SUPPLY AND SERVICES CANADA

STATISTICAL ANALYSIS OF WATER CHEMISTRY DATA FROM THE COLUMBIA AND PEND D'OREILLE

E5496

DECEMBER 1987

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STATISTICAL ANALYSIS OF WATER CHEMISTRY DATA FROM THE COLUMBIA AND PEND D'OREILLE RIVERS

For

WATER QUALITY BRANCH
INLAND WATERS DIRECTORATE
ENVIRONMENT CANADA

REPORT
E5496

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CONTENTS

1. INTRODUCTION

The Columbia River is a major international watercourse that originates in the Canadian Rocky Mountains and flows into the USA near Trail. The river and its tributaries are regulated by four dams and by the regulation of Kootenay Lake. See Figure 1.1 for location and layout of the study area.

During the mid 1970 the Water Quality Branch (WQB) of Inland Waters and Lands, and the Environmental Protection Service became concerned with the water quality of the Columbia River at the International Border near Trail. The identified sources of pollution included Westar's pulp and paper mill at Castlegar, the municipal sewage treatment plant at Trail, and Cominco's lead-zinc and fertilizer complex at Trail.

A study, under the direction of WQB, was initiated in 1978. The study's main objectives were to determine the concentration of nutrients and metals at the border crossing, and to identify the main source of pollutants measured at the border. (Cominco's lead-zinc smelter and its fertilizer plant were expected to be the main contributor to the deteriorated water quality of Columbia river below Trail).

Furthermore, WQB was asked to provide advice to the BC Ministry of Environment regarding potential wastewater discharge permit modifications, and to interpret the water quality measured near the border in terms of the Boundary Waters Treaty.

The water quality sampling program ran from 1978-1984, and generated about 10,000 receiving water data values and about 7,000 values of effluent quality data for Cominco's operations. The receiving water data were collected at Birchbank located upstream of Trail, and from Waneta which is located immediately upstream of the confluence of the Pend d'Oreille River near the border (see Figure 1.1 for location of the sampling stations).

Sigma Engineering Ltd was retained by the WQB under a Department of Supply and Services contract to transfer, summarize, and analyze the receiving water and effluent data. The main objectives of this work have been to determine:

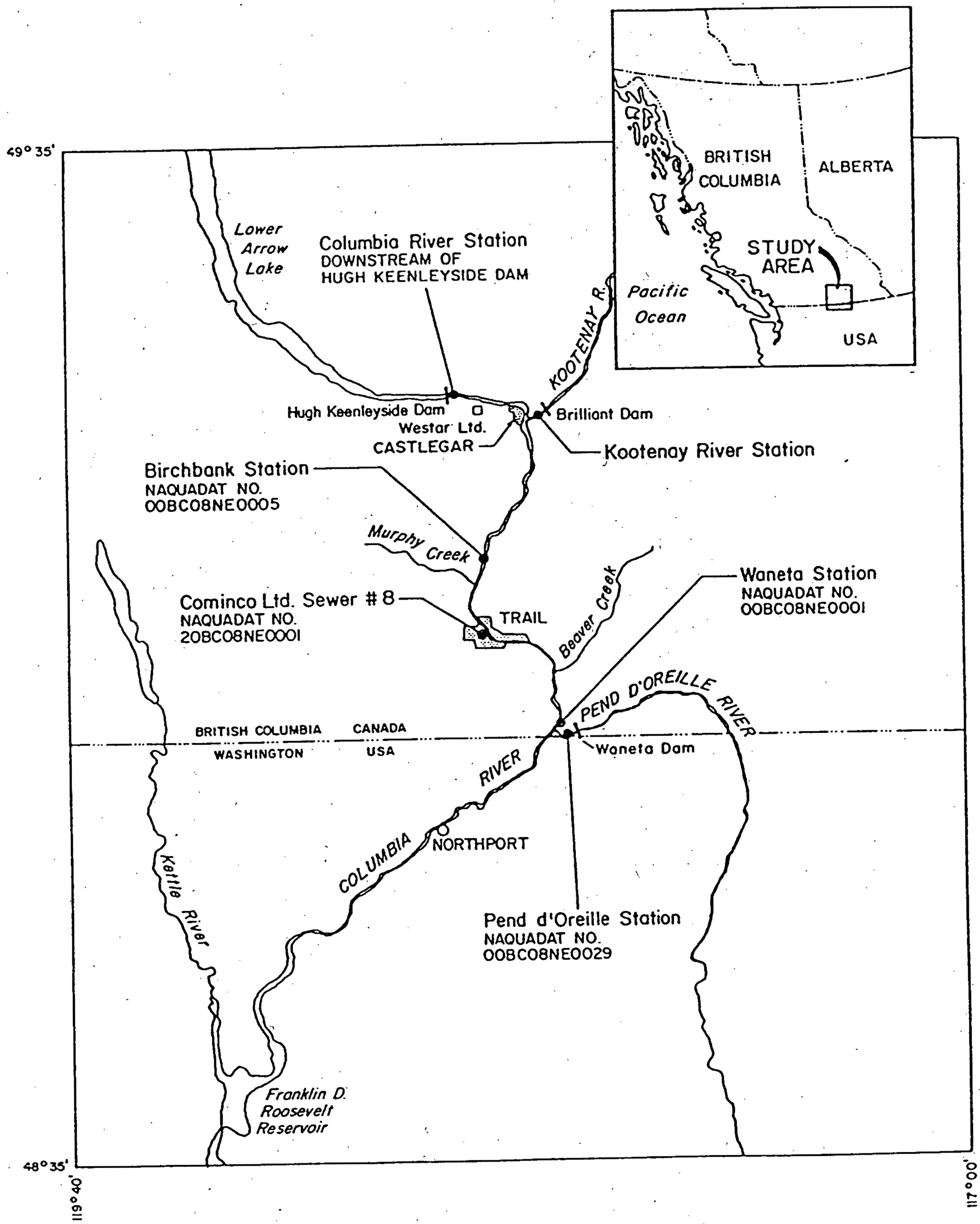
1. The effect of Cominco's lead-zinc smelter and fertilizer plant on the water quality of the Columbia River.

2. The effect of dilution by the Pend d'Oreille River on the measurements taken on the American side of the border.

Our work also included an evaluation of the effect sampling interval had on the results of the receiving water measurements.

Refer to Appendix E for a copy of the Terms of Reference which formed a part of WQB's Request for Proposal.

FIGURE 1.1 - LOCATION PLAN OF THE STUDY AREA
(From Sheehan and Lamb, 1987)



2. RAW DATA

Data Sources

The water quality data used in this report came from three different sources:

1. "Water Chemistry of the Columbia and the Pend d'Oreille Rivers near the International Boundary", Data Report by SW Sheehan and M Lamb, Inland Waters and Lands, Pacific and Yukon Region, Environment Canada, March 1987 (referred to as "Sheehan and Lamb, 1987" in this report).

2. "Effluent Discharges From Cominco Ltd, Trail, BC to The Columbia River", Draft copy prepared by CA Johnson, Waste Management Branch, Kootenay Region, BC Ministry of Environment (referred to as "MOE Report").

3. "Acid Discharge to the Columbia River", by RC Brown, GF Kenyon, JD McCunn and DM Glover, Cominco Ltd, Trail BC, Dec 1985 ("Cominco Report, 1985").

Water Quality Parameters

Table 2.1 summarizes the parameters measured. The parameters of particular concern to this study were phosphorus (from Cominco's fertilizer plant), and zinc and lead (from the lead-zinc smelter operation). Cadmium and especially mercury were also of concern because of their high toxicity at low concentrations. Other parameters such as nitrogen, iron, and copper, although present in detectable concentrations, were not considered important for this study and therefore not analyzed. The same is true for those parameters whose values were at or near their respective detection limits.

We used the total concentrations for the statistical analyses as the dissolved (or soluble) fraction likely change from the point of discharge to the Waneta sampling station.

Data transformations

During the period of investigation, the lead-zinc smelter discharged wastewater to the Columbia River through several sewer pipes. Effluent from the fertilizer plant was discharged to Stony Creek in 1978 and 1979. Refer to the MOE Report and the Cominco Report (1985) for detailed description of the sewer pipe configuration and sampling methods.

The total mass of pollutants discharged into the river during a sampling period was estimated from effluent quality and flow measurements taken from each sewer pipe. The average mass rate of discharge of a certain parameter was divided by the river flow to give an equivalent receiving water concentration for comparison with the concentrations observed at Birchbank and Waneta.

TABLE 2.1 - PARAMETERS MEASURED DURING THE FIVE TIME SERIES STUDIES
(from Sheehan and Lamb, 1987)

Parameter	Sept. 1978	Sept. 1979	May 1981	Oct. 1983	March 1984
Total Phosphorus	+	+			
Dissolved Phosphorus	+	+			
Nitrate + Nitrite	+	+			
Ammonia	+	+			
Total Dissolved Nitrogen	+	+			
Particulate Nitrogen	+	+			
Particulate Carbon	+	+			
Fluoride		+			
Sulphate					+
Major Ions, Residues and Physical Parameters	+				+
Total Cd	+		+	+	+
Dissolved Cd				+	+
Total Cu	+		+	+	+
Dissolved Cu				+	+
Total Fe	+			+	+
Dissolved Fe				+	+
Total Mn	+			+	+
Dissolved Mn				+	+
Total Ni	+				
Total Pb	+		+	+	+
Dissolved Pb				+	+
Total Zn	+		+	+	+
Dissolved Zn				+	+
Extractable As			+	+	+
Extractable Se			+	+	+
Extractable Hg	+		+	+	+

Data sets

Five sets of time series data were collected between 1978-1984. The first set, collected in 1978, was of a limited and exploratory nature and did not include sampling of Cominco's sewer discharges, or of water quality at Birchbank.

During 1979, 1981, and 1983 water quality at Birchbank and Waneta was determined from grab samples collected every hour for 72 hours (see Sheehan and Lamb, 1987, for description of collection procedures). Three hour composite samples and flow measurements were taken from each of Cominco's sewers during the same time period.

In 1984, Cominco ran a controlled acid discharge study, as part of their application to have the wastewater discharge permit amended to allow for emergency discharges of up to 200 tons per day of 93% sulphuric acid to the Columbia River. The tests included four days of controlled acid discharges. One composite sample was collected from each sewer pipe during each run (one run per day of about 6-8 hrs length). The effluents were tested for zinc and mercury but not for lead and cadmium. The lead smelter and the zinc plant operated continuously during the test period.

Table 2.2 - Time Series Data Sets of Selected Parameters

Location	1978 Sept 19-20	1979 Sept 17-20	1981 May 12-15	1983 Oct 17-20	1984 Mar 26-30
Birchbank		TP	Metals	Metals	Metals
Cominco		**	Metals	Metals	Zn,Hg only
Waneta	TP,Metals	TP	Metals	Metals	Metals

** The wastewater flow from the fertilizer plant was not recorded (Stony Creek). The total mass discharged to the Columbia River can therefore not be estimated.

3. SUMMARY STATISTICS

Scatter Plots

Scatter plots of the raw data are presented in Appendix A. Gaps in the graphs represent times at which sampling for some reason was missed. The graphs were plotted at the same scale for each parameter so that different data sets could be easily compared.

The background levels of zinc, lead and phosphorus, measured at Birchbank, were fairly constant and considerably lower than the values observed at Waneta. The Waneta measurements show a high degree of variability. This variability reflects the fluctuating quality of Cominco's effluent discharges.

The increase in concentration of cadmium and mercury caused by Cominco's discharges diluted into the Columbia River were very low (assuming complete mixing). In fact, as shown by the scatter plots, the diluted concentrations represents values below the normal detection limits.

Descriptive Statistics

Tables 3.1, 3.2 and 3.3 below summarize the means and standard deviations of the time series data. The frequency distributions, maximum and minimum values, and standard errors can be found in Appendix B. The concentration means are also depicted in Figures 3.1, 3.2, and 3.3.

Note that the concentrations plotted for Cominco represents the combined discharges from the lead-zinc smelter and the fertilizer plant diluted into the Columbia River. Adding these concentrations to the background levels measured at Birchbank, gives an estimate of the total concentration of water quality parameters at Trail assuming complete mixing of the discharges by the river.

Note that the concentrations measured at Cominco represent the amount of metal discharged to the river and should be added to the concentrations reported for Birchbank (background levels) to give an estimate of the actual metal concentration of the Columbia River at Trail.

The frequency distributions of the receiving water data were generally skewed as one would expect for data of this nature. The distributions are likely to be of the Poisson or negative binomial type. The Waneta observations are more highly skewed than those of Birchbank. This is to be expected as Waneta is affected by Cominco and therefore has more "spikes" of high concentrations.

Table 3.1 - TOTAL ZINC: Sample size, Means, and Standard Deviations.

Location	1978 Sept 19-20	1981 May 12-15	1983 Oct 17-20	1984 Mar 26-30	LOCATION Means
Birchbank	*	72 0.0024 0.0012	69 0.0036 0.0018	88 0.0060 0.0052	229 0.0042 0.0038
Cominco	*	21 0.035 0.031	24 0.012 0.004	4 0.039 0.021	49 0.024 0.024
Waneta	13 0.041 0.015	61 0.029 0.012	67 0.038 0.044	92 0.034 0.018	220 0.034 0.028
YEAR Means	13 0.041 0.015	54 0.017 0.019	160 0.019 0.033	184 0.021 0.020	498[A] 0.019 0.025

A. Not including Waneta 1978.
* No Data.
Means and standard deviations in mg/l.

Table 3.2 - TOTAL LEAD: Sample size, Means, and Standard Deviations.

Location	1978 Sep 19-20	1981 May 12-15	1983 Oct 17-20	1984 Mar 26-30	LOCATION Means
Birchbank	*	72 0.0012 0.0007	69 0.0032 0.0014	88 0.0021 0.0021	229 0.0022 0.0017
Cominco	*	21 0.0049 0.0032	24 0.0030 0.0028	*	45 0.0039 0.0031
Waneta	13 0.0052 0.0016	61 0.0049 0.0029	67 0.0089 0.0076	92 0.0068 0.0048	220 0.0069 0.0056
YEAR Means	13 0.0052 0.0016	154 0.0032 0.0029	160 0.0056 0.0059	180 0.0045 0.0044	494[A] 0.0044 0.0047

A. Not including Waneta 1978.
* No Data.
Means and standard deviations in mg/l.

Table 3.3 - TOTAL PHOSPHORUS: Sample size, Means, and Standard Deviations.

