	0.0005	0.00050	0.00000	0.0005
1984	Oct	7	0.0005	0.0008	0.00057	0.00005	0.0005
1984	Nov	4	0.0005	0.0007	0.00055	0.00005	0.0005
1984	Dec	4	0.0005	0.0020	0.00093	0.00036	0.0006
1985	Jan	6	0.0005	0.0012	0.00065	0.00011	0.0005
1985	Feb	4	0.0005	0.0005	0.00050	0.00000	0.0005
1985	Mar	4	0.0005	0.0005	0.00050	0.00000	0.0005
1985	Apr	3	0.0005	0.0010	0.00077	0.00015	0.0008
1985	May	2	0.0007	0.0008	0.00075	0.00005	0.0008
1985	Jun	2	0.0007	0.0008	0.00075	0.00005	0.0008
1985	Jul	2	0.0005	0.0015	0.00100	0.00050	0.0010
1985	Aug	2	0.0007	0.0010	0.00085	0.00015	0.0009
1985	Sep	1	0.0008	0.0008	0.00080	.	0.0008
1985	Oct	3	0.0007	0.0020	0.00123	0.00039	0.0010
1985	Nov	2	0.0010	0.0012	0.00110	0.00010	0.0011
1985	Dec	2	0.0005	0.0012	0.00085	0.00035	0.0008
1986	Jan	2	0.0005	0.0007	0.00060	0.00010	0.0006
1986	Feb	2	0.0005	0.0005	0.00050	0.00000	0.0005
1986	Mar	2	0.0005	0.0005	0.00050	0.00000	0.0005
1986	Apr	3	0.0005	0.0012	0.00073	0.00023	0.0005
1986	May	2	0.0005	0.0005	0.00050	0.00000	0.0005
1986	Jun	2	0.0005	0.0010	0.00075	0.00025	0.0008
1986	Jul	2	0.0005	0.0005	0.00050	0.00000	0.0005
1986	Aug	2	0.0005	0.0005	0.00050	0.00000	0.0005
1986	Sep	2	0.0005	0.0005	0.00050	0.00000	0.0005
1986	Oct	3	0.0005	0.0005	0.00050	0.00000	0.0005
1986	Nov	2	0.0005	0.0017	0.00110	0.00060	0.0011
1986	Dec	2	0.0005	0.0005	0.00050	0.00000	0.0005
1987	Jan	1	0.0005	0.0005	0.00050	.	0.0005
1987	Feb	2	0.0005	0.0005	0.00050	0.00000	0.0005
1987	Mar	3	0.0005	0.0005	0.00050	0.00000	0.0005
1987	Apr	2	0.0005	0.0005	0.00050	0.00000	0.0005
1987	May	2	0.0005	0.0005	0.00050	0.00000	0.0005
1987	Jun	3	0.0005	0.0007	0.00057	0.00007	0.0005
1987	Jul	2	0.0013	0.0018	0.00155	0.00025	0.0015
1987	Aug	3	0.0018	0.0022	0.00200	0.00012	0.0020
1987	Sep	3	0.0017	0.0020	0.00190	0.00010	0.0020
1987	Oct	2	0.0150	0.0157	0.01535	0.00035	0.0153
1987	Nov	2	0.0010	0.0057	0.00335	0.00235	0.0034
1987	Dec	2	0.0007	0.0008	0.00075	0.00005	0.0008
1988	Jan	2	0.0010	0.0020	0.00150	0.00050	0.0015
1988	Feb	2	0.0007	0.0007	0.00070	0.00000	0.0007
1988	Mar	3	0.0005	0.0007	0.00063	0.00007	0.0007
1988	Apr	2	0.0005	0.0010	0.00075	0.00025	0.0008
1988	May	2	0.0015	0.0110	0.00625	0.00475	0.0062
1988	Jun	2	0.0005	0.0005	0.00050	0.00000	0.0005
1988	Jul	2	0.0005	0.0035	0.00200	0.00150	0.0020
1988	Aug	3	0.0005	0.0083	0.00310	0.00260	0.0005
1988	Sep	2	0.0005	0.0005	0.00050	0.00000	0.0005
1988	Oct	2	0.0005	0.0005	0.00050	0.00000	0.0005
1988	Nov	2	0.0005	0.0008	0.00065	0.00015	0.0006
1988	Dec	2	0.0010	0.0010	0.00100	0.00000	0.0010

APPENDIX B

TABLE 3. Summary Statistics for Discharge (m^3/s) in the Similkameen River near the Canada-United States Boundary.

84-8	N	Minimum	Maximum	Mean	Std.Error	Median
	170	4.5	430.0	55.45	6.27	17.1

---------- STATION=near the Canada-United States Boundary ----------

YEAR	N	Minimum	Maximum	Mean	Std.Error	Median
1984	50	5.4	311.0	70.90	12.50	30.5
1985	35	7.4	368.0	37.54	11.62	13.6
1986	29	9.5	430.0	74.73	18.78	30.9
1987	29	5.1	385.0	45.05	14.26	14.7
1988	27	4.5	245.0	40.52	11.43	11.6

---------- STATION=near the Canada-United States Boundary ----------

MONTH	N	Minimum	Maximum	Mean	Std.Error	Median
Jan	13	4.5	50.1	14.65	3.08	12.7
Feb	13	4.8	21.7	12.52	1.16	13.3
Mar	13	8.9	59.2	21.22	4.33	12.7
Apr	15	12.5	107.0	56.62	8.00	55.8
May	15	42.2	430.0	180.43	33.58	116.0
Jun	17	77.9	311.0	195.36	19.84	199.0
Jul	12	21.9	177.0	64.67	12.28	51.8
Aug	16	9.0	39.1	20.89	2.54	18.7
Sep	14	6.4	18.2	12.36	1.21	14.0
Oct	18	6.5	38.2	15.39	1.71	15.0
Nov	12	6.7	57.2	18.72	4.27	15.6
Dec	12	5.1	17.6	11.28	1.25	11.8

TABLE 3. Cont'd

YEAR	MONTH	N	Minimum	Maximum	Mean	Std.Error	Median
1984	Jan	1	50.1	50.1	50.10	.	50.1
1984	Feb	1	21.7	21.7	21.70	.	21.7
1984	Mar	1	31.4	31.4	31.40	.	31.4
1984	Apr	5	28.6	51.0	36.98	4.85	30.3
1984	May	6	42.2	178.0	89.83	19.90	87.7
1984	Jun	7	175.0	311.0	263.86	18.01	278.0
1984	Jul	4	49.8	177.0	103.00	27.48	92.6
1984	Aug	6	21.0	39.1	30.42	3.08	30.8
1984	Sep	4	14.4	18.2	16.50	0.83	16.7
1984	Oct	7	14.3	19.0	16.16	0.69	15.3
1984	Nov	4	12.5	17.6	15.33	1.07	15.6
1984	Dec	4	5.4	12.7	8.98	1.93	8.9
1985	Jan	6	7.4	14.2	11.81	1.01	12.5
1985	Feb	5	9.6	14.1	12.79	0.81	13.3
1985	Mar	4	11.4	12.7	12.23	0.28	12.4
1985	Apr	3	12.5	91.5	53.27	22.84	55.8
1985	May	2	87.5	368.0	227.75	140.25	227.8
1985	Jun	2	82.7	201.0	141.85	59.15	141.9
1985	Jul	2	21.9	44.5	33.20	11.30	33.2
1985	Aug	2	9.3	13.7	11.52	2.18	11.5
1985	Sep	2	7.5	15.6	11.54	4.06	11.5
1985	Oct	3	11.9	38.2	21.07	8.57	13.1
1985	Nov	2	7.7	17.8	12.73	5.08	12.7
1985	Dec	2	13.6	16.4	15.00	1.40	15.0
1986	Jan	2	11.0	15.0	13.00	2.00	13.0
1986	Feb	2	9.5	14.7	12.12	2.58	12.1
1986	Mar	2	44.5	59.2	51.85	7.35	51.8
1986	Apr	3	57.8	90.6	75.43	9.55	77.9
1986	May	3	100.0	430.0	273.00	95.60	289.0
1986	Jun	3	119.0	280.0	199.33	46.48	199.0
1986	Jul	2	53.8	64.0	58.90	5.10	58.9
1986	Aug	2	17.7	30.9	24.30	6.60	24.3
1986	Sep	3	13.5	16.9	15.30	0.99	15.5
1986	Oct	3	15.0	22.9	18.70	2.29	18.2
1986	Nov	2	10.7	57.2	33.95	23.25	34.0
1986	Dec	2	16.1	17.6	16.85	0.75	16.9
1987	Jan	2	14.7	15.3	15.00	0.30	15.0
1987	Feb	2	14.5	15.7	15.10	0.60	15.1
1987	Mar	3	13.2	26.6	21.20	4.08	23.8
1987	Apr	2	58.3	107.0	82.65	24.35	82.7
1987	May	2	147.0	385.0	266.00	119.00	266.0
1987	Jun	3	77.9	143.0	100.17	21.42	79.6
1987	Jul	2	26.3	48.7	37.50	11.20	37.5
1987	Aug	3	10.3	16.2	13.20	1.70	13.1
1987	Sep	3	6.4	8.0	7.01	0.51	6.6
1987	Oct	3	6.5	7.2	6.85	0.21	6.9
1987	Nov	2	6.7	7.8	7.27	0.55	7.3
1987	Dec	2	5.1	9.2	7.12	2.03	7.1
1988	Jan	2	4.5	9.0	6.77	2.23	6.8
1988	Feb	3	4.8	9.5	7.56	1.41	8.4
1988	Mar	3	8.9	9.9	9.44	0.30	9.6
1988	Apr	2	13.3	99.7	56.50	43.20	56.5
1988	May	2	116.0	245.0	180.50	64.50	180.5
1988	Jun	2	143.0	149.0	146.00	3.00	146.0
1988	Jul	2	35.1	69.7	52.40	17.30	52.4
1988	Aug	3	9.0	19.7	13.48	3.22	11.8
1988	Sep	2	6.8	10.2	8.50	1.70	8.5
1988	Oct	2	8.1	16.0	12.07	3.93	12.1
1988	Nov	2	16.4	39.1	27.75	11.35	27.8
1988	Dec	2	9.9	11.6	10.75	0.84	10.8