Location	1978 Sep 19-20	1979 Sep 17-20	LOCATION Means
Birchbank	*	71 0.0066 0.0017	71 0.0066 0.0017
Waneta	13 0.044 0.052	72 0.080 0.037	85 0.074 0.0426
YEAR Means	13 0.044 0.052	143 0.044 0.045	156 0.044 0.046

* No Data.
Means and standard deviations in mg/l.

Figure 3.1 - Average Concentrations: TOTAL ZINC - 1978 to 1984

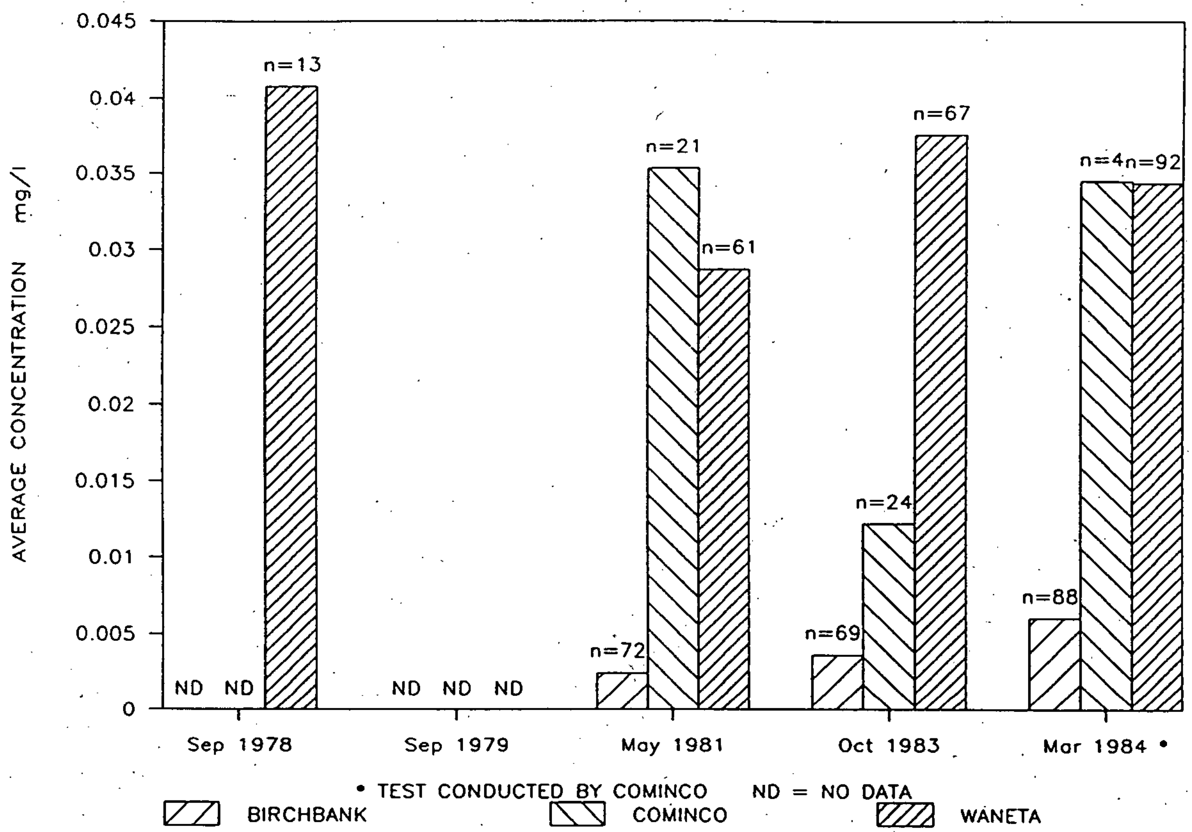


Figure 3.2 - Average Concentrations: TOTAL LEAD - 1978 to 1984

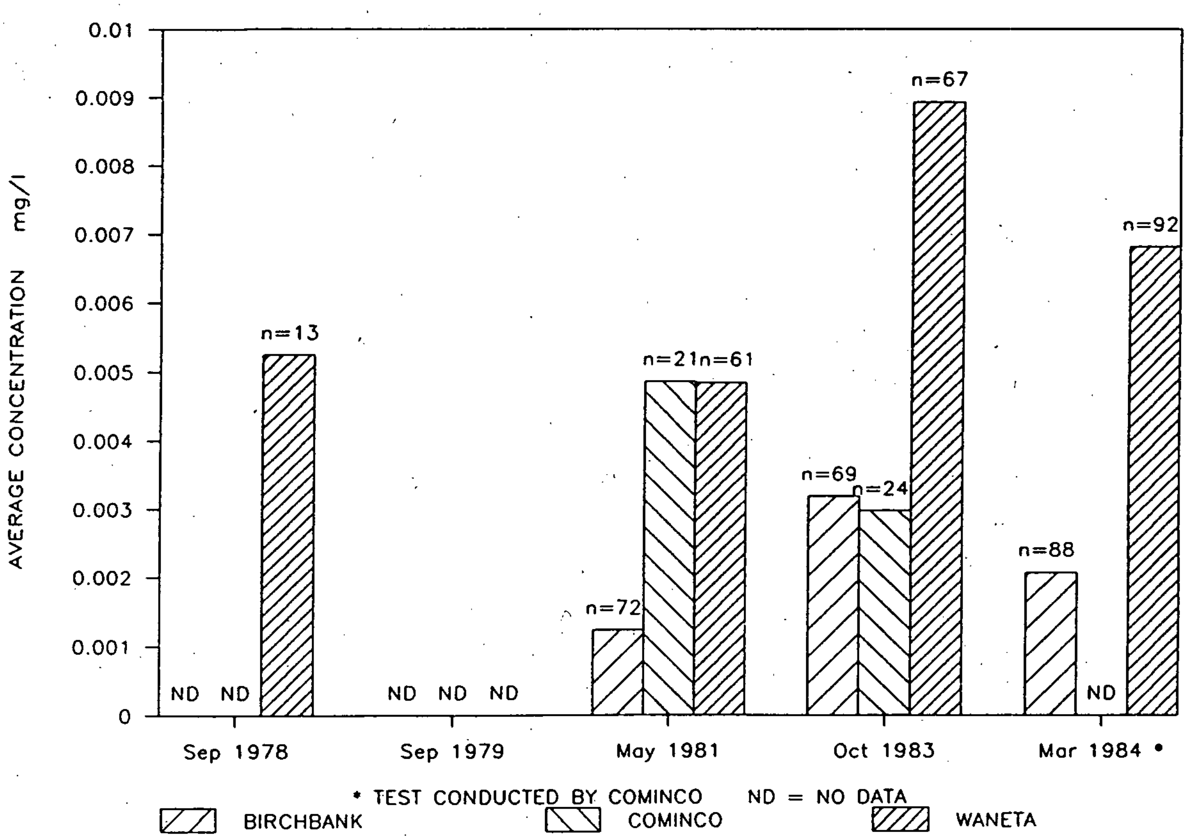
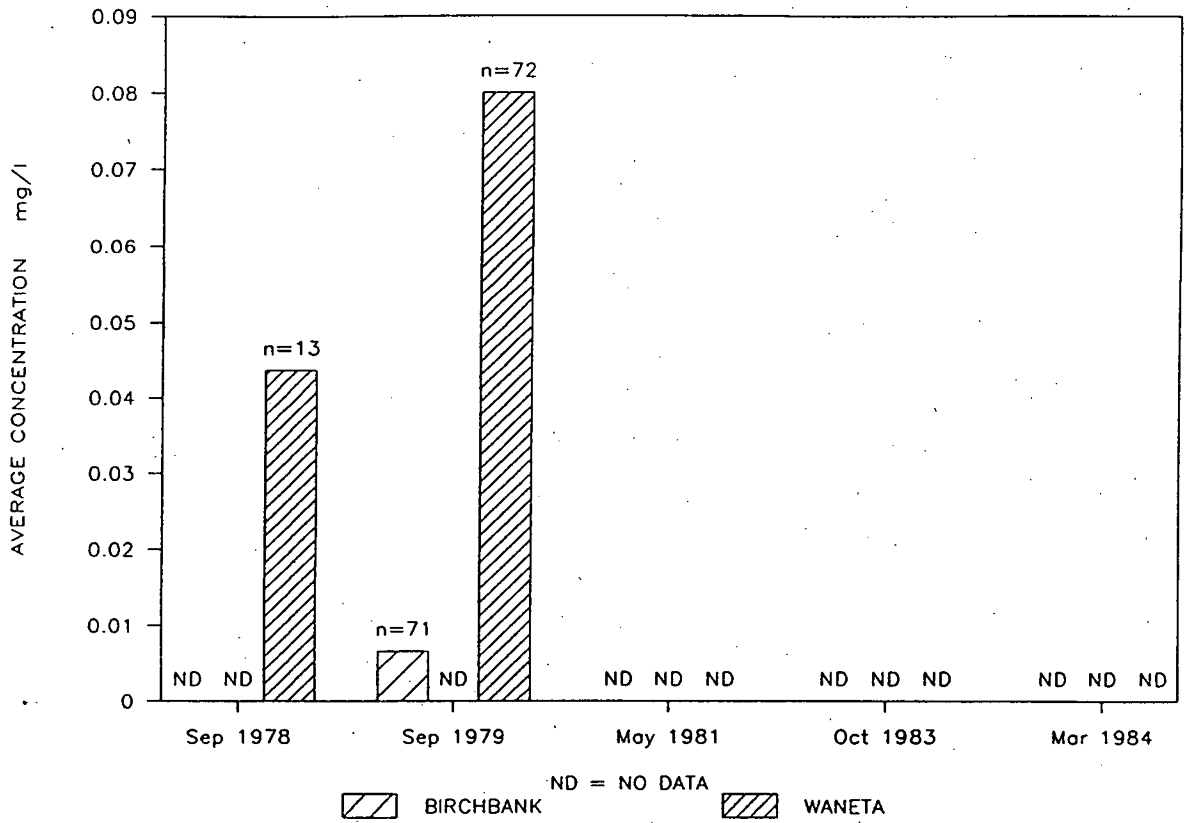


Figure 3.3 - Average Concentrations: TOTAL PHOSPHORUS - 1978 to 1984



4. STATISTICAL ANALYSES

Lag Correlation Analyses

Multiple lag correlation analyses were carried out on selected data sets from Waneta and Cominco. The correlation between data sets collected at Cominco and Waneta was estimated for 2 to 8 hour shift. The Waneta data was shifted to correct for the anticipated flow time From Cominco's discharges (see Table 5.1 for estimated mean river flow times).

The results for 1983 indicated a 4 hr lag but showed a very low correlation coefficient. Reasons for the apparent low lag correlation, despite the obvious strong affect of Cominco's discharge on the Waneta measurements, are discussed in the following section.

Histograms

The mass rate histograms give a visual presentation of the pollutant loading of the Columbia River. The Birchbank and Waneta histograms were determined from water quality observations and from the recorded flow of the River (see Table 4.1 below). The mass rate of discharge from Cominco was estimated from the water quality and flow measurements of the sewers. These histograms are especially useful for comparing pollutant loadings of the river over time. The variation in river flow is eliminated and the actual mass discharge compared. This gives a somewhat different picture of the water quality as is evident by comparing Figures 3.1 and 3.2 with Figures 4.1 and 4.2.

Table 4.1 - Mean Flows of The Columbia River

DATE	YEAR	MEAN FLOW[1], m^3/s
Sept 19-20	1978	1960
Sept 17-20	1979	1540
May 12-15	1981	1570
Oct 17-20	1983	1300
Mar 26-30	1984	820

1. Mean flows are based on daily flow measurements for period of water quality sampling.

Analysis of Variance (ANOVA)

ANOVA Assumptions

Analysis of Variance is a statistical test that allows for comparison of more than two means by partitioning the variation (in terms of sums of squares) into recognized components. The test assumes that the experimental error is a normally distributed (i.e. independent random effect has a mean value of zero and a variance that is the same for all treatments or levels).

Moderate departures from the assumption that the variances are homogeneous do not seriously affect the accuracy of the decision reached by the Analysis of Variance (F-Test) and multiple range tests (Box, 1954). In more technical language, these tests are robust with respect to moderate departures from the hypothesis of homogeneity of variance. The term moderate in this context, is relative to the magnitude of sample sizes. If the sample sizes are greater than 30 (per mean to be compared) the effect of unequal variances is negligible. (Note that each composite sample represents a number of discrete sample points).

The work of Box also indicates that the Analysis of Variance and multiple range tests are robust with respect to the assumption of normality of the distributions. Even when population distributions are markedly skewed, the sampling distributions of the "t" and the "F" statistics provide a good approximation to the exact sampling distribution which assumes normality.

Very serious departures from normality and homogeneity of variance will change the level of significance in the direction of rejecting the null hypothesis (that the means are equal) more often than should be the case. This means that the ANOVA results may have suggested a significant difference between data sets when this was not the case.

In some cases the original data can be transformed to remedy departures from the assumptions, and the ANOVA carried out on the transformed data sets. However, the results will reflect the behavior of the transformed data and drawing conclusion regarding the original data may be difficult. The risk of carrying out ANOVA on data sets of non homogeneous variances is that sets of high variances will bias the ANOVA results.

The ANOVA also assumes that the observations in one data group are independent of the observation in other groups receiving different treatment. The samples taken at Birchbank are certainly independent of those taken at Cominco. Lag-correlation analysis of the Cominco and the Waneta observation were very low, so the assumption of low dependency is reasonable.

Finally, the fact that ANOVA is carried out on randomly collected data means that data in each set can be analyzed independently of sampling order, and that lag effects can be ignored.

Methods

Analysis of Variance (ANOVA) and Neuman-Keuls Multiple Range Tests were carried out to order the means of the time series data sets into groups having statistically similar means.

The one-way analyses were carried using Powerstat, a MS-DOS based software program. The two-way analyses were carried out on the UBC mainframe using GENLIN. Printouts from the analyses can be found in Appendix C.

Results

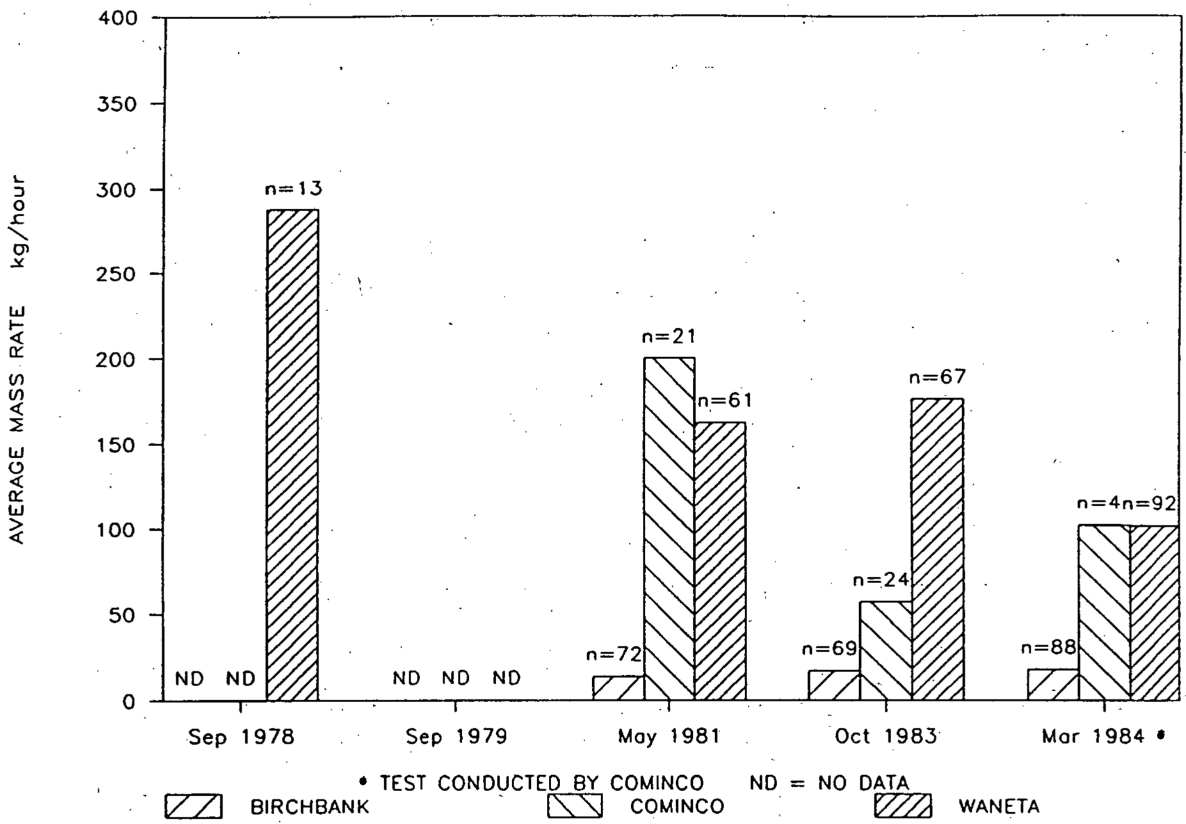
It is important to realize that the metal concentrations used for the Cominco station in the ANOVA tests represent the combined sewer discharges diluted into the Columbia River. Adding these concentrations to the background levels gives an estimate of the total pollutant load at Trail.

The ANOVA results and the results of the Multiple Range tests are presented in the Tables 4.2 through 4.7 below. The Two-Way ANOVA results for zinc are shown in Table 4.2 and 4.3. The year effect was not significant whereas the location effect and the location by year interaction were significant. For discussion of these results see the next section (Section 5).

The Two-Way ANOVA of lead suggest that the YEAR and LOCATION effects, and the YEAR * LOCATION interaction were all significant as shown in Tables 4.4 and 4.5.

Phophorus was only measured at Birchbank in 1979 and at Waneta in 1978 and 1979. The effect of LOCATION was highly significant as shown in Tables 4.6 and 4.7.

Figures 4.1 - Average Loadings: TOTAL ZINC - 1978 to 1984



Figures 4.2 - Average Loadings: TOTAL LEAD - 1978 to 1984

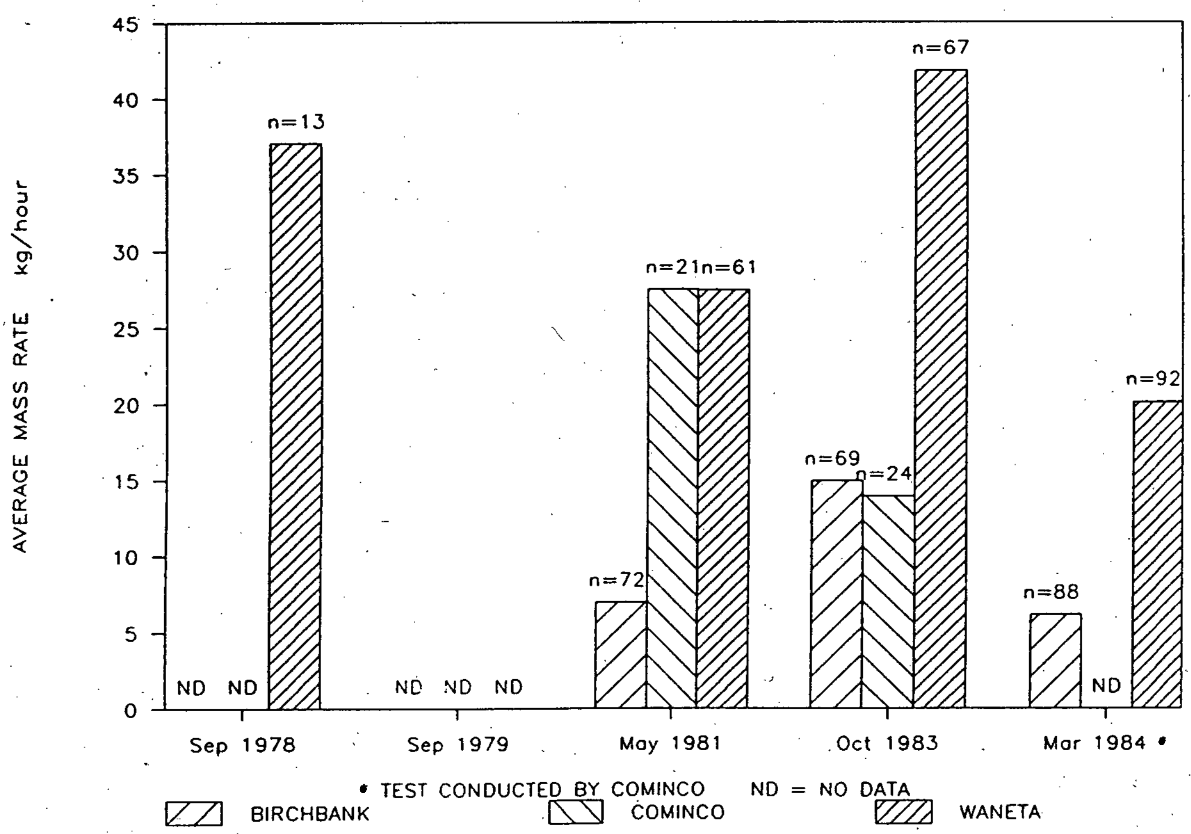


Table 4.2 - TOTAL ZINC: TWO-WAY ANOVA Results

SOURCE	Sum of Squares	Degrees of Freedom	Mean Square	F-Ratio	Probability Level
LOCATION	0.09959	2	0.0498	129.45	0.00000
YEAR	0.000749	2	0.000375	0.98	0.3783
LOC*YEAR	0.00930	4	0.00233	6.05	0.00009
Residual	0.1881	489	0.000385		
Total	0.2981	497			

Comment: The Probability Level represents the probability of the means being not significantly different. The confidence level of the means being different is equal to (1 - prob level). For example, we are 100% confident that the LOCATION means are significantly different.

Means in mg/l.

Table 4.3 - TOTAL ZINC: Comparison of Concentration Means

LOCATION	LOCATION by YEAR Means 1981 May 12-15	1983 Oct 17-20	1984 Mar 26-30	LOCATION Means
Birchbank	0.0024^{A}	0.0036^{A}	0.0060^{A}	0.0042^{A}
Cominco	0.035^{B}	0.012^{AB}	0.040^{B}	0.024^{B}
Waneta	0.029^{B}	0.038^{B}	0.034^{B}	0.034^{C}
YEAR Means	0.017^{A}	0.019^{A}	0.021^{A}	

Comment: The letters "A, B and C" rank the LOCATION by YEAR, the LOCATION, and the YEAR means separately into groups of statistically different values (at a 95% confidence level). The letter "A" represents the group with lowest means and "C" the highest.

Means in mg/l.

Table 4.4 - TOTAL LEAD: TWO-WAY ANOVA Results

SOURCE	Sum of Squares	Degrees of Freedom	Mean Square	F-Ratio	Probability Level
LOCATION	0.002522	2	0.001261	83.271	0.00000
YEAR	0.0004104	2	0.0002052	13.55	0.00000
LOC*YEAR	0.0003011	3	0.0001004	6.627	0.00022
Residual	0.007360	486	0.00001514		
Total	0.010640	493			

Comment: The Probability Level represents the probability of the means being not significantly different. The confidence level of the means being different is equal to (1 - prob level). For example, we are 100% confident that the LOCATION means are significantly different.

Means in mg/l.

Table 4.5 - TOTAL LEAD: Comparison of Concentration Means

LOCATION	LOCATION by YEAR Means 1981	1983	1984	LOCATION Means
Birchbank	0.00124^{A}	0.00320^{BC}	0.00208^{AB}	0.00215^{A}
Cominco	0.00486^{C}	0.00299^{ABC}	*	0.00386^{A}
Waneta	0.00485^{C}	0.00894^{E}	0.00683^{D}	0.00692^{B}
YEAR Means	0.00316^{A}	0.00557^{B}	0.00451^{AB}	

Comment: The letters "A, B, C, D and E" rank the LOCATION by YEAR, the LOCATION, and the YEAR means separately into groups of statistically different values. The letter "A" represents the group with lowest means and "E" the highest.

* = No Data

Means in mg/l.

Table 4.6 - TOTAL PHOSPHORUS: ONE-WAY ANOVA Results

SOURCE	Sum of Squares	Degrees of Freedom	Mean Square	F-Ratio	Probability Level
LOCATION	0.1933	1	0.1933	275.46	0.0000
Residual	0.0989	141	0.000702		
Total	0.2922	142			

Comment: The Probability Level represents the probability of the means being not significantly different. The confidence level of the means being different is equal to (1 - prob level). For example, we are 100% confident that the LOCATION means are significantly different.

Means in mg/l.

Table 4.7 - TOTAL PHOSPHORUS: LOCATION Effect

TYPE	YEAR	Birchbank	Cominco	Waneta
ONE-WAY ANOVA	1979	0.00656[A]	*	0.0801[B]

Comment: The letters "A and B" rank the LOCATION means for each year into groups of statistically different values. The letter "A" represents the lowest means and "B" the highest.

* = No Data.

Means in mg/l.

5. DISCUSSION OF RESULTS

Lag Correlation Analysis

The different nature of the raw data collected at Cominco and Waneta makes it difficult to perform lag correlation analyses. The composite samples taken at Cominco smoothed metal concentration peaks in the effluent. At Waneta however, one hour grab samples would have detected some but missed most of these peaks.

Despite this fact, the raw data clearly show that Cominco has a major effect on the zinc and phosphorus concentration at Waneta. The effect of Cominco's discharge on lead concentrations are not so obvious. The scatter plots suggest a lag period of 3-5 hours between Cominco and Waneta. However, multiple lag correlation analysis produced very low correlation coefficients.

River velocities measured at Waneta during July 5 1979 suggests a lag of 4.2 hours as shown in the table below. The Cominco effluent is discharged to a backchannel along the west bank. As the flow is generally slower along the bank and mixing of the effluent plume relatively slow, one would expect the actual plume lag to be somewhat greater than the estimated average flow time.

Table 5.1 - Estimated Columbia River Flow Times*: July 5, 1979

STATIONS	DISTANCE, km	TIME, hrs
Birchbank to Cominco	9	1.7
Cominco to Waneta	17	4.2
Birchbank to Waneta	26	5.9

* Based on a mean river flow of 1.5 m/s (as measured on July 5, 1979, Q=1257 m^3/s).

Multiple lag correlation analysis assumes that the sampling frequency is greater than the fundamental frequency of the variable sampled. It appears that the metal concentration of the Cominco effluents fluctuated at a frequency greater than that of sampling. This is probably the main reason why the correlation between Cominco and Waneta observations are so low. Other factors that would effect lag correlation analysis include changes in metal concentrations caused by chemical reactions (such as precipitation or leaching of metals), and incomplete mixing of the effluent plume.

Water Quality Background Levels (as measured at Birchbank)

The time series data represent detailed water quality information for a short period of time (typically 72 hrs). When comparing these data sets it is important to realize that seasonal fluctuations in background levels, weekly and monthly variations in plant operation, and other variations not accounted for by the available data, may distort any conclusion regarding trends. The long term trends can only be assessed if, in addition to the time series data, water quality data collected on a weekly or monthly basis are available.

As shown in Figure 3.1, backgrounds levels of zinc (as measured at Birchbank) were only about one tenth of those observed at Waneta. The measurements taken in May 1981 (mean=0.0024 mg/l) were somewhat lower than those of October 1983 (mean=0.0036) and March 1984 (mean=0.0060), but the differences were not significant when compared to the changes observed at Cominco and Waneta, as demonstrated by the ANOVA tests[1] (Table 4.2 and 4.3).

The background levels of lead, on the other hand, was about one third of the Waneta values indicating major sources of lead pollution upstream of Birchbank.