TABLE 4. Summary Statistics for Water Quality Measurements in the Similkameen River near the Canada-United States Boundary. Hardness 10603 (mg/L).

84-8	N	Minimum	Maximum	Mean	Std.Error	Median
	172	27.1	121.1	76.70	1.83	83.9

---------- STATION=near the Canada-United States Boundary ----------

YEAR	N	Minimum	Maximum	Mean	Std.Error	Median
1984	52	27.1	115.0	68.78	3.12	75.9
1985	35	28.8	105.0	85.27	3.59	94.9
1986	28	29.0	103.0	70.77	4.11	73.2
1987	30	28.5	113.2	81.11	4.48	87.7
1988	27	30.0	121.1	82.07	5.20	92.8

---------- STATION=near the Canada-United States Boundary ----------

MONTH	N	Minimum	Maximum	Mean	Std.Error	Median
Jan	13	66.3	121.1	95.52	3.53	95.0
Feb	13	87.1	116.6	98.52	2.21	99.2
Mar	14	55.1	105.2	90.29	3.98	96.7
Apr	15	48.3	102.0	71.05	4.16	69.2
May	16	28.5	72.8	46.23	3.70	47.0
Jun	17	27.1	50.3	36.24	1.70	34.6
Jul	13	35.6	75.8	55.27	3.25	58.3
Aug	16	64.8	96.3	81.19	2.64	82.3
Sep	13	79.9	102.0	92.18	2.23	92.1
Oct	17	55.0	103.9	86.01	2.75	86.3
Nov	13	52.2	105.8	86.91	4.96	88.7
Dec	12	86.0	115.0	98.03	2.77	95.2

TABLE 4. - Cont'd

YEAR	MONTH	N	Minimum	Maximum	Mean	Std.Error	Median
1984	Jan	1	66.3	66.3	66.30	.	66.3
1984	Feb	1	87.1	87.1	87.10	.	87.1
1984	Mar	1	82.2	82.2	82.20	.	82.2
1984	Apr	5	61.8	83.2	75.90	4.39	82.0
1984	May	7	34.9	72.8	55.73	5.02	50.7
1984	Jun	7	27.1	38.3	31.77	1.40	31.7
1984	Jul	5	35.6	59.8	45.70	4.02	42.7
1984	Aug	6	64.8	81.0	71.13	2.89	68.2
1984	Sep	4	79.9	88.3	83.78	1.79	83.4
1984	Oct	7	79.7	87.0	84.30	1.15	85.1
1984	Nov	4	82.2	93.5	87.70	2.36	87.6
1984	Dec	4	97.6	115.0	104.47	4.11	102.7
1985	Jan	6	91.0	101.0	97.70	1.62	99.2
1985	Feb	5	98.3	105.0	100.40	1.25	99.4
1985	Mar	4	99.4	104.0	101.03	1.05	100.3
1985	Apr	3	50.1	102.0	73.17	15.26	67.4
1985	May	2	28.8	54.9	41.85	13.05	41.8
1985	Jun	2	34.9	50.3	42.60	7.70	42.6
1985	Jul	2	60.3	75.8	68.05	7.75	68.0
1985	Aug	2	87.6	95.8	91.70	4.10	91.7
1985	Sep	2	84.1	101.0	92.55	8.45	92.5
1985	Oct	3	55.0	94.0	79.10	12.16	88.3
1985	Nov	2	79.4	99.8	89.60	10.20	89.6
1985	Dec	2	89.9	92.9	91.40	1.50	91.4
1986	Jan	2	87.3	95.0	91.15	3.85	91.2
1986	Feb	2	90.0	103.0	96.50	6.50	96.5
1986	Mar	2	55.1	72.5	63.80	8.70	63.8
1986	Apr	3	62.2	69.5	65.80	2.11	65.7
1986	May	3	29.0	59.2	41.13	9.21	35.2
1986	Jun	3	34.6	44.3	38.30	3.03	36.0
1986	Jul	2	58.3	59.3	58.80	0.50	58.8
1986	Aug	2	73.9	89.1	81.50	7.60	81.5
1986	Sep	2	88.5	92.1	90.30	1.80	90.3
1986	Oct	3	74.7	89.9	83.63	4.59	86.3
1986	Nov	2	53.0	97.4	75.20	22.20	75.2
1986	Dec	2	88.7	91.8	90.25	1.55	90.2
1987	Jan	2	86.5	91.1	88.80	2.30	88.8
1987	Feb	2	88.9	91.2	90.05	1.15	90.1
1987	Mar	4	79.5	93.9	84.85	3.44	83.0
1987	Apr	2	48.3	69.2	58.75	10.45	58.7
1987	May	2	28.5	39.5	34.00	5.50	34.0
1987	Jun	3	29.8	48.3	41.40	5.83	46.1
1987	Jul	2	54.5	71.3	62.90	8.40	62.9
1987	Aug	3	83.7	92.2	87.20	2.57	85.7
1987	Sep	3	97.0	101.2	99.67	1.34	100.8
1987	Oct	2	103.2	103.9	103.55	0.35	103.6
1987	Nov	3	105.1	105.8	105.50	0.21	105.6
1987	Dec	2	103.2	113.2	108.20	5.00	108.2
1988	Jan	2	108.2	121.1	114.65	6.45	114.7
1988	Feb	3	99.2	116.6	106.20	5.30	102.8
1988	Mar	3	102.5	105.2	103.57	0.83	103.0
1988	Apr	2	53.0	98.8	75.90	22.90	75.9
1988	May	2	30.0	44.5	37.25	7.25	37.2
1988	Jun	2	32.6	36.7	34.65	2.05	34.7
1988	Jul	2	46.9	63.6	55.25	8.35	55.2
1988	Aug	3	78.7	96.3	88.07	5.11	89.2
1988	Sep	2	96.6	102.0	99.30	2.70	99.3
1988	Oct	2	78.7	98.0	88.35	9.65	88.3
1988	Nov	2	52.2	80.7	66.45	14.25	66.5
1988	Dec	2	86.0	92.8	89.40	3.40	89.4

TABLE 5. Summary Statistics for Water Quality Measurements in the Similkameen River near the Canada-United States Boundary. Lead Total 82002 (mg/L).