The background lead concentrations were lowest in May 1981 (mean=0.0012 mg/l), more than doubled in October 1983 (mean=0.0032 mg/l), and about halfway in between in March 1984 (mean=0.0021 mg/l). The 1983 increase was found to be significant (Two-Way ANOVA at 5 % probability level). The 1983 mean concentration was not significantly different from either the 1981 or the 1984 means (Table 4.5).

Data for total phosphorus are only available for 1979. The background level that year (mean= 0.00656 mg/l) was just below one tenth of the concentration observed at Waneta (mean=0.0801 mg/l). The two means were found to be significantly different (Tables 4.6 and 4.7).

Cominco's Combined Sewer Discharge

Cominco installed a treatment facility between 1981 and 1983. Keeping in mind the limitations of the data sets, the treatment facility appears to have reduced the zinc discharge as shown in Figure 4.1 (from 210 kg/hr to 60 kg/hr). The ANOVA results of Table 4.3 show that the October 1983 mean (0.012 mg/l) were not significantly different from either the background level mean (0.0042 mg/l) or the mean measured at Waneta (0.034 mg/l), indicating a reduction in zinc discharge. The March 1984 data were taken during a controlled acid discharge experiment and therefore may not reflect the plant discharge during normal operation.

The Cominco discharge of lead was also lower in October 1983 as shown in Figure 4.1. In fact the 1983 discharge was about the same as the amount of lead present at Birchbank (background level) and only about one third of the Waneta observations. The ANOVA of

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1. Note that ANOVA is a statistical test for comparisons of means. The comparison of the means of the three intensive time series data sets include seasonal variations that can not be separated from other variations. The ANOVA tests therefore, while ranking the means of the given data sets, do not tell us whether the observed differences are due to seasonal effects or variations of pollution discharges upstream.

mean lead concentrations showed that the October 1983 measurements (mean=0.0030 mg/l) were not significantly different from either the 1981 mean (0.0022 mg/l) or the March 1984 mean (0.049 mg/l).

Waneta Observations

The concentrations measured at Waneta were significantly greater than the background levels as demonstrated by scatter plots, histograms and ANOVA results (ranging from 3 times for TPb to 10 times for TP and TZn). The increase in concentration was due to Cominco's discharges and possibly to other sources of pollutants between Birchbank and Waneta.

The mean concentrations of zinc measured at Waneta in Sept 1978, Sept 1979, May 1981, Oct 1983, and Mar 1984 were all about the same (Figure 3.1). However, the mass discharge rate was highest in 1978 and lowest in 1984, corresponding to the recorded river flows (See Figure 4.1 and Table 5.1).

The ANOVA performed on the Waneta mean concentrations showed that the values were not significantly different (Table 4.2 and Table C.3).

Lead concentrations at Waneta were comparable for the September 1978 (mean=0.0052 mg/l) and the May 1981 (mean=0.0049 mg/l) data sets. The October 1983 mean lead concentration was higher at 0.0089 mg/l, whereas the March 1984 mean was about halfway in between (0.0068 mg/l). The differences were all significantly different at the 5% probability level (or better), as shown in Table 4.4 and 4.5.

The ANOVA results showed that the zinc concentrations at Waneta were comparable for all the time series data sets at the 5% probability level (Table 4.3). The same is true for lead (Table 4.7).

Effect of Cominco's Discharge on The Columbia River

The histograms and the ANOVA results all show that the concentrations of lead, zinc and phosphorus increased significantly downstream of Trail. Zinc and phosphorus increased about 10 times, and lead about 3 times. This suggest that Cominco is a major contributor of these pollutants. Just how much of the increase was due to Cominco is displayed in Figures 4.1 and 4.2 (average mass rate in kg/hr). Recall that the background levels should be added to the Cominco discharge to reflect the total pollutant load of the Columbia River at Trail.

In 1981, Cominco contributed more zinc (200 kg/hr) and lead (27 kg/hr) to the river (not including the background levels: zinc=14 kg/hr; lead=7 kg/hr) than could be accounted for at Waneta (zinc=162 kg/hr; lead=27 kg/hr). This was reversed in 1983, when about one third of the metal appeared to come from sources other than Cominco (Figures 4.1 and 4.2).

A likely scenario is that although the different sampling programs (composite versus grab samples) may be the cause of some of the difference between the Cominco and the Waneta measurements, the major source of the apparent loss of metal in 1981 and the gain in 1983 may be due to chemical reactions occurring in the river. During 1981, metal may have been lost to the sediment by precipitation, whereas metal may have been leached from the sediments in 1983.

The ANOVA tests were carried out on observed (Birchbank and Waneta) and estimated (Cominco) water quality concentrations. The estimated water quality concentrations for Cominco represents the combined sewer discharges diluted by the Columbia River assuming complete mixing.

In the case of zinc, the Cominco observations were not significantly different from those measured at Waneta in May 1981, Oct 1983 and Mar 1984. (Table 4.3). The same is true for lead in May 1981 (Table 4.5). The Oct 1983 lead concentrations measured at Cominco (mean=0.0030 mg/l), on the other hand, were significantly lower than those observed at Waneta supporting the argument that metal have been leached from the sediments.

The differences observed between Cominco and Waneta metal concentrations may also in part have been caused by incomplete mixing of the effluents. However, investigations by others (pers. comm. Steve Sheehan) suggest that the effluents are well mixed at Waneta and that any differences attributed to incomplete mixing were negligible.

6. DILUTION BY THE PEND D'OREILLE RIVER

Transverse Mixing by Turbulent Diffusion

An initial analysis was carried out to determine the degree of completion of mixing of waters from the two rivers at various distances downstream of their confluence. The international border crosses the river diagonally at a distance of about 800 meters downstream of the confluence, and the U.S. sampling station at Northport, Washington is at about 16 km. downstream of the confluence.

For this initial analysis the channel was assumed to be rectangular, with an average depth equal to the mean depth of the channel at Waneta. The average breadth of the channel was assumed to be about 20% larger than the breadth of the channel at Waneta, because the Columbia widens after receiving flows from the Pend d'Oreille. Three values for turbulent diffusion coefficients in natural streams were used, following the range of values recommended by HB Fischer (Mixing in Inland and Coastal Waters, Chapter 5, 1979).

Analysis of aerial photographs and river discharges for September 28, 1976 and July 13, 1979 showed the following:

Table 6.1 - River Mixing Information.

Date	Discharges		Ratio	Width of section filled by Pend d'Oreille waters 400m below confluence (from air photos)
	Columbia m3/s	Pend d'Oreille m3/s		
28-9-76	2010	562	22%	29%
13-7-79	1890	776	29%	43%

The table shows that the Pend d'Oreille waters fill slightly more of the river breadth at distance x = 400m than would be attributable to the direct apportionment of flows. It was assumed that the Pend d'Oreille waters filled one third (33%) of the section at the confluence (used as the initial condition for the turbulent diffusion modelling).

Calculations were run for two sets of hydraulic conditions, the first a summer condition, using data from 1st. June 1978, with sections for Waneta given by Sheehan and Lamb (1987), and the second a winter condition, using typical winter low flows and depths of flows and velocities estimated from the summer data.

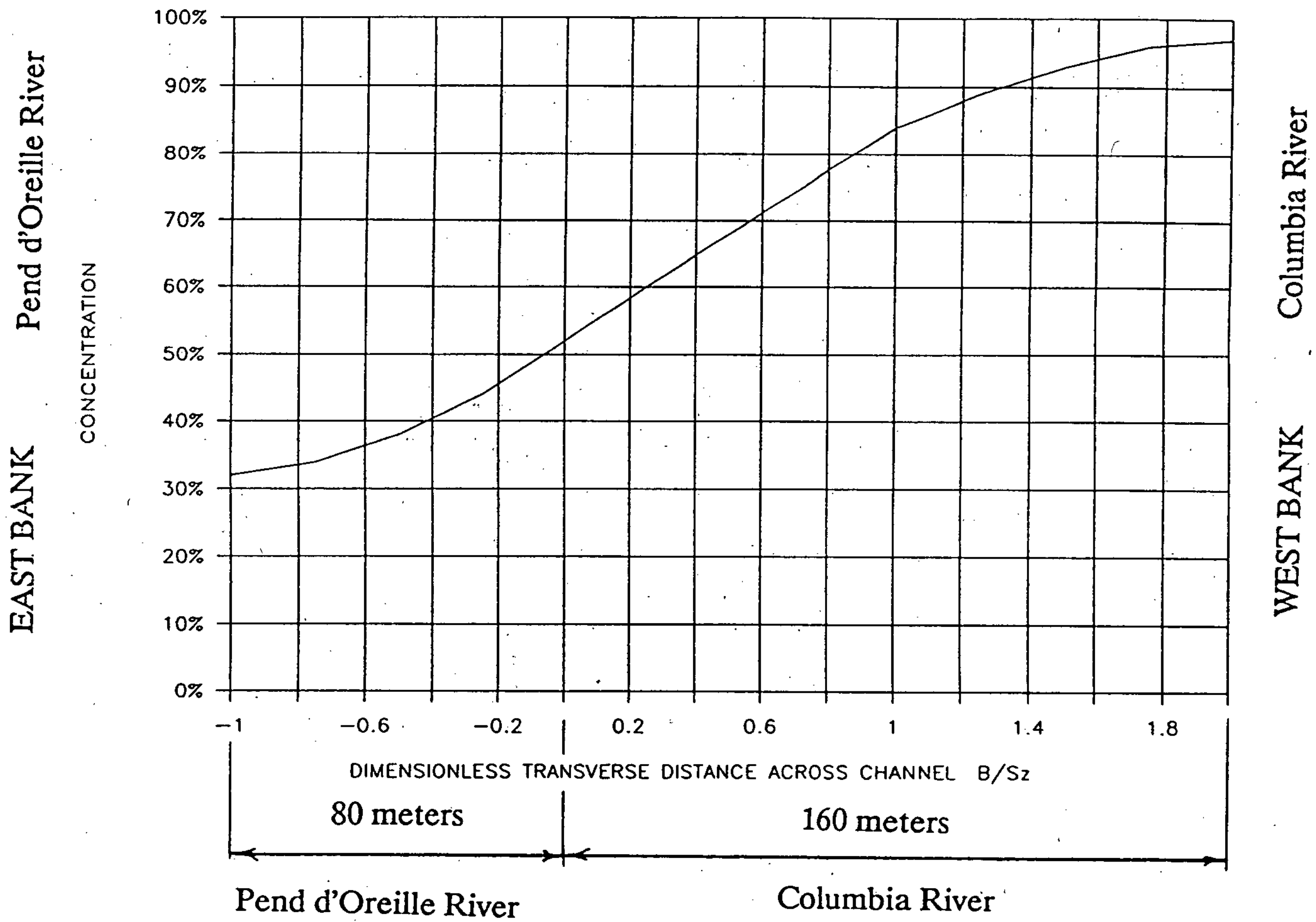
Summer conditions are presented in Appendix D Table D.1, with the width scale of mixing "S_z" shown for various distances downstream of the confluence. This "S_z" distance is a measure of the width of spreading (or smudging) of the interface between the waters of the two rivers. The relative width of channel in relation to the width of transverse spreading is listed in Table D.1 using the ratio (B/S_z) where B is the breadth of the river channel downstream of the confluence (assumed to be 240 meters in summer conditions).

Winter conditions are presented in Table D.2, with smaller values for channel depth, velocity and breadth used. The final ratios of channel breadth to width of transverse spreading (B/S_z) are approximately the same as the values under summer flow conditions (see Table D.1), showing that the distances for the completion of mixing are insensitive to the hydraulic conditions.

The spread of the step distribution of concentration is examined using the theory for diffusive spreading in rectangular channels (Figure 2.6 and Table 2.1 of Fischer, 1979). Data for 10 km downstream, using the largest value of the turbulent diffusion coefficient found in summer conditions ($D_z = 0.96\ m^2/s$), are plotted in Figure 7.1. The diffusing waters start reaching the channel boundaries at about 2.5 km downstream, and the reflection superposition principle is used to determine the concentration curves. Use of the largest value of the turbulent diffusion coefficient is justified because this reach of river has some severe bends which provide enhanced transverse mixing.

The degree of completion of mixing is poor, even at 10 km downstream from the confluence. At this distance samples taken from the river would be either slightly diluted or heavily diluted with Pend d'Oreille water. On the west bank, concentrations would be about 95% of the water quality measured Waneta, and on the east bank only about 32%. The situation at Northport (16 km downstream of the confluence) is difficult to predict because the Columbia is backed up by the headwaters of Franklin D. Roosevelt Lake, but the transverse mixing may be not much more complete than at 10 km.

Figure 7.1 - Transverse Distribution of Dissolved Matter 10 km Downstream of the Columbia-Pend d'Oreille Confluence.



1. B = 240m = total river channel width (summer conditions)
2. S_z = width scale of mixing
3. $D_z = 0.96\ m^2/s$ = diffusion coefficient (high value)
4. The left side of the graph represents the East bank (Pend d'Oreille River water), and the right side represents the West bank (Columbia River water).
5. $B/S_z = 0$ represents the plane of separation between the Pend d'Oreille and Columbia waters at the confluence. Based on Table 6.1 we assumed that Pend d'Oreille River would initially occupy 1/3 of the river channel.

7. SHORT TERM VARIABILITY OF WATER QUALITY MEASUREMENTS

The WQB carried out a sampling program to investigate the effect of sampling interval on the measured concentrations. Water samples were collected in replicates at 1 minute intervals and as "quickly as possible" (less than 1 minute), from several different depths at Waneta, and from the surface only of the Pend d'Oreille River near the Columbia River confluence.

Methods

Comparison of means of the collected data would include changes in river quality over the few hours it took to complete the sampling and would therefore mask any changes occurring as a result of the sampling frequency. Comparison of the sampling variances of the data collected by the two sampling frequencies, however, would tell us whether any significant differences were due to sampling technique.

The hypothesis is that variance increases with decreasing sample frequency. Data collected at a very high frequency would have a variance close to zero. As the frequency decreases the variance should increase.

The F-Test is used to compare variances. Since we are not interested in the depth effect, the variances were estimated from means normalized over depth (normalized value = observed value - mean value; for each depth). The variances were compared at 5 % probability level. The results are shown in Table 7.1 and 7.2. The normalized data can be found in Appendix E. For detailed information about the sampling program, refer to Sheehan and Lamb, 1987.

Discussion

Only nitrate at Waneta and total phosphorus at Pend d'Oreille showed a significant increase in variance for the 1 minute sampling frequency. All the other parameters had variances that were independent of the two sampling frequency, Quick and 1 minute. Parameters with values at or near the detection limit were not included.

The conclusion then, is that the two sampling frequencies most likely produced the same results.

Table 7.1 - F-TEST RESULTS: Waneta Station, Columbia River

	TP	NO3	NH4	TN	Fe	Pb	Zn
Standard Deviation (Quick)	0.0020	0.0135	0.0142	0.0499	0.0904	0.0008	0.0041
Standard Deviation (1 Minute)	0.0015	0.0518	0.0130	0.0407	0.0636	0.0009	0.0061
Number of data values (Quick)	34	50	50	50	30	30	30
Number of data values (1 Minute)	34	50	50	50	30	30	30
Calculated f value	1.35	3.84	1.09	1.23	1.42	1.09	1.48
Tabulated F value at 5% level	1.81	1.62	1.62	1.62	1.86	1.86	1.86
Variance comparison	NSD	SD	NSD	NSD	NSD	NSD	NSD

Standard deviations im mg/l.

Table 7.2 - F-TEST RESULTS: Pend d'Oreille River near Waneta

	TP	NO3	NH4	TN	Fe	Pb	Zn
Standard Deviation (Quick)	0.0008	0.0048	0.0068	0.0357	0.0280	0.0005	0.0046
Standard Deviation (1 Minute)	0.0053	0.0037	0.0046	0.0236	0.0287	0.0006	0.0064
Number of data values (Quick)	7	10	10	10	10	10	10
Number of data values (1 Minute)	6	10	10	10	10	10	10
Calculated f value	6.39	1.29	1.50	1.51	1.03	1.31	1.38
Tabulated F value at 5% level	4.39	3.18	3.18	3.18	3.18	3.18	3.18
Variance comparison	SD	NSD	NSD	NSD	NSD	NSD	NSD

Standard deviations im mg/l.

LEGEND

NSD NO SIGNIFICANT DIFFERENCE
SD SIGNIFICANT DIFFERENCE

8. CONCLUSIONS AND RECOMMENDATIONS

1. From the information presented in this report, it appears that Cominco's lead-zinc smelter and its fertilizer plant contributed most of the lead, zinc, and phophorus measured at Waneta.

2. The apparent loss of metal between Cominco and Waneta in May 1981, and gain in October 1983 may have been a result of precipitation/leaching of metal to/from the river sediments. Other causes include differences in sampling methods (3hr composite at Cominco and grab samples every hour at Waneta), and incomplete mixing of the Cominco effluents over the 17 km distance between Cominco and Waneta.

3 Lag correlation analysis of the Cominco and Waneta observations produced very low correlation coefficients. It appears that the fundamental frequency of Cominco's metal discharges were higher than the frequency of sampling. If this was the case, important frequency information would have been lost producing low correlation. Another factor is the different sampling program as described in point #2 (above).

4. ANOVA and Multiple Range Tests

   - The measurements at Birchbank represent the background levels. The background levels were generally found to be significantly lower than both the Cominco and Waneta measurements (except for Cominco, Oct 1983, lead and zinc).

   - The October 1983 observations at Cominco were generally lower that those of May 1981, suggesting a possible improvement in Cominco's wastewater treatment. However, more data, collected throughout the year, are necessary for evaluation of the effectiveness of the installed treatment plant.

   - The combined Cominco sewer discharges diluted into the Columbia River were not significantly different from those of Waneta in May 1981 and March 1984. In October 1983, the Waneta observations were considerably greater than the estimated Cominco water quality concentrations. This may be due, in part, to leaching of metal from the river sediments.

   - ANOVA Assumptions: The fact that the data sets violated assumptions of homogeneity of variance and the normality of distributions are not considered to be serious. The large sample sizes (greater than 30 for Birchbank and Waneta) suggest that the affects of nonhomogeneity of variance are small. The effects of the skewness of the Birchbank and Waneta data sets are also expected to be small as the sampling distributions of the "F" statistics provide a good approximation to the exact sampling distribution (which assumes normality).

4. Transverse Turbulent Mixing by the Pend d'Oreille River was found to be relatively poor. It is unlikely that the waters from the two rivers are completely mixed by the time the water reaches the American water quality station at Northport, some 16 km downstream.

5 Short Term Variability: F-tests of the sampling variance for data collected at 1 minute interval, and at intervals much less than 1 minute (termed "Quick"),

showed no significant difference for 6 out of 7 parameters. This indicates that the two sampling frequencies produced the same results.

9. REFERENCES

Box, GEP, 1954,"Some Theorems on Quadratic Forms Applied in the Study of Analysis of Variance Problems", The Annals of Mathematical Statistics, 25, 290-302, 484-498.

Sheehan, SW and M Lamb, 1987,"Water Chemistry of the Columbia and the Pend d'Oreille Rivers near the International Boundary", Inland Waters and Lands, Pacific and Yukon Region, Environment Canada, March 1987.

Johnson, CA,"Effluent Discharges From Cominco Ltd, Trail, BC to The Columbia River", Draft copy prepared by Waste Management Branch, Kootenay Region, BC Ministry of Environment.

Brown RC, GF Kenyon, JD McCunn and DM Glover, 1985 "Acid Discharge to the Columbia River", by Cominco Ltd, Trail BC, Dec 1985.

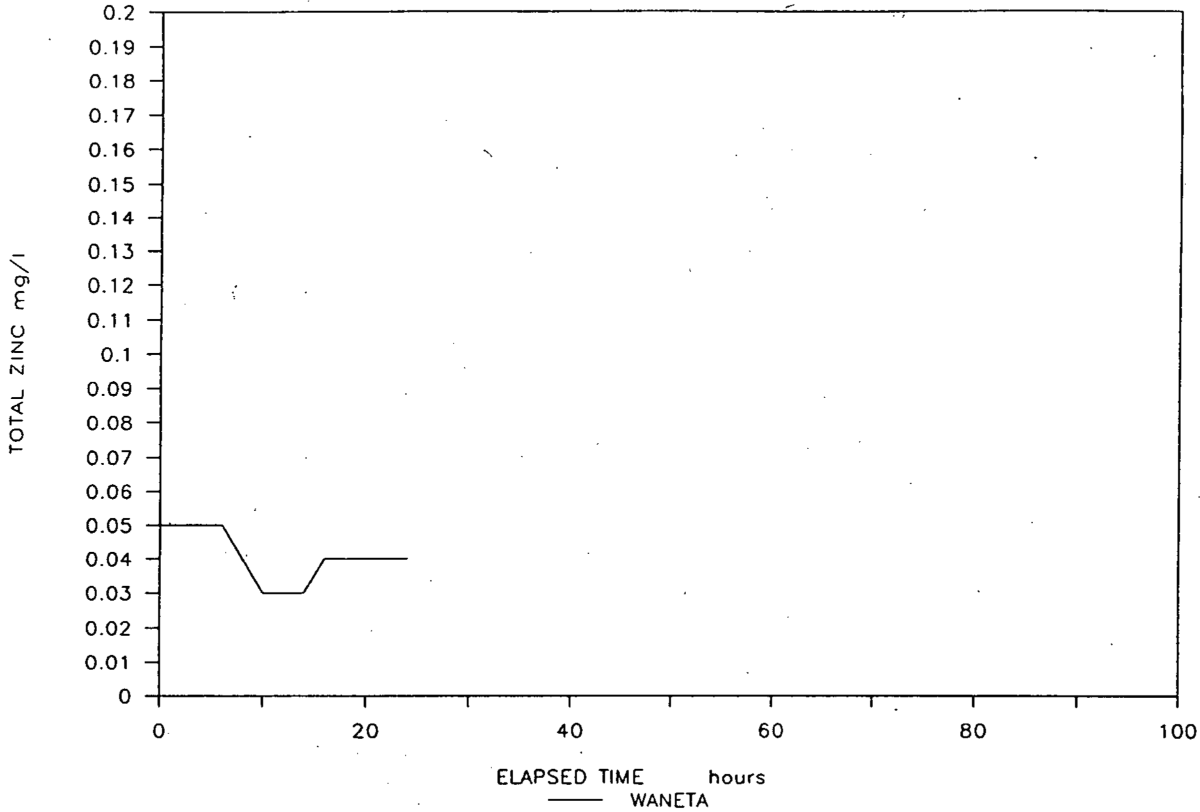
10. APPENDICES

A	SCATTER PLOTS
B	FREQUENCY DISTRIBUTION PLOTS
C	ANALYSIS OF VARIANCE RESULTS
D	TRANSVERSE MIXING TABLES
E	RAW DATA FILES
F	TERMS OF REFERENCE

APPENDIX A - SCATTER PLOTS

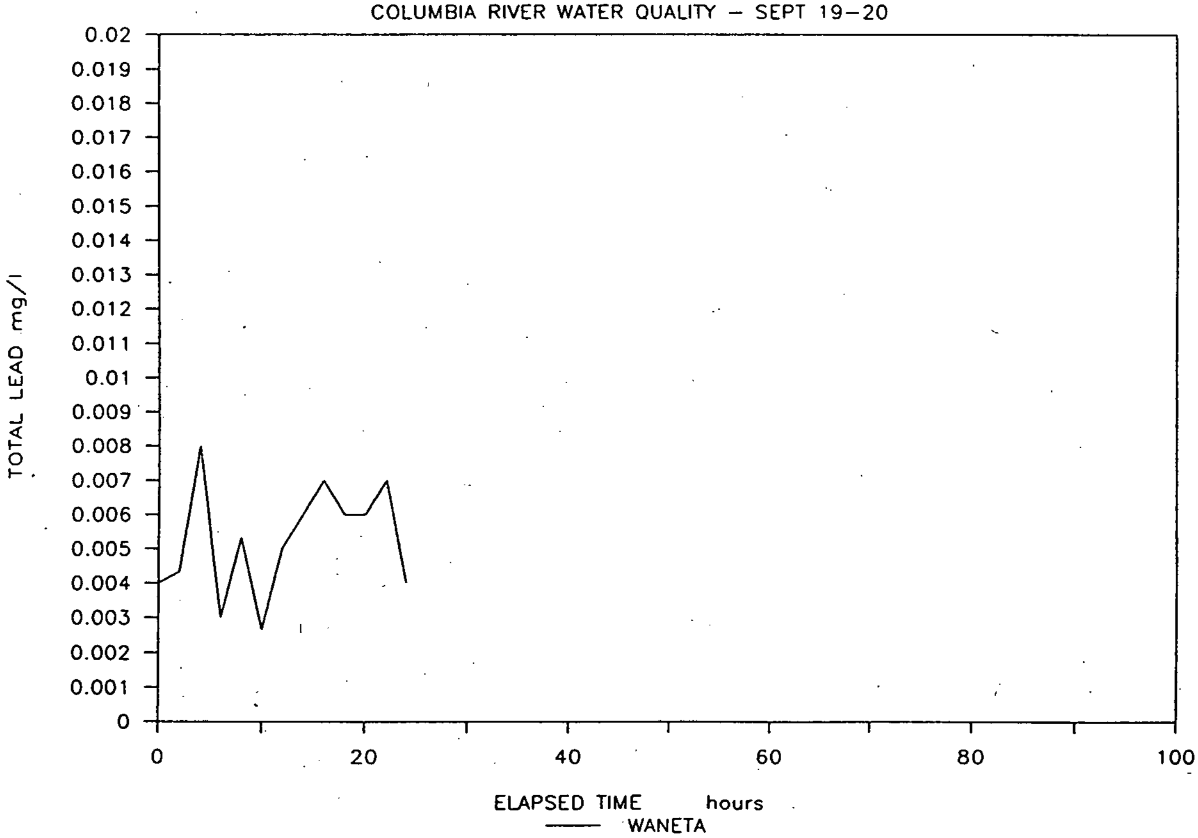
TOTAL ZINC – 1978

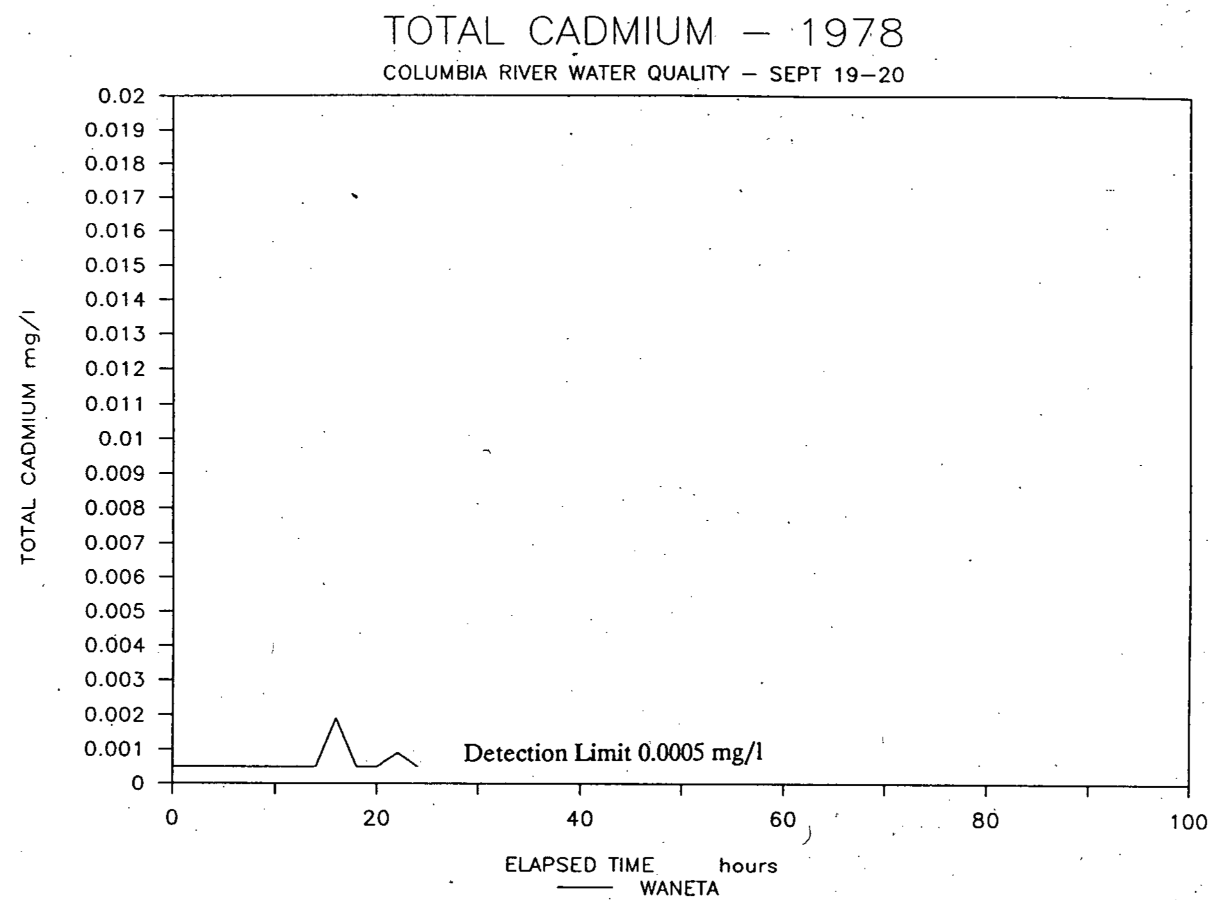
COLUMBIA RIVER WATER QUALITY – SEPT 19–20