84-8	N	Minimum	Maximum	Mean	Std.Error	Median
	169	0.0007	0.0103	0.00148	0.00012	0.0010

---------- STATION=near the Canada-United States Boundary ----------

YEAR	N	Minimum	Maximum	Mean	Std.Error	Median
1984	48	0.0010	0.0090	0.00140	0.00020	0.0010
1985	35	0.0010	0.0030	0.00111	0.00007	0.0010
1986	28	0.0007	0.0070	0.00159	0.00028	0.0010
1987	31	0.0007	0.0043	0.00126	0.00018	0.0007
1988	27	0.0007	0.0103	0.00222	0.00058	0.0007

---------- STATION=near the Canada-United States Boundary ----------

MONTH	N	Minimum	Maximum	Mean	Std.Error	Median
Jan	12	0.0007	0.0038	0.00140	0.00025	0.0010
Feb	12	0.0007	0.0010	0.00087	0.00004	0.0010
Mar	13	0.0007	0.0015	0.00093	0.00006	0.0010
Apr	15	0.0007	0.0025	0.00118	0.00014	0.0010
May	16	0.0010	0.0096	0.00279	0.00069	0.0011
Jun	17	0.0007	0.0030	0.00117	0.00014	0.0010
Jul	13	0.0007	0.0024	0.00112	0.00014	0.0010
Aug	16	0.0007	0.0034	0.00126	0.00020	0.0010
Sep	13	0.0007	0.0103	0.00215	0.00083	0.0010
Oct	17	0.0007	0.0094	0.00157	0.00050	0.0010
Nov	13	0.0007	0.0043	0.00135	0.00028	0.0010
Dec	12	0.0007	0.0090	0.00174	0.00068	0.0010

TABLE 5. Cont'd

YEAR	MONTH	N	Minimum	Maximum	Mean	Std.Error	Median
1984	Jan	0	.	.	.	.	.
1984	Feb	0	.	.	.	.	.
1984	Mar	0	.	.	.	.	.
1984	Apr	5	0.0010	0.0020	0.00140	0.00024	0.0010
1984	May	7	0.0010	0.0060	0.00171	0.00071	0.0010
1984	Jun	7	0.0010	0.0030	0.00143	0.00030	0.0010
1984	Jul	5	0.0010	0.0010	0.00100	0.00000	0.0010
1984	Aug	6	0.0010	0.0020	0.00117	0.00017	0.0010
1984	Sep	4	0.0010	0.0010	0.00100	0.00000	0.0010
1984	Oct	6	0.0010	0.0010	0.00100	0.00000	0.0010
1984	Nov	4	0.0010	0.0010	0.00100	0.00000	0.0010
1984	Dec	4	0.0010	0.0090	0.00300	0.00200	0.0010
1985	Jan	6	0.0010	0.0010	0.00100	0.00000	0.0010
1985	Feb	5	0.0010	0.0010	0.00100	0.00000	0.0010
1985	Mar	4	0.0010	0.0010	0.00100	0.00000	0.0010
1985	Apr	3	0.0010	0.0010	0.00100	0.00000	0.0010
1985	May	2	0.0010	0.0020	0.00150	0.00050	0.0015
1985	Jun	2	0.0010	0.0010	0.00100	0.00000	0.0010
1985	Jul	2	0.0010	0.0020	0.00150	0.00050	0.0015
1985	Aug	2	0.0010	0.0010	0.00100	0.00000	0.0010
1985	Sep	2	0.0010	0.0010	0.00100	0.00000	0.0010
1985	Oct	3	0.0010	0.0010	0.00100	0.00000	0.0010
1985	Nov	2	0.0010	0.0010	0.00100	0.00000	0.0010
1985	Dec	2	0.0010	0.0030	0.00200	0.00100	0.0020
1986	Jan	2	0.0020	0.0020	0.00200	0.00000	0.0020
1986	Feb	2	0.0010	0.0010	0.00100	0.00000	0.0010
1986	Mar	2	0.0010	0.0010	0.00100	0.00000	0.0010
1986	Apr	3	0.0010	0.0010	0.00100	0.00000	0.0010
1986	May	3	0.0010	0.0070	0.00467	0.00186	0.0060
1986	Jun	3	0.0010	0.0010	0.00100	0.00000	0.0010
1986	Jul	2	0.0010	0.0010	0.00100	0.00000	0.0010
1986	Aug	2	0.0010	0.0029	0.00195	0.00095	0.0020
1986	Sep	2	0.0007	0.0018	0.00125	0.00055	0.0012
1986	Oct	3	0.0007	0.0021	0.00147	0.00041	0.0016
1986	Nov	2	0.0008	0.0012	0.00100	0.00020	0.0010
1986	Dec	2	0.0008	0.0010	0.00090	0.00010	0.0009
1987	Jan	2	0.0010	0.0013	0.00115	0.00015	0.0011
1987	Feb	2	0.0007	0.0007	0.00070	0.00000	0.0007
1987	Mar	4	0.0007	0.0015	0.00100	0.00019	0.0009
1987	Apr	2	0.0008	0.0025	0.00165	0.00085	0.0016
1987	May	2	0.0012	0.0032	0.00220	0.00100	0.0022
1987	Jun	3	0.0007	0.0007	0.00070	0.00000	0.0007
1987	Jul	2	0.0007	0.0024	0.00155	0.00085	0.0015
1987	Aug	3	0.0007	0.0034	0.00160	0.00090	0.0007
1987	Sep	3	0.0007	0.0007	0.00070	0.00000	0.0007
1987	Oct	3	0.0007	0.0007	0.00070	0.00000	0.0007
1987	Nov	3	0.0007	0.0043	0.00257	0.00104	0.0027
1987	Dec	2	0.0007	0.0010	0.00085	0.00015	0.0009
1988	Jan	2	0.0007	0.0038	0.00225	0.00155	0.0022
1988	Feb	3	0.0007	0.0007	0.00070	0.00000	0.0007
1988	Mar	3	0.0007	0.0007	0.00070	0.00000	0.0007
1988	Apr	2	0.0007	0.0007	0.00070	0.00000	0.0007
1988	May	2	0.0017	0.0096	0.00565	0.00395	0.0056
1988	Jun	2	0.0014	0.0014	0.00140	0.00000	0.0014
1988	Jul	2	0.0007	0.0007	0.00070	0.00000	0.0007
1988	Aug	3	0.0007	0.0010	0.00083	0.00009	0.0008
1988	Sep	2	0.0070	0.0103	0.00865	0.00165	0.0086
1988	Oct	2	0.0018	0.0094	0.00560	0.00380	0.0056
1988	Nov	2	0.0007	0.0012	0.00095	0.00025	0.0009
1988	Dec	2	0.0007	0.0007	0.00070	0.00000	0.0007

TABLE 6. Summary Statistics for Water Quality Measurements in the Similkameen River near the Canada United States Boundary. Phosphorus Total 15406 (mg/L).