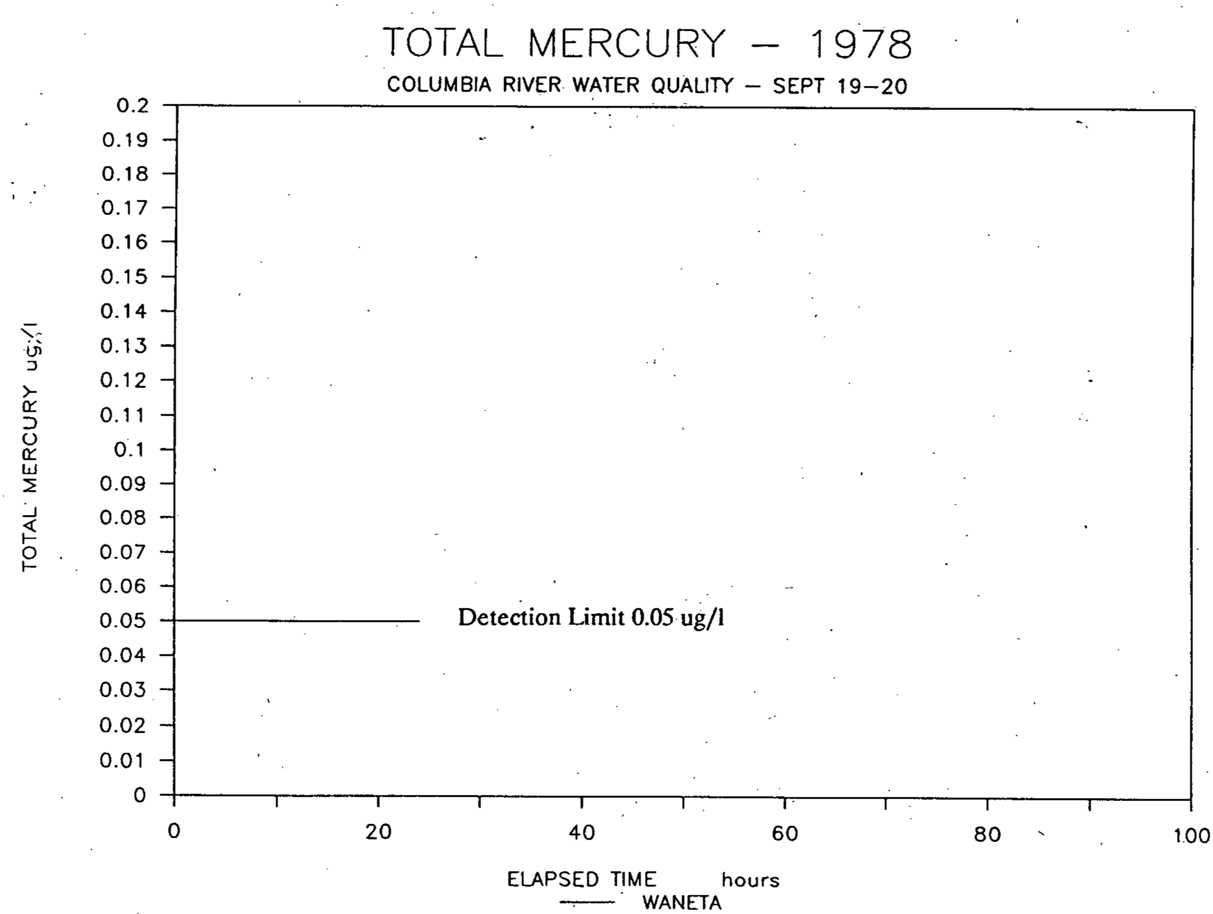


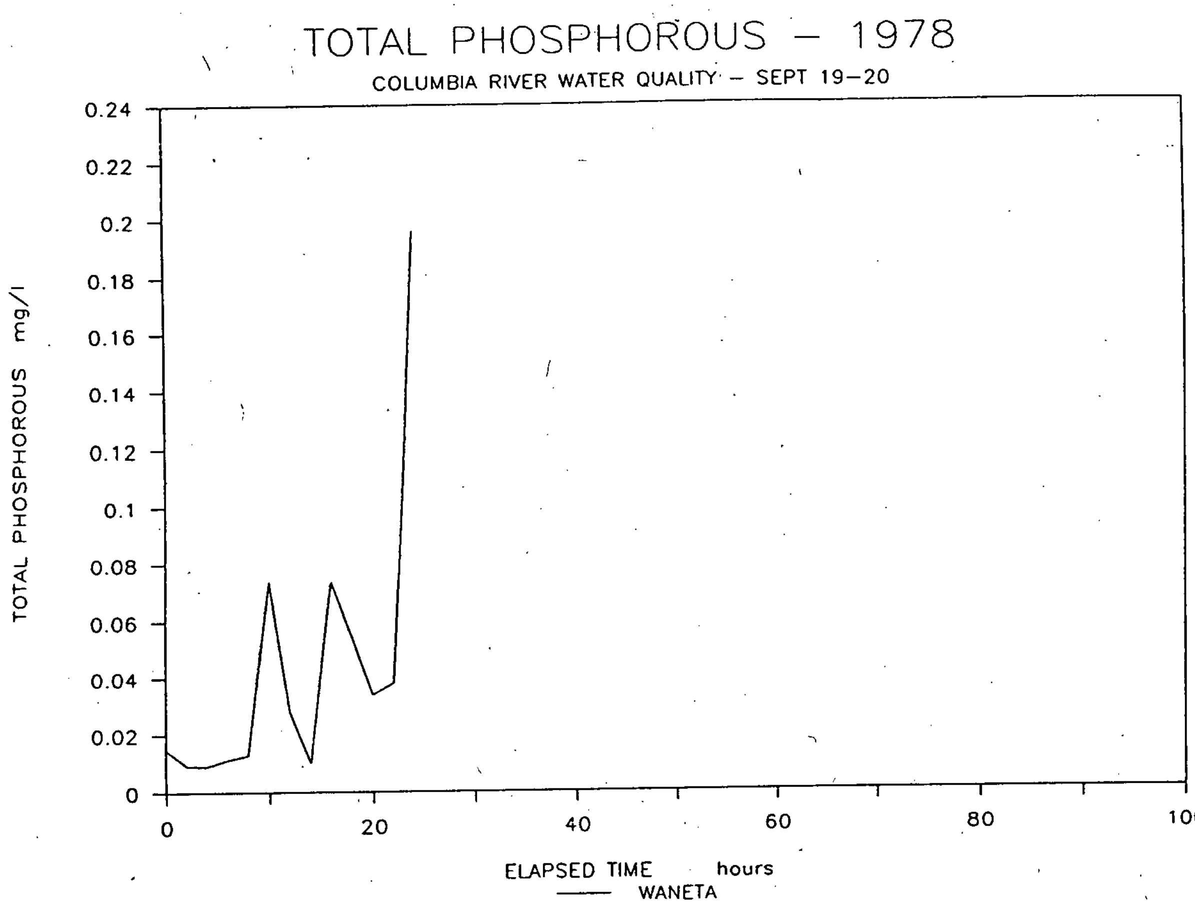
TOTAL LEAD – 1978

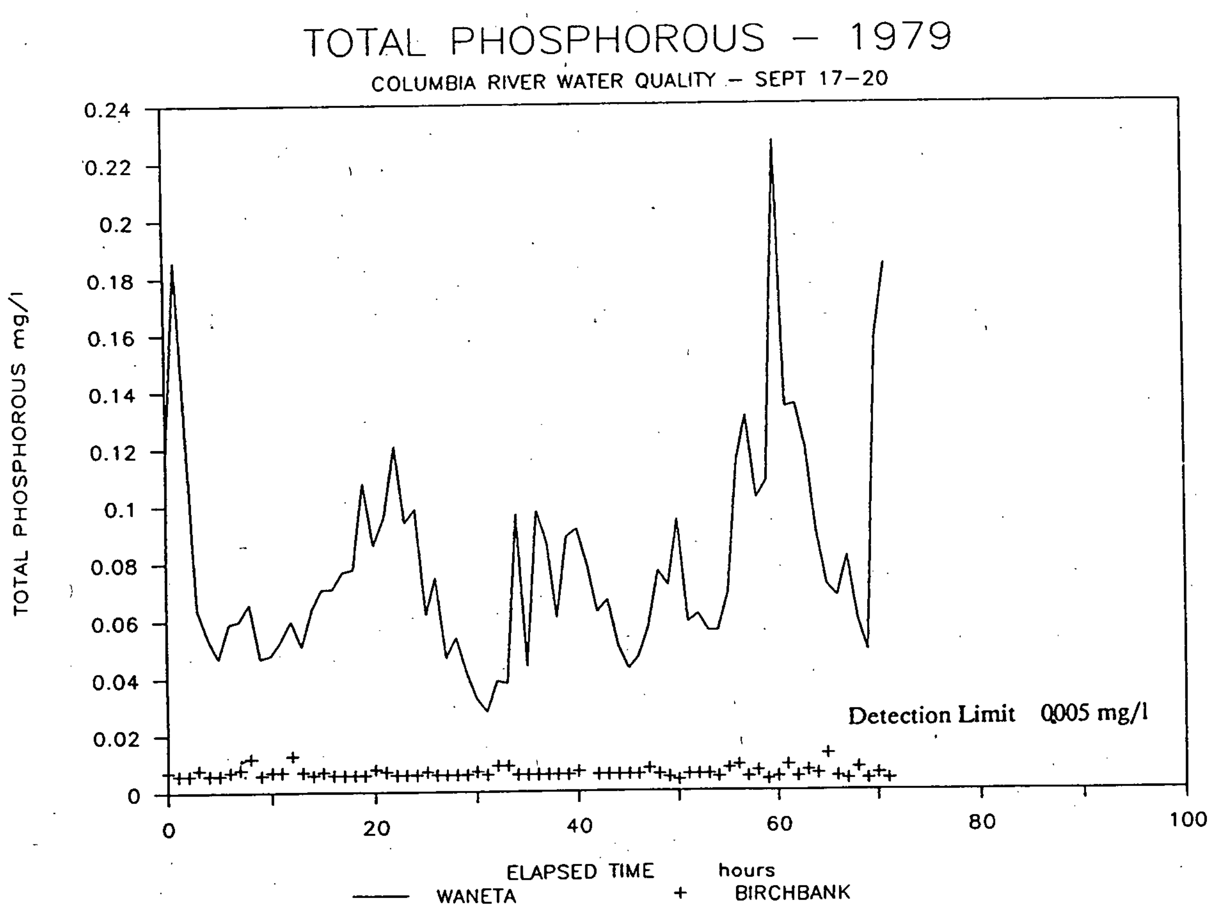
COLUMBIA RIVER WATER QUALITY – SEPT 19–20




TOTAL CADMIUM — 1978
COLUMBIA RIVER WATER QUALITY — SEPT 19–20
TOTAL CADMIUM mg/l
0.02
0.019
0.018
0.017
0.016
0.015
0.014
0.013
0.012
0.011
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
Detection Limit 0.0005 mg/l
0
20
40
60
80
100
ELAPSED TIME hours
WANETA

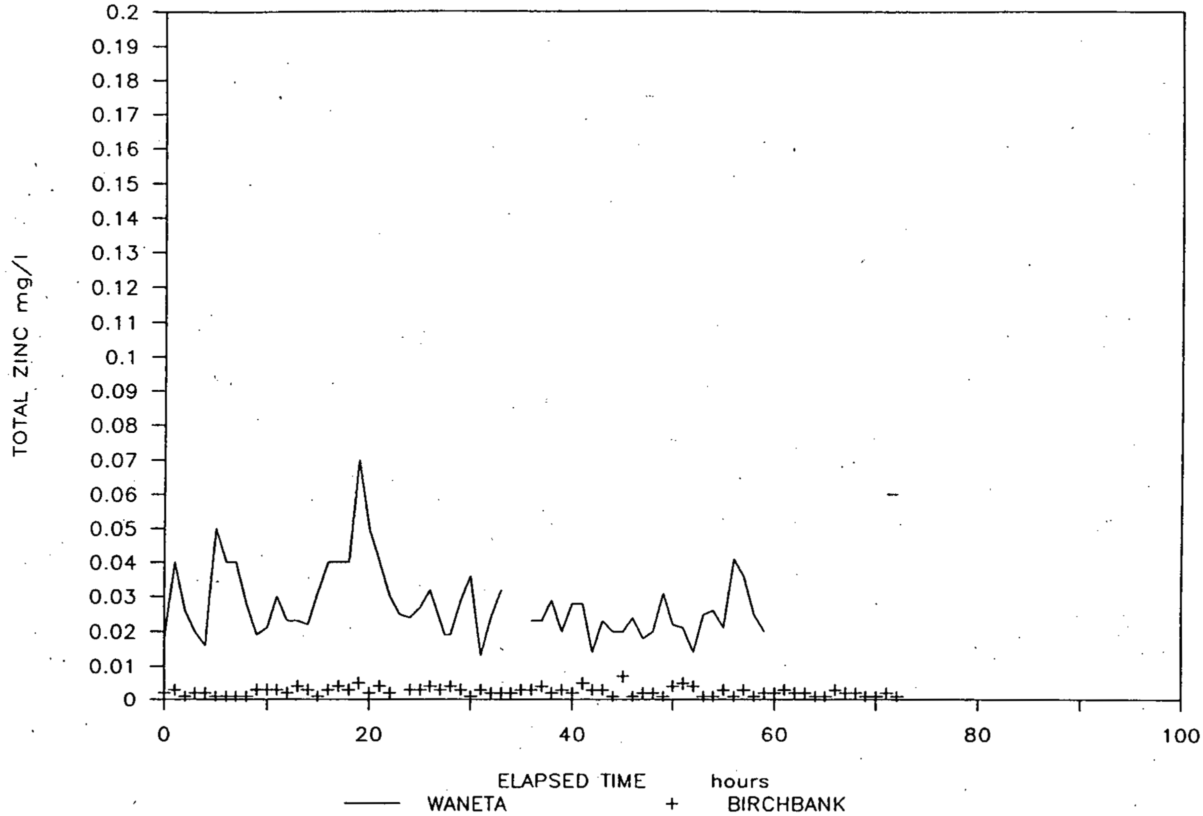

TOTAL MERCURY — 1978
COLUMBIA RIVER WATER QUALITY — SEPT 19–20
TOTAL MERCURY ug/l
0.2
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Detection Limit 0.05 ug/l
0
20
40
60
80
100
ELAPSED TIME hours
WANETA


TOTAL PHOSPHOROUS – 1978
COLUMBIA RIVER WATER QUALITY – SEPT 19–20
TOTAL PHOSPHOROUS mg/l
0.24
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
20
40
60
80
100
ELAPSED TIME hours
WANETA


TOTAL PHOSPHOROUS – 1979
COLUMBIA RIVER WATER QUALITY – SEPT 17–20
TOTAL PHOSPHOROUS mg/l
0.24
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Detection Limit 0.005 mg/l
0
20
40
60
80
100
ELAPSED TIME hours
WANETA
+ BIRCHBANK

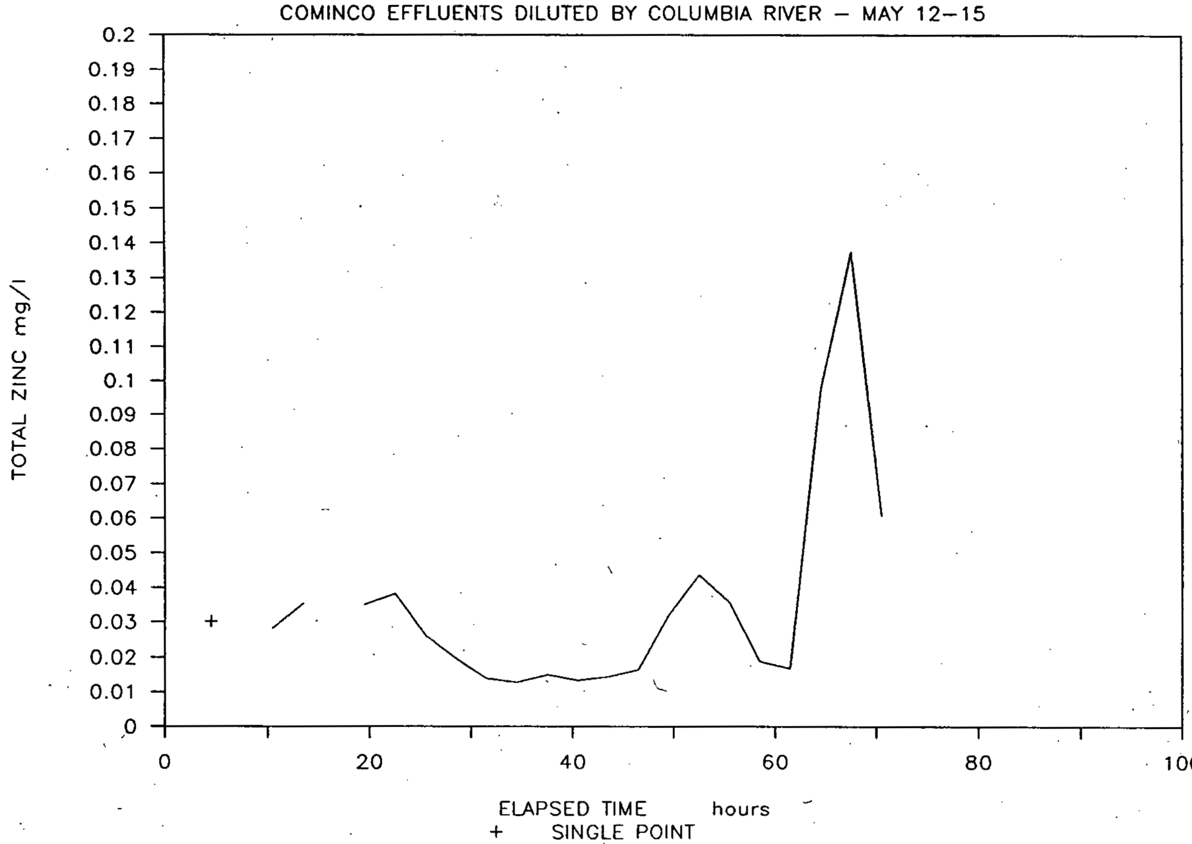
TOTAL ZINC – 1981

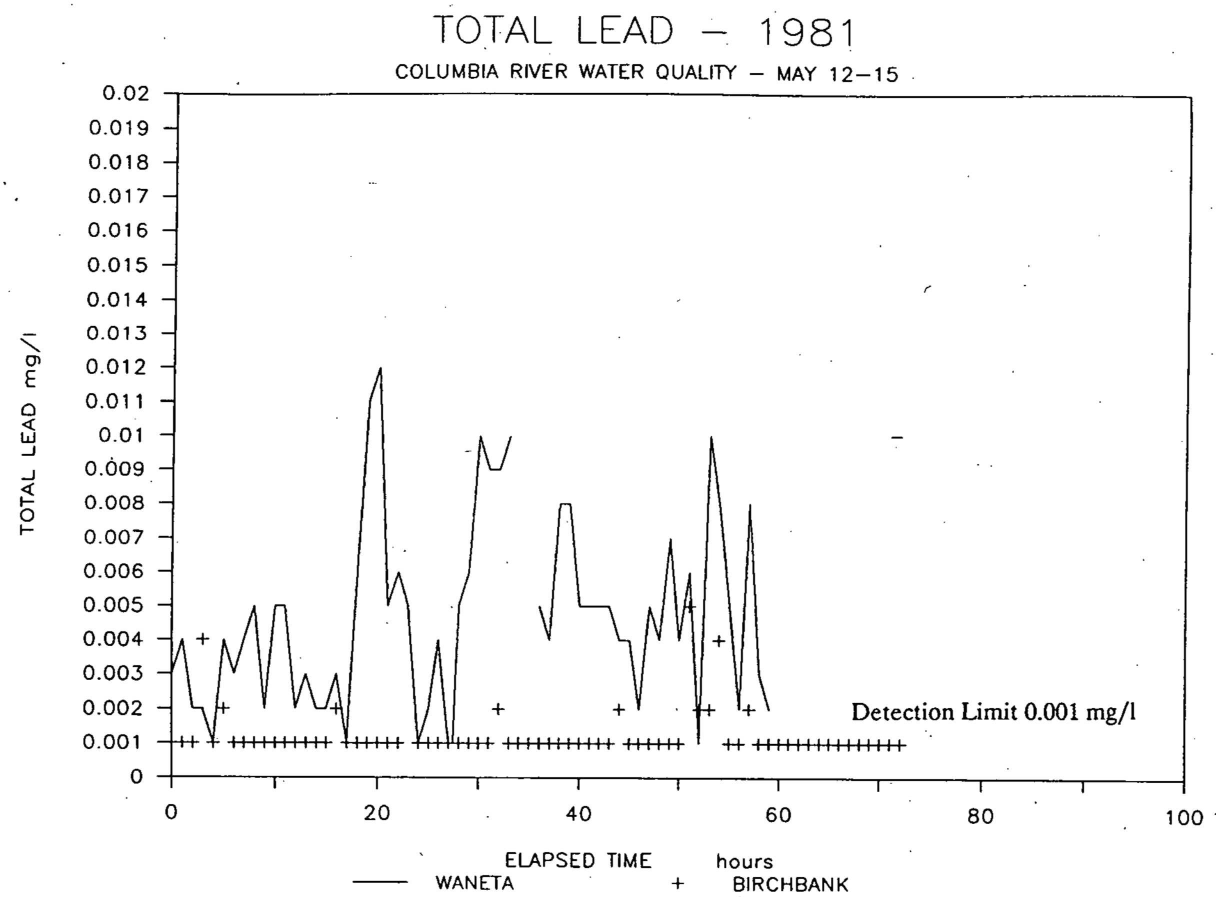
COLUMBIA RIVER WATER QUALITY – MAY 12–15