84-8	N	Minimum	Maximum	Mean	Std.Error	Median
	172	0.002	1.360	0.0430	0.0111	0.008

---------- STATION=near the Canada-United States Boundary ----------

YEAR	N	Minimum	Maximum	Mean	Std.Error	Median
1984	52	0.002	1.360	0.0532	0.0269	0.008
1985	35	0.002	0.252	0.0169	0.0072	0.006
1986	28	0.004	1.048	0.0820	0.0398	0.021
1987	30	0.003	0.545	0.0413	0.0207	0.007
1988	27	0.003	0.099	0.0184	0.0044	0.009

---------- STATION=near the Canada-United States Boundary ----------

MONTH	N	Minimum	Maximum	Mean	Std.Error	Median
Jan	13	0.003	0.026	0.0088	0.0021	0.006
Feb	13	0.002	0.022	0.0073	0.0017	0.006
Mar	14	0.003	0.043	0.0109	0.0027	0.008
Apr	15	0.004	0.303	0.0371	0.0194	0.016
May	16	0.007	1.360	0.2555	0.1025	0.050
Jun	17	0.008	0.383	0.0855	0.0225	0.058
Jul	13	0.006	0.031	0.0125	0.0021	0.009
Aug	16	0.004	0.050	0.0119	0.0030	0.008
Sep	13	0.003	0.050	0.0105	0.0034	0.008
Oct	17	0.002	0.126	0.0140	0.0071	0.006
Nov	13	0.002	0.073	0.0103	0.0053	0.004
Dec	12	0.003	0.012	0.0059	0.0009	0.005

TABLE 6. - Cont'd

84-8	N	Minimum	Maximum	Mean	Std.Error	Median
	172	0.002	1.360	0.0430	0.0111	0.008

---------- STATION=near the Canada-United States Boundary ----------

YEAR	N	Minimum	Maximum	Mean	Std.Error	Median
1984	52	0.002	1.360	0.0532	0.0269	0.008
1985	35	0.002	0.252	0.0169	0.0072	0.006
1986	28	0.004	1.048	0.0820	0.0398	0.021
1987	30	0.003	0.545	0.0413	0.0207	0.007
1988	27	0.003	0.099	0.0184	0.0044	0.009

---------- STATION=near the Canada-United States Boundary ----------

MONTH	N	Minimum	Maximum	Mean	Std.Error	Median
Jan	13	0.003	0.026	0.0088	0.0021	0.006
Feb	13	0.002	0.022	0.0073	0.0017	0.006
Mar	14	0.003	0.043	0.0109	0.0027	0.008
Apr	15	0.004	0.303	0.0371	0.0194	0.016
May	16	0.007	1.360	0.2555	0.1025	0.050
Jun	17	0.008	0.383	0.0855	0.0225	0.058
Jul	13	0.006	0.031	0.0125	0.0021	0.009
Aug	16	0.004	0.050	0.0119	0.0030	0.008
Sep	13	0.003	0.050	0.0105	0.0034	0.008
Oct	17	0.002	0.126	0.0140	0.0071	0.006
Nov	13	0.002	0.073	0.0103	0.0053	0.004
Dec	12	0.003	0.012	0.0059	0.0009	0.005

TABLE 7. Summary Statistics for Water Quality Measurements in the Similkameen River near the Canada-United States Boundary. Mercury Total 80011 (ug/L).

84-8	N	Minimum	Maximum	Mean	Std.Error	Median
	157	0.01	0.83	0.031	0.007	0.02

---------- STATION=near the Canada-United States Boundary ----------

YEAR	N	Minimum	Maximum	Mean	Std.Error	Median
1984	44	0.02	0.83	0.059	0.024	0.02
1985	28	0.02	0.02	0.020	0.000	0.02
1986	28	0.02	0.03	0.020	0.000	0.02
1987	30	0.01	0.05	0.018	0.001	0.02
1988	27	0.01	0.08	0.022	0.004	0.01

---------- STATION=near the Canada-United States Boundary ----------

MONTH	N	Minimum	Maximum	Mean	Std.Error	Median
Jan	7	0.01	0.02	0.019	0.001	0.02
Feb	11	0.01	0.02	0.018	0.001	0.02
Mar	13	0.01	0.05	0.021	0.003	0.02
Apr	15	0.01	0.02	0.019	0.001	0.02
May	16	0.01	0.03	0.019	0.001	0.02
Jun	17	0.01	0.04	0.021	0.001	0.02
Jul	12	0.01	0.02	0.018	0.001	0.02
Aug	16	0.01	0.02	0.018	0.001	0.02
Sep	13	0.01	0.83	0.080	0.063	0.02
Oct	15	0.01	0.74	0.073	0.048	0.02
Nov	12	0.01	0.10	0.034	0.009	0.02
Dec	10	0.01	0.05	0.026	0.005	0.02

TABLE 7. - Cont'd

YEAR	MONTH	N	Minimum	Maximum	Mean	Std.Error	Median
1984	Jan	0	.	.	.	.	.
1984	Feb	0	.	.	.	.	.
1984	Mar	0	.	.	.	.	.
1984	Apr	5	0.02	0.02	0.020	0.000	0.02
1984	May	7	0.02	0.02	0.020	0.000	0.02
1984	Jun	7	0.02	0.04	0.023	0.003	0.02
1984	Jul	4	0.02	0.02	0.020	0.000	0.02
1984	Aug	6	0.02	0.02	0.020	0.000	0.02
1984	Sep	4	0.02	0.83	0.227	0.201	0.03
1984	Oct	5	0.02	0.74	0.172	0.142	0.02
1984	Nov	4	0.02	0.10	0.040	0.020	0.02
1984	Dec	2	0.02	0.04	0.030	0.010	0.03
1985	Jan	1	0.02	0.02	0.020	.	0.02
1985	Feb	4	0.02	0.02	0.020	0.000	0.02
1985	Mar	4	0.02	0.02	0.020	0.000	0.02
1985	Apr	3	0.02	0.02	0.020	0.000	0.02
1985	May	2	0.02	0.02	0.020	0.000	0.02
1985	Jun	2	0.02	0.02	0.020	0.000	0.02
1985	Jul	2	0.02	0.02	0.020	0.000	0.02
1985	Aug	2	0.02	0.02	0.020	0.000	0.02
1985	Sep	2	0.02	0.02	0.020	0.000	0.02
1985	Oct	3	0.02	0.02	0.020	0.000	0.02
1985	Nov	1	0.02	0.02	0.020	.	0.02
1985	Dec	2	0.02	0.02	0.020	0.000	0.02
1986	Jan	2	0.02	0.02	0.020	0.000	0.02
1986	Feb	2	0.02	0.02	0.020	0.000	0.02
1986	Mar	2	0.02	0.02	0.020	0.000	0.02
1986	Apr	3	0.02	0.02	0.020	0.000	0.02
1986	May	3	0.02	0.03	0.023	0.003	0.02
1986	Jun	3	0.02	0.02	0.020	0.000	0.02
1986	Jul	2	0.02	0.02	0.020	0.000	0.02
1986	Aug	2	0.02	0.02	0.020	0.000	0.02
1986	Sep	2	0.02	0.02	0.020	0.000	0.02
1986	Oct	3	0.02	0.02	0.020	0.000	0.02
1986	Nov	2	0.02	0.02	0.020	0.000	0.02
1986	Dec	2	0.02	0.02	0.020	0.000	0.02
1987	Jan	2	0.02	0.02	0.020	0.000	0.02
1987	Feb	2	0.02	0.02	0.020	0.000	0.02
1987	Mar	4	0.02	0.05	0.028	0.008	0.02
1987	Apr	2	0.02	0.02	0.020	0.000	0.02
1987	May	2	0.02	0.02	0.020	0.000	0.02
1987	Jun	3	0.02	0.02	0.020	0.000	0.02
1987	Jul	2	0.02	0.02	0.020	0.000	0.02
1987	Aug	3	0.02	0.02	0.020	0.000	0.02
1987	Sep	3	0.01	0.01	0.010	0.000	0.01
1987	Oct	2	0.01	0.02	0.015	0.005	0.02
1987	Nov	3	0.01	0.01	0.010	0.000	0.01
1987	Dec	2	0.01	0.01	0.010	0.000	0.01
1988	Jan	2	0.01	0.02	0.015	0.005	0.02
1988	Feb	3	0.01	0.02	0.013	0.003	0.01
1988	Mar	3	0.01	0.02	0.013	0.003	0.01
1988	Apr	2	0.01	0.01	0.010	0.000	0.01
1988	May	2	0.01	0.01	0.010	0.000	0.01
1988	Jun	2	0.01	0.03	0.020	0.010	0.02
1988	Jul	2	0.01	0.01	0.010	0.000	0.01
1988	Aug	3	0.01	0.01	0.010	0.000	0.01
1988	Sep	2	0.01	0.01	0.010	0.000	0.01
1988	Oct	2	0.01	0.07	0.040	0.030	0.04
1988	Nov	2	0.08	0.08	0.080	0.000	0.08
1988	Dec	2	0.05	0.05	0.050	0.000	0.05

TABLE 8. Summary Statistics for Water Quality Measurements in the Similkameen River near the Canada-United States Boundary. Selenium Total 34008 (mg/L).

84-8	N	Minimum	Maximum	Mean	Std.Error	Median
	129	0.0001	0.0007	0.00025	0.00001	0.0002

---------- STATION=near the Canada-United States Boundary ----------

YEAR	N	Minimum	Maximum	Mean	Std.Error	Median
1984	9	0.0001	0.0003	0.00023	0.00002	0.0002
1985	35	0.0001	0.0005	0.00026	0.00002	0.0003
1986	28	0.0001	0.0007	0.00027	0.00003	0.0002
1987	30	0.0001	0.0006	0.00023	0.00002	0.0002
1988	27	0.0001	0.0004	0.00023	0.00002	0.0002

---------- STATION=near the Canada-United States Boundary ----------

MONTH	N	Minimum	Maximum	Mean	Std.Error	Median
Jan	12	0.0002	0.0004	0.00028	0.00002	0.0003
Feb	12	0.0001	0.0004	0.00024	0.00003	0.0003
Mar	13	0.0001	0.0005	0.00026	0.00004	0.0002
Apr	11	0.0001	0.0007	0.00025	0.00005	0.0002
May	9	0.0001	0.0006	0.00033	0.00006	0.0003
Jun	10	0.0001	0.0003	0.00017	0.00002	0.0002
Jul	9	0.0001	0.0002	0.00014	0.00002	0.0001
Aug	10	0.0001	0.0004	0.00024	0.00003	0.0003
Sep	9	0.0001	0.0006	0.00026	0.00006	0.0002
Oct	10	0.0001	0.0005	0.00027	0.00004	0.0003
Nov	12	0.0002	0.0005	0.00028	0.00002	0.0003
Dec	12	0.0001	0.0004	0.00025	0.00002	0.0003

TABLE 8. - Cont'd

[illegible] Statistics
River near [illegible]
[illegible] Field 02061?

YEAR	MONTH	N	Minimum	Maximum	Mean	Std.Error	Median
1984	Jan	0	.	.	.	.	.
1984	Feb	0	.	.	.	.	.
1984	Mar	0	.	.	.	.	.
1984	Apr	1	0.0002	0.0002	0.00020	.	0.0002
1984	May	0	.	.	.	.	.
1984	Jun	0	.	.	.	.	.
1984	Jul	1	0.0002	0.0002	0.00020	.	0.0002
1984	Aug	0	.	.	.	.	.
1984	Sep	0	.	.	.	.	.
1984	Oct	0	.	.	.	.	.
1984	Nov	3	0.0002	0.0003	0.00023	0.00003	0.0002
1984	Dec	4	0.0001	0.0003	0.00025	0.00005	0.0003
1985	Jan	6	0.0002	0.0003	0.00027	0.00002	0.0003
1985	Feb	5	0.0001	0.0004	0.00030	0.00005	0.0003
1985	Mar	4	0.0001	0.0004	0.00025	0.00006	0.0003
1985	Apr	3	0.0002	0.0003	0.00027	0.00003	0.0003
1985	May	2	0.0003	0.0003	0.00030	0.00000	0.0003
1985	Jun	2	0.0002	0.0002	0.00020	0.00000	0.0002
1985	Jul	2	0.0001	0.0002	0.00015	0.00005	0.0002
1985	Aug	2	0.0003	0.0003	0.00030	0.00000	0.0003
1985	Sep	2	0.0001	0.0001	0.00010	0.00000	0.0001
1985	Oct	3	0.0001	0.0005	0.00033	0.00012	0.0004
1985	Nov	2	0.0002	0.0005	0.00035	0.00015	0.0004
1985	Dec	2	0.0002	0.0003	0.00025	0.00005	0.0003
1986	Jan	2	0.0003	0.0003	0.00030	0.00000	0.0003
1986	Feb	2	0.0002	0.0003	0.00025	0.00005	0.0003
1986	Mar	2	0.0003	0.0005	0.00040	0.00010	0.0004
1986	Apr	3	0.0002	0.0007	0.00037	0.00017	0.0002
1986	May	3	0.0004	0.0006	0.00050	0.00006	0.0005
1986	Jun	3	0.0001	0.0002	0.00017	0.00003	0.0002
1986	Jul	2	0.0001	0.0001	0.00010	0.00000	0.0001
1986	Aug	2	0.0002	0.0003	0.00025	0.00005	0.0003
1986	Sep	2	0.0001	0.0002	0.00015	0.00005	0.0002
1986	Oct	3	0.0002	0.0003	0.00023	0.00003	0.0002
1986	Nov	2	0.0002	0.0003	0.00025	0.00005	0.0003
1986	Dec	2	0.0002	0.0002	0.00020	0.00000	0.0002
1987	Jan	2	0.0002	0.0002	0.00020	0.00000	0.0002
1987	Feb	2	0.0001	0.0001	0.00010	0.00000	0.0001
1987	Mar	4	0.0001	0.0005	0.00028	0.00009	0.0003
1987	Apr	2	0.0001	0.0002	0.00015	0.00005	0.0002
1987	May	2	0.0001	0.0005	0.00030	0.00020	0.0003
1987	Jun	3	0.0001	0.0003	0.00017	0.00007	0.0001
1987	Jul	2	0.0001	0.0001	0.00010	0.00000	0.0001
1987	Aug	3	0.0001	0.0002	0.00017	0.00003	0.0002
1987	Sep	3	0.0002	0.0006	0.00037	0.00012	0.0003
1987	Oct	2	0.0002	0.0003	0.00025	0.00005	0.0003
1987	Nov	3	0.0003	0.0003	0.00030	0.00000	0.0003
1987	Dec	2	0.0002	0.0003	0.00025	0.00005	0.0003
1988	Jan	2	0.0003	0.0004	0.00035	0.00005	0.0004
1988	Feb	3	0.0001	0.0003	0.00023	0.00007	0.0003
1988	Mar	3	0.0001	0.0002	0.00017	0.00003	0.0002
1988	Apr	2	0.0001	0.0002	0.00015	0.00005	0.0002
1988	May	2	0.0001	0.0002	0.00015	0.00005	0.0002
1988	Jun	2	0.0001	0.0002	0.00015	0.00005	0.0002
1988	Jul	2	0.0002	0.0002	0.00020	0.00000	0.0002
1988	Aug	3	0.0001	0.0004	0.00027	0.00009	0.0003
1988	Sep	2	0.0003	0.0004	0.00035	0.00005	0.0004
1988	Oct	2	0.0002	0.0003	0.00025	0.00005	0.0003
1988	Nov	2	0.0002	0.0003	0.00025	0.00005	0.0003
1988	Dec	2	0.0002	0.0004	0.00030	0.00010	0.0003

TABLE 9. Summary Statistics for Water Quality Masurements in the Similkameen River near the Canada-United States Boundary. Temperature Water, Field 02061S (°C)

84-8	N	Minimum	Maximum	Mean	Std.Error	Median
	173	-1.0	27.0	8.91	0.47	9.0

---------- STATION=near the Canada-United States Boundary ----------

YEAR	N	Minimum	Maximum	Mean	Std.Error	Median
1984	52	-1.0	20.0	9.38	0.82	10.0
1985	35	-0.5	20.0	6.44	1.10	4.0
1986	29	0.5	18.5	8.78	1.07	8.5
1987	30	1.5	27.0	10.62	1.19	10.3
1988	27	1.0	19.5	9.43	1.12	9.0

---------- STATION=near the Canada-United States Boundary ----------

MONTH	N	Minimum	Maximum	Mean	Std.Error	Median
Jan	13	-0.5	3.0	1.23	0.32	1.5
Feb	13	0.0	5.0	2.15	0.48	2.0
Mar	13	1.0	12.0	6.08	0.79	6.0
Apr	15	6.5	13.5	9.37	0.56	8.5
May	16	8.5	13.0	10.13	0.34	10.0
Jun	17	8.5	18.0	12.56	0.64	12.0
Jul	13	14.0	27.0	17.81	0.97	18.0
Aug	16	15.0	20.0	17.59	0.42	18.0
Sep	14	11.0	20.0	14.41	0.72	14.3
Oct	18	-0.5	12.0	7.66	0.88	8.8
Nov	13	0.0	7.0	2.69	0.62	2.0
Dec	12	-1.0	5.0	1.21	0.47	0.8

TABLE 9. - Cont'd

1984	Jan	1	2.0	2.0	2.00	.	2.0
1984	Feb	1	5.0	5.0	5.00	.	5.0
1984	Mar	1	12.0	12.0	12.00	.	12.0
1984	Apr	5	7.5	10.0	8.40	0.43	8.0
1984	May	7	8.5	13.0	10.07	0.53	10.0
1984	Jun	7	8.5	12.5	10.64	0.56	11.5
1984	Jul	5	14.0	18.5	16.20	0.86	16.5
1984	Aug	6	15.0	20.0	17.58	0.85	17.8
1984	Sep	4	11.0	15.0	12.63	0.90	12.3
1984	Oct	7	-0.5	12.0	6.11	2.02	3.3
1984	Nov	4	0.0	1.0	0.75	0.25	1.0
1984	Dec	4	-1.0	0.0	-0.25	0.25	0.0
1985	Jan	6	-0.5	1.5	0.25	0.28	0.0
1985	Feb	5	0.0	2.0	1.00	0.42	0.5
1985	Mar	4	1.0	6.0	3.37	1.07	3.2
1985	Apr	3	8.0	11.5	10.17	1.09	11.0
1985	May	2	9.0	10.0	9.50	0.50	9.5
1985	Jun	2	12.0	16.0	14.00	2.00	14.0
1985	Jul	2	18.5	20.0	19.25	0.75	19.3
1985	Aug	2	15.0	17.5	16.25	1.25	16.3
1985	Sep	2	11.0	18.0	14.50	3.50	14.5
1985	Oct	3	5.0	10.0	8.00	1.53	9.0
1985	Nov	2	0.5	1.0	0.75	0.25	0.8
1985	Dec	2	0.5	2.0	1.25	0.75	1.3
1986	Jan	2	2.0	2.0	2.00	0.00	2.0
1986	Feb	2	0.5	3.5	2.00	1.50	2.0
1986	Mar	2	4.0	5.5	4.75	0.75	4.7
1986	Apr	3	6.5	8.0	7.17	0.44	7.0
1986	May	3	9.0	10.0	9.33	0.33	9.0
1986	Jun	3	11.0	18.0	14.00	2.08	13.0
1986	Jul	2	14.5	18.0	16.25	1.75	16.3
1986	Aug	2	18.0	18.5	18.25	0.25	18.3
1986	Sep	3	12.0	17.0	14.23	1.47	13.7
1986	Oct	3	8.5	9.0	8.67	0.17	8.5
1986	Nov	2	2.0	2.5	2.25	0.25	2.2
1986	Dec	2	0.5	3.0	1.75	1.25	1.8
1987	Jan	2	1.5	3.0	2.25	0.75	2.2
1987	Feb	2	2.0	4.0	3.00	1.00	3.0
1987	Mar	3	6.0	8.0	6.67	0.67	6.0
1987	Apr	2	11.0	13.0	12.00	1.00	12.0
1987	May	2	10.0	12.0	11.00	1.00	11.0
1987	Jun	3	14.0	15.0	14.67	0.33	15.0
1987	Jul	2	19.0	27.0	23.00	4.00	23.0
1987	Aug	3	16.5	20.0	18.33	1.01	18.5
1987	Sep	3	14.5	20.0	16.50	1.76	15.0
1987	Oct	3	6.5	10.5	8.00	1.26	7.0
1987	Nov	3	5.0	7.0	5.67	0.67	5.0
1987	Dec	2	1.5	5.0	3.25	1.75	3.2
1988	Jan	2	1.0	3.0	2.00	1.00	2.0
1988	Feb	3	1.0	5.0	2.67	1.20	2.0
1988	Mar	3	8.0	8.0	8.00	0.00	8.0
1988	Apr	2	9.0	13.5	11.25	2.25	11.3
1988	May	2	9.5	13.0	11.25	1.75	11.3
1988	Jun	2	10.0	15.0	12.50	2.50	12.5
1988	Jul	2	14.0	19.5	16.75	2.75	16.8
1988	Aug	3	15.5	18.5	17.33	0.93	18.0
1988	Sep	2	14.0	16.0	15.00	1.00	15.0
1988	Oct	2	9.0	12.0	10.50	1.50	10.5
1988	Nov	2	4.0	5.0	4.50	0.50	4.5
1988	Dec	2	1.0	2.0	1.50	0.50	1.5

APPENDIX C

TABLE 10. Summary Statistics for Water Quality Measurements in the Similkameen River near the Canada-United States Boundary. Chloride Dissolved 17206 (mg/L).

84-8	N	Minimum	Maximum	Mean	Std.Error	Median
	172	0.4	5.3	1.40	0.04	1.5

---------- STATION=near the Canada-United States Boundary ----------

YEAR	N	Minimum	Maximum	Mean	Std.Error	Median
1984	52	0.4	5.3	1.18	0.10	1.2
1985	35	0.6	1.8	1.43	0.05	1.5
1986	28	0.6	2.0	1.42	0.08	1.6
1987	30	0.5	2.4	1.59	0.09	1.8
1988	27	0.5	3.0	1.59	0.11	1.6

---------- STATION=near the Canada-United States Boundary ----------

MONTH	N	Minimum	Maximum	Mean	Std.Error	Median
Jan	13	1.2	2.0	1.64	0.07	1.6
Feb	13	1.5	2.3	1.78	0.07	1.8
Mar	14	1.6	2.4	1.93	0.08	1.9
Apr	15	1.1	3.0	1.51	0.12	1.4
May	16	0.7	1.2	0.94	0.05	0.9
Jun	17	0.4	0.8	0.61	0.03	0.6
Jul	13	0.5	1.2	0.82	0.07	0.9
Aug	16	0.9	1.6	1.28	0.06	1.3
Sep	13	1.2	1.9	1.52	0.06	1.6
Oct	17	1.2	1.9	1.45	0.05	1.4
Nov	13	1.3	2.4	1.68	0.08	1.7
Dec	12	1.5	5.3	2.06	0.30	1.8

TABLE 10. - Cont'd

YEAR	MONTH	N	Minimum	Maximum	Mean	Std.Error	Median
1984	Jan	1	1.2	1.2	1.20	.	1.2
1984	Feb	1	1.5	1.5	1.50	.	1.5
1984	Mar	1	1.6	1.6	1.60	.	1.6
1984	Apr	5	1.1	1.5	1.34	0.08	1.4
1984	May	7	0.8	1.2	0.99	0.07	0.9
1984	Jun	7	0.4	0.7	0.56	0.05	0.6
1984	Jul	5	0.5	0.7	0.56	0.04	0.5
1984	Aug	6	0.9	1.3	1.02	0.07	1.0
1984	Sep	4	1.2	1.3	1.22	0.03	1.2
1984	Oct	7	1.2	1.4	1.29	0.03	1.3
1984	Nov	4	1.4	2.4	1.67	0.24	1.5
1984	Dec	4	1.5	5.3	2.52	0.93	1.6
1985	Jan	6	1.4	1.8	1.58	0.06	1.6
1985	Feb	5	1.5	1.6	1.58	0.02	1.6
1985	Mar	4	1.6	1.7	1.65	0.03	1.6
1985	Apr	3	1.1	1.8	1.43	0.20	1.4
1985	May	2	0.7	1.1	0.90	0.20	0.9
1985	Jun	2	0.6	0.7	0.65	0.05	0.6
1985	Jul	2	1.0	1.2	1.10	0.10	1.1
1985	Aug	2	1.3	1.5	1.40	0.10	1.4
1985	Sep	2	1.4	1.6	1.50	0.10	1.5
1985	Oct	3	1.3	1.4	1.37	0.03	1.4
1985	Nov	2	1.5	1.7	1.60	0.10	1.6
1985	Dec	2	1.6	1.6	1.60	0.00	1.6
1986	Jan	2	1.6	2.0	1.80	0.20	1.8
1986	Feb	2	1.9	2.0	1.95	0.05	2.0
1986	Mar	2	1.6	1.8	1.70	0.10	1.7
1986	Apr	3	1.3	1.7	1.50	0.12	1.5
1986	May	3	0.8	1.2	1.03	0.12	1.1
1986	Jun	3	0.6	0.7	0.63	0.03	0.6
1986	Jul	2	0.9	0.9	0.90	0.00	0.9
1986	Aug	2	1.2	1.5	1.35	0.15	1.4
1986	Sep	2	1.6	1.7	1.65	0.05	1.6
1986	Oct	3	1.3	1.7	1.50	0.12	1.5
1986	Nov	2	1.7	1.7	1.70	0.00	1.7
1986	Dec	2	1.8	1.9	1.85	0.05	1.9
1987	Jan	2	1.4	1.8	1.60	0.20	1.6
1987	Feb	2	1.8	1.9	1.85	0.05	1.9
1987	Mar	4	1.9	2.4	2.25	0.12	2.3
1987	Apr	2	1.2	1.7	1.45	0.25	1.5
1987	May	2	0.7	0.8	0.75	0.05	0.8
1987	Jun	3	0.5	0.8	0.70	0.10	0.8
1987	Jul	2	0.9	1.2	1.05	0.15	1.1
1987	Aug	3	1.4	1.5	1.47	0.03	1.5
1987	Sep	3	1.6	1.9	1.77	0.09	1.8
1987	Oct	2	1.9	1.9	1.90	0.00	1.9
1987	Nov	3	1.8	2.0	1.90	0.06	1.9
1987	Dec	2	2.0	2.0	2.00	0.00	2.0
1988	Jan	2	1.8	2.0	1.90	0.10	1.9
1988	Feb	3	1.9	2.3	2.07	0.12	2.0
1988	Mar	3	2.0	2.3	2.13	0.09	2.1
1988	Apr	2	1.3	3.0	2.15	0.85	2.1
1988	May	2	0.7	1.0	0.85	0.15	0.9
1988	Jun	2	0.5	0.6	0.55	0.05	0.6
1988	Jul	2	0.7	1.1	0.90	0.20	0.9
1988	Aug	3	1.3	1.6	1.47	0.09	1.5
1988	Sep	2	1.6	1.6	1.60	0.00	1.6
1988	Oct	2	1.6	1.7	1.65	0.05	1.6
1988	Nov	2	1.3	1.6	1.45	0.15	1.5
1988	Dec	2	1.8	1.9	1.85	0.05	1.9

TABLE 11. Summary Statistics for Water Quality Measurements in the Similkameen River near the Canada-United States Boundary. Silica Reactive 14105 (mg/L).

84-8	N	Minimum	Maximum	Mean	Std.Error	Median
	172	6.90	12.80	10.661	0.083	10.90

---------- STATION=near the Canada-United States Boundary ----------

YEAR	N	Minimum	Maximum	Mean	Std.Error	Median
1984	52	8.20	12.80	10.919	0.130	11.10
1985	35	8.50	12.60	11.080	0.165	11.30
1986	28	8.70	12.20	10.868	0.204	11.30
1987	30	8.00	11.50	10.113	0.156	10.30
1988	27	6.90	12.10	10.015	0.249	10.00

---------- STATION=near the Canada-United States Boundary ----------

MONTH	N	Minimum	Maximum	Mean	Std.Error	Median
Jan	13	10.10	12.50	11.238	0.205	11.00
Feb	13	9.50	12.20	11.038	0.203	11.20
Mar	14	9.10	11.40	10.493	0.213	10.75
Apr	15	9.00	11.60	10.773	0.204	11.00
May	16	6.90	11.80	9.988	0.355	10.45
Jun	17	8.00	10.40	9.247	0.180	9.20
Jul	13	9.10	11.20	10.008	0.174	9.80
Aug	16	9.00	12.20	11.244	0.228	11.50
Sep	13	10.30	12.20	11.300	0.189	11.30
Oct	17	8.80	12.00	11.047	0.198	11.40
Nov	13	8.50	12.60	10.485	0.338	10.50
Dec	12	9.40	12.80	11.467	0.267	11.45

TABLE 11. - Cont'd

YEAR	MONTH	N	Minimum	Maximum	Mean	Std.Error	Median
1984	Jan	1	10.10	10.10	10.100	.	10.10
1984	Feb	1	11.30	11.30	11.300	.	11.30
1984	Mar	1	11.00	11.00	11.000	.	11.00
1984	Apr	5	10.80	11.20	10.980	0.080	11.00
1984	May	7	9.40	11.30	10.871	0.253	11.10
1984	Jun	7	8.20	10.40	9.543	0.324	9.70
1984	Jul	5	9.30	10.60	9.800	0.217	9.70
1984	Aug	6	10.90	12.20	11.567	0.194	11.50
1984	Sep	4	10.80	12.20	11.425	0.290	11.35
1984	Oct	7	11.00	11.80	11.414	0.116	11.40
1984	Nov	4	10.90	11.30	11.125	0.085	11.15
1984	Dec	4	11.80	12.80	12.275	0.250	12.25
1985	Jan	6	11.00	12.50	11.817	0.227	11.85
1985	Feb	5	11.20	12.20	11.560	0.175	11.50
1985	Mar	4	10.80	11.40	11.125	0.138	11.15
1985	Apr	3	10.00	10.80	10.500	0.252	10.70
1985	May	2	8.50	11.00	9.750	1.250	9.75
1985	Jun	2	9.10	9.70	9.400	0.300	9.40
1985	Jul	2	9.80	11.20	10.500	0.700	10.50
1985	Aug	2	11.30	12.00	11.650	0.350	11.65
1985	Sep	2	11.00	12.10	11.550	0.550	11.55
1985	Oct	3	8.80	11.50	10.467	0.841	11.10
1985	Nov	2	10.50	12.60	11.550	1.050	11.55
1985	Dec	2	11.40	11.50	11.450	0.050	11.45
1986	Jan	2	10.50	11.40	10.950	0.450	10.95
1986	Feb	2	10.60	11.70	11.150	0.550	11.15
1986	Mar	2	9.50	10.40	9.950	0.450	9.95
1986	Apr	3	11.20	11.60	11.467	0.133	11.60
1986	May	3	9.10	11.80	10.300	0.794	10.00
1986	Jun	3	8.90	9.70	9.233	0.240	9.10
1986	Jul	2	10.50	10.50	10.500	0.000	10.50
1986	Aug	2	11.70	11.90	11.800	0.100	11.80
1986	Sep	2	11.80	11.80	11.800	0.000	11.80
1986	Oct	3	11.10	12.00	11.533	0.260	11.50
1986	Nov	2	8.70	12.10	10.400	1.700	10.40
1986	Dec	2	11.40	12.20	11.800	0.400	11.80
1987	Jan	2	10.90	11.00	10.950	0.050	10.95
1987	Feb	2	10.80	10.90	10.850	0.050	10.85
1987	Mar	4	10.50	11.40	10.875	0.193	10.80
1987	Apr	2	11.10	11.50	11.300	0.200	11.30
1987	May	2	8.50	9.60	9.050	0.550	9.05
1987	Jun	3	8.00	9.20	8.800	0.400	9.20
1987	Jul	2	9.10	10.50	9.800	0.700	9.80
1987	Aug	3	9.00	10.00	9.600	0.306	9.80
1987	Sep	3	10.30	10.50	10.367	0.067	10.30
1987	Oct	2	10.00	10.40	10.200	0.200	10.20
1987	Nov	3	9.50	10.10	9.767	0.176	9.70
1987	Dec	2	9.40	10.60	10.000	0.600	10.00
1988	Jan	2	10.30	11.00	10.650	0.350	10.65
1988	Feb	3	9.50	11.00	10.133	0.448	9.90
1988	Mar	3	9.10	9.60	9.333	0.145	9.30
1988	Apr	2	9.00	9.20	9.100	0.100	9.10
1988	May	2	6.90	8.30	7.600	0.700	7.60
1988	Jun	2	8.00	9.50	8.750	0.750	8.75
1988	Jul	2	9.30	10.20	9.750	0.450	9.75
1988	Aug	3	11.10	12.00	11.600	0.265	11.70
1988	Sep	2	11.30	12.10	11.700	0.400	11.70
1988	Oct	2	10.00	11.50	10.750	0.750	10.75
1988	Nov	2	8.50	10.10	9.300	0.800	9.30
1988	Dec	2	10.90	11.10	11.000	0.100	11.00

TABLE 12. Summary Statistics for Water Quality Measurements in the Similkameen River near the Canada-United States Boundary. Sodium Dissolved 11103 (mg/L).

84-8	N	Minimum	Maximum	Mean	Std.Error	Median
	172	1.4	8.1	3.62	0.08	3.9

---------- STATION=near the Canada-United States Boundary ----------

YEAR	N	Minimum	Maximum	Mean	Std.Error	Median
1984	52	1.4	8.1	3.29	0.16	3.5
1985	35	1.5	4.9	3.96	0.16	4.4
1986	28	1.7	4.9	3.32	0.18	3.5
1987	30	1.5	5.0	3.86	0.20	4.2
1988	27	1.7	5.5	3.89	0.23	4.2

---------- STATION=near the Canada-United States Boundary ----------

MONTH	N	Minimum	Maximum	Mean	Std.Error	Median
Jan	13	3.0	5.4	4.33	0.16	4.4
Feb	13	4.1	5.5	4.62	0.11	4.6
Mar	14	2.9	5.0	4.36	0.16	4.6
Apr	15	2.6	4.9	3.53	0.18	3.4
May	16	1.5	3.5	2.36	0.18	2.2
Jun	17	1.4	2.4	1.88	0.07	1.8
Jul	13	1.9	3.8	2.75	0.16	2.7
Aug	16	3.0	4.5	3.81	0.11	3.8
Sep	13	2.1	4.7	4.13	0.19	4.3
Oct	17	2.6	5.0	4.04	0.13	4.1
Nov	13	2.0	4.9	3.85	0.26	4.2
Dec	12	2.2	8.1	4.51	0.40	4.3

TABLE 12. - Cont'd

YEAR	MONTH	N	Minimum	Maximum	Mean	Std.Error	Median
1984	Jan	1	3.0	3.0	3.00	.	3.0
1984	Feb	1	4.1	4.1	4.10	.	4.1
1984	Mar	1	3.9	3.9	3.90	.	3.9
1984	Apr	5	3.1	3.9	3.64	0.17	3.9
1984	May	7	1.7	3.5	2.70	0.28	2.7
1984	Jun	7	1.4	2.1	1.74	0.09	1.7
1984	Jul	5	1.9	3.8	2.52	0.33	2.2
1984	Aug	6	3.0	3.8	3.40	0.14	3.3
1984	Sep	4	2.1	3.9	3.40	0.43	3.8
1984	Oct	7	3.8	4.2	3.99	0.06	4.0
1984	Nov	4	2.0	4.2	3.55	0.53	4.0
1984	Dec	4	4.3	8.1	5.48	0.88	4.7
1985	Jan	6	4.3	4.5	4.45	0.03	4.5
1985	Feb	5	4.5	4.6	4.58	0.02	4.6
1985	Mar	4	4.7	4.8	4.75	0.03	4.7
1985	Apr	3	2.6	4.9	3.63	0.67	3.4
1985	May	2	1.5	2.9	2.20	0.70	2.2
1985	Jun	2	1.8	2.3	2.05	0.25	2.0
1985	Jul	2	2.7	3.4	3.05	0.35	3.0
1985	Aug	2	4.0	4.4	4.20	0.20	4.2
1985	Sep	2	4.0	4.7	4.35	0.35	4.3
1985	Oct	3	2.6	4.2	3.60	0.50	4.0
1985	Nov	2	3.6	4.4	4.00	0.40	4.0
1985	Dec	2	4.2	4.4	4.30	0.10	4.3
1986	Jan	2	3.5	4.3	3.90	0.40	3.9
1986	Feb	2	4.3	4.9	4.60	0.30	4.6
1986	Mar	2	2.9	3.6	3.25	0.35	3.2
1986	Apr	3	3.2	3.5	3.33	0.09	3.3
1986	May	3	1.7	3.1	2.20	0.45	1.8
1986	Jun	3	1.7	2.4	1.97	0.22	1.8
1986	Jul	2	2.8	2.9	2.85	0.05	2.8
1986	Aug	2	3.5	4.1	3.80	0.30	3.8
1986	Sep	2	4.1	4.3	4.20	0.10	4.2
1986	Oct	3	3.5	4.2	3.97	0.23	4.2
1986	Nov	2	2.5	4.4	3.45	0.95	3.5
1986	Dec	2	2.2	4.3	3.25	1.05	3.2
1987	Jan	2	4.1	4.3	4.20	0.10	4.2
1987	Feb	2	4.1	4.4	4.25	0.15	4.2
1987	Mar	4	4.1	4.5	4.22	0.09	4.2
1987	Apr	2	2.6	3.5	3.05	0.45	3.0
1987	May	2	1.5	2.1	1.80	0.30	1.8
1987	Jun	3	1.6	2.3	2.03	0.22	2.2
1987	Jul	2	2.4	3.5	2.95	0.55	3.0
1987	Aug	3	3.9	4.3	4.10	0.12	4.1
1987	Sep	3	4.5	4.7	4.60	0.06	4.6
1987	Oct	2	4.8	5.0	4.90	0.10	4.9
1987	Nov	3	4.8	4.9	4.87	0.03	4.9
1987	Dec	2	4.8	5.0	4.90	0.10	4.9
1988	Jan	2	5.0	5.4	5.20	0.20	5.2
1988	Feb	3	4.9	5.5	5.13	0.19	5.0
1988	Mar	3	4.8	5.0	4.90	0.06	4.9
1988	Apr	2	2.8	4.9	3.85	1.05	3.8
1988	May	2	1.8	2.4	2.10	0.30	2.1
1988	Jun	2	1.7	2.0	1.85	0.15	1.9
1988	Jul	2	2.4	3.0	2.70	0.30	2.7
1988	Aug	3	3.7	4.5	4.10	0.23	4.1
1988	Sep	2	4.5	4.7	4.60	0.10	4.6
1988	Oct	2	3.7	4.6	4.15	0.45	4.2
1988	Nov	2	2.6	3.8	3.20	0.60	3.2
1988	Dec	2	3.1	4.2	3.65	0.55	3.7

APPENDIX D

TABLE 13. Cyanides under different Discharge Conditions in the Similkameen River. Near the Canada-United States Boundary observed in 1984-1988 as compared with Concentrations (in brackets) recommended by various Agencies to protect Aquatic Life.

Simple Cyanide

Discharge Conditions	Canadian Water Quality Guidelines*** Freshwater Aquatic Life (0.005 mg/L Guideline) % Below	% Above	British Columbia Ministry of Environment Water Quality Objectives* Freshwater Aquatic Life (≤ 0.005 mg/L Average) % Below	% Above	(0.010 mg/L Maximum) % Below	% Above	Number of Observations
Low Flow	97	3	97	3	98	2	117
High Flow	98	2	98	2	100	–	45
Overall	97	3	97	3	98	2	162

	United States Environmental Protection Agency Water Quality Criteria*** Freshwater Aquatic Life (CCC = 0.0042 mg/L) % Below	% Above	(CMC = 0.0313 mg/L) % Below	% Above	Rainbow Trout (CCC = 0.0026 mg/L) % Below	% Above	(CMC = 0.0224 mg/L) % Below	% Above	
Low Flow	97	3	100	–	96	4	100	–	117
High Flow	98	2	100	–	98	2	100	–	45
Overall	97	3	100	–	96	4	100	–	162

Total Cyanide

Discharge Conditions	Canadian Water Quality Guidelines*** Freshwater Aquatic Life (0.005 mg/L Guideline) % Below	% Above	British Columbia Ministry of Environment Water Quality Objective** Drinking Water (0.20 mg/L Maximum) % Below	% Above	
Low Flow	97	3	100	–	116
High Flow	98	2	100	–	45
Overall	97	3	100	–	161

	United States Environmental Protection Agency Water Quality Criteria*** Freshwater Aquatic Life (CCC = 0.0042 mg/L) % Below	% Above	(CMC = 0.0313 mg/L) % Below	% Above	Rainbow Trout (CCC = 0.0026 mg/L) % Below	% Above	(CMC = 0.0224 mg/L) % Below	% Above	
Low Flow	97	3	100	–	96	4	100	–	116
High Flow	98	2	100	–	98	2	100	–	45
Overall	97	3	100	–	96	4	100	–	161

* weak-acid dissociable cyanide

** strong-acid dissociable cyanide

*** free cyanide

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