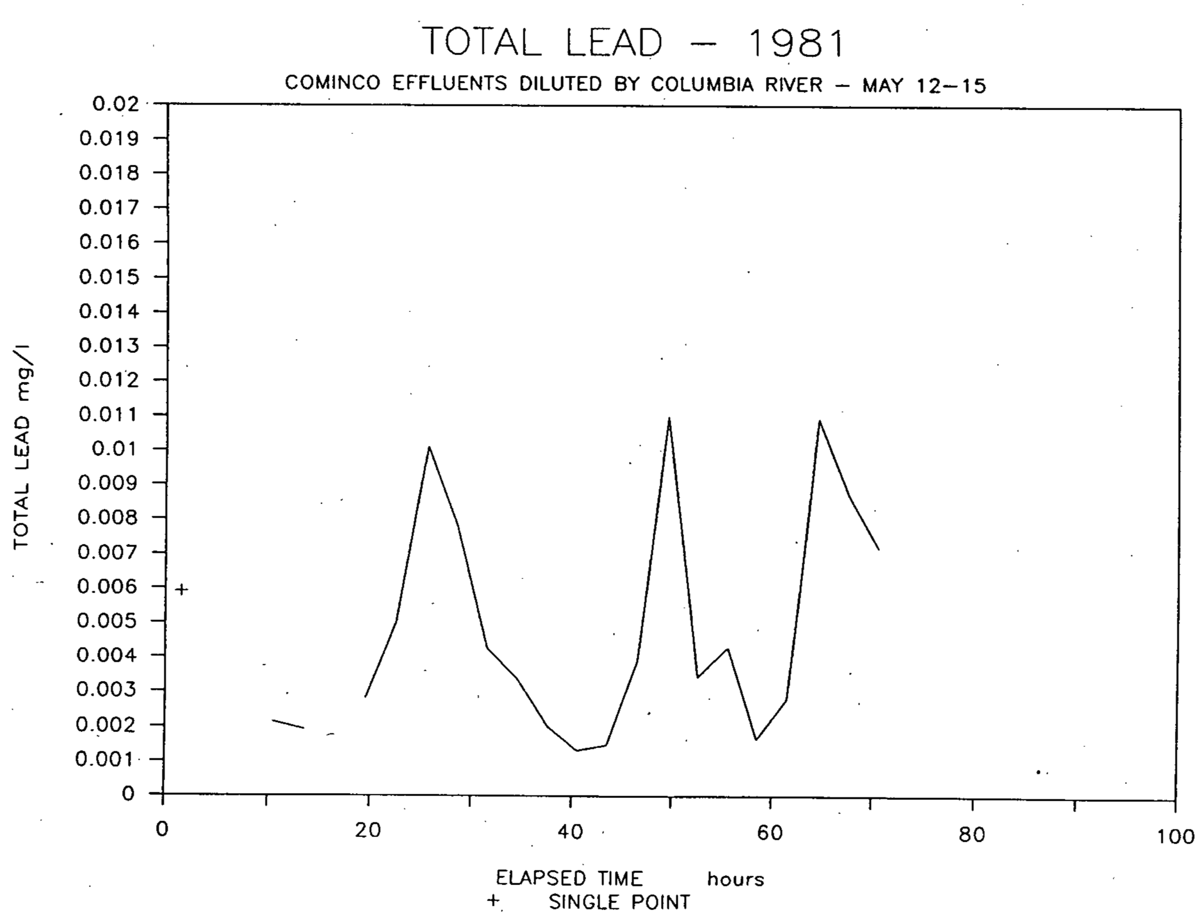


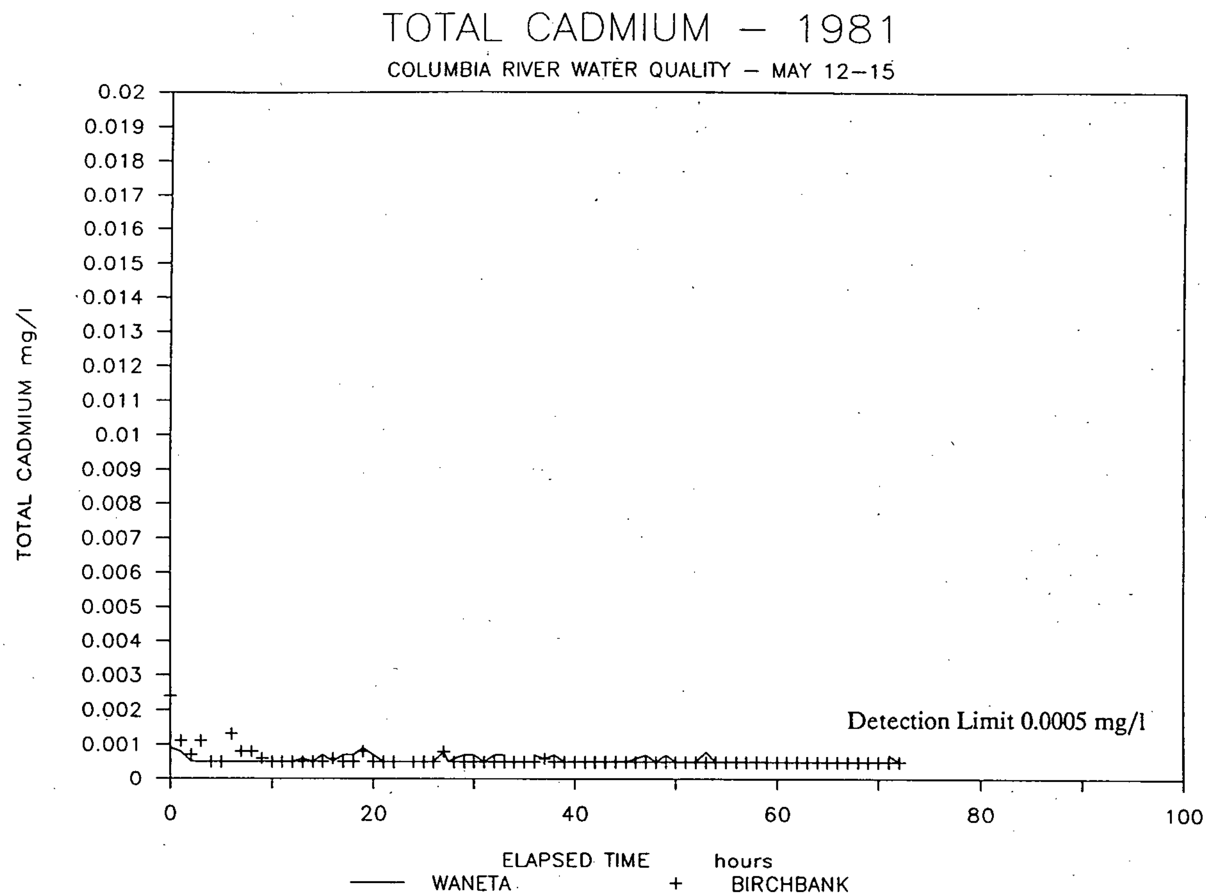
TOTAL ZINC – 1981

COMINCO EFFLUENTS DILUTED BY COLUMBIA RIVER – MAY 12–15

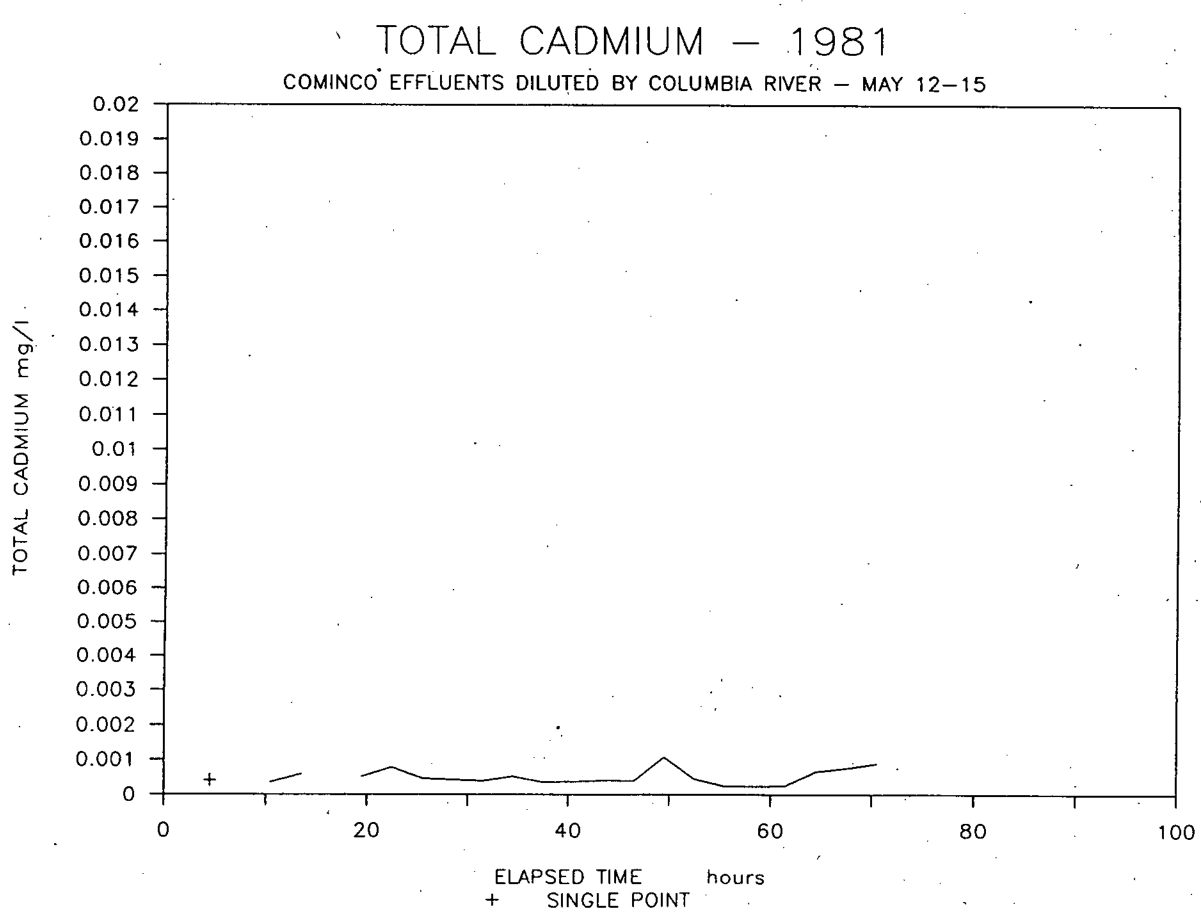



TOTAL LEAD – 1981
COLUMBIA RIVER WATER QUALITY – MAY 12–15
TOTAL LEAD mg/l
0.02
0.019
0.018
0.017
0.016
0.015
0.014
0.013
0.012
0.011
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
0
20
40
60
80
100
Detection Limit 0.001 mg/l
ELAPSED TIME hours
WANETA
+ BIRCHBANK

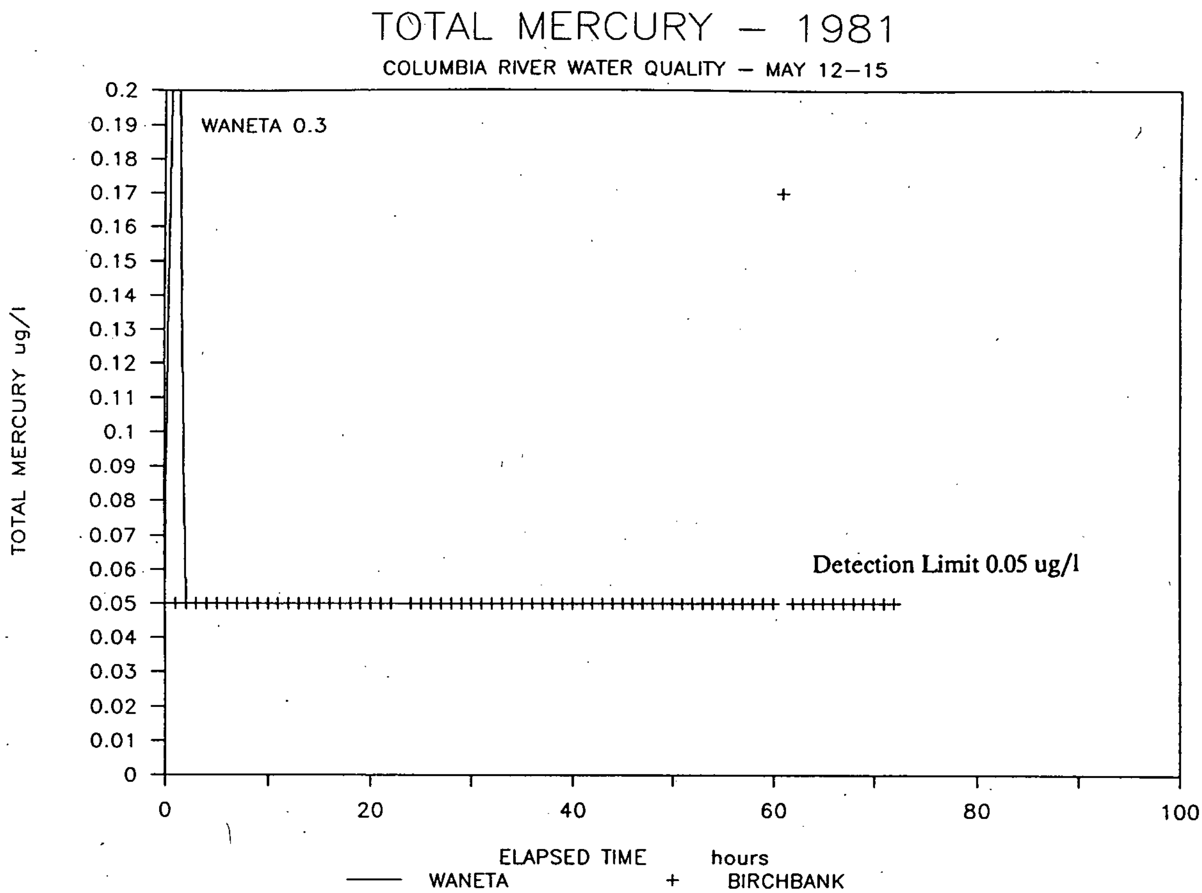

TOTAL LEAD – 1981
COMINCO EFFLUENTS DILUTED BY COLUMBIA RIVER – MAY 12–15
TOTAL LEAD mg/l
0.02
0.019
0.018
0.017
0.016
0.015
0.014
0.013
0.012
0.011
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
0
20
40
60
80
100
ELAPSED TIME hours
+ SINGLE POINT



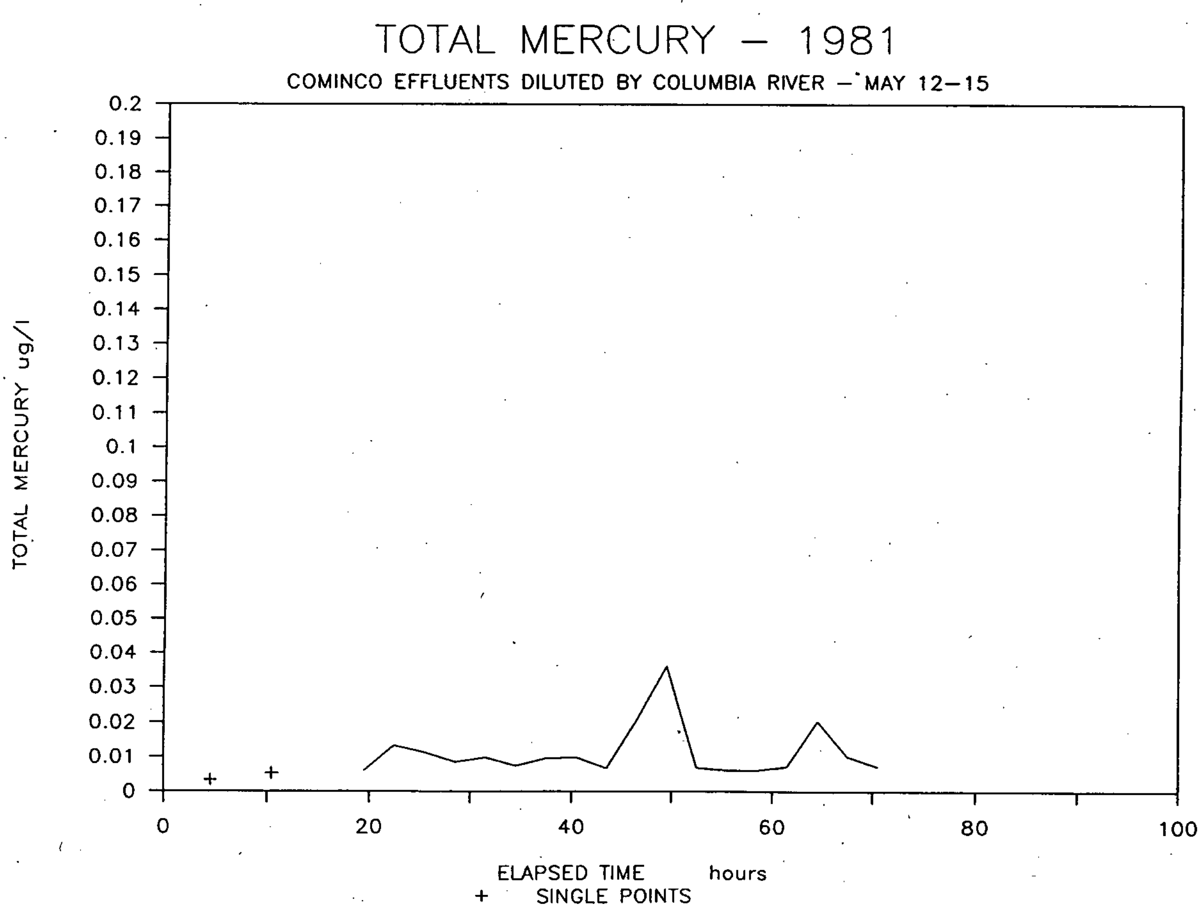
TOTAL CADMIUM – 1981
COLUMBIA RIVER WATER QUALITY – MAY 12–15
TOTAL CADMIUM mg/l
0.02
0.019
0.018
0.017
0.016
0.015
0.014
0.013
0.012
0.011
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
Detection Limit 0.0005 mg/l
0
20
40
60
80
100
ELAPSED TIME hours
WANETA
BIRCHBANK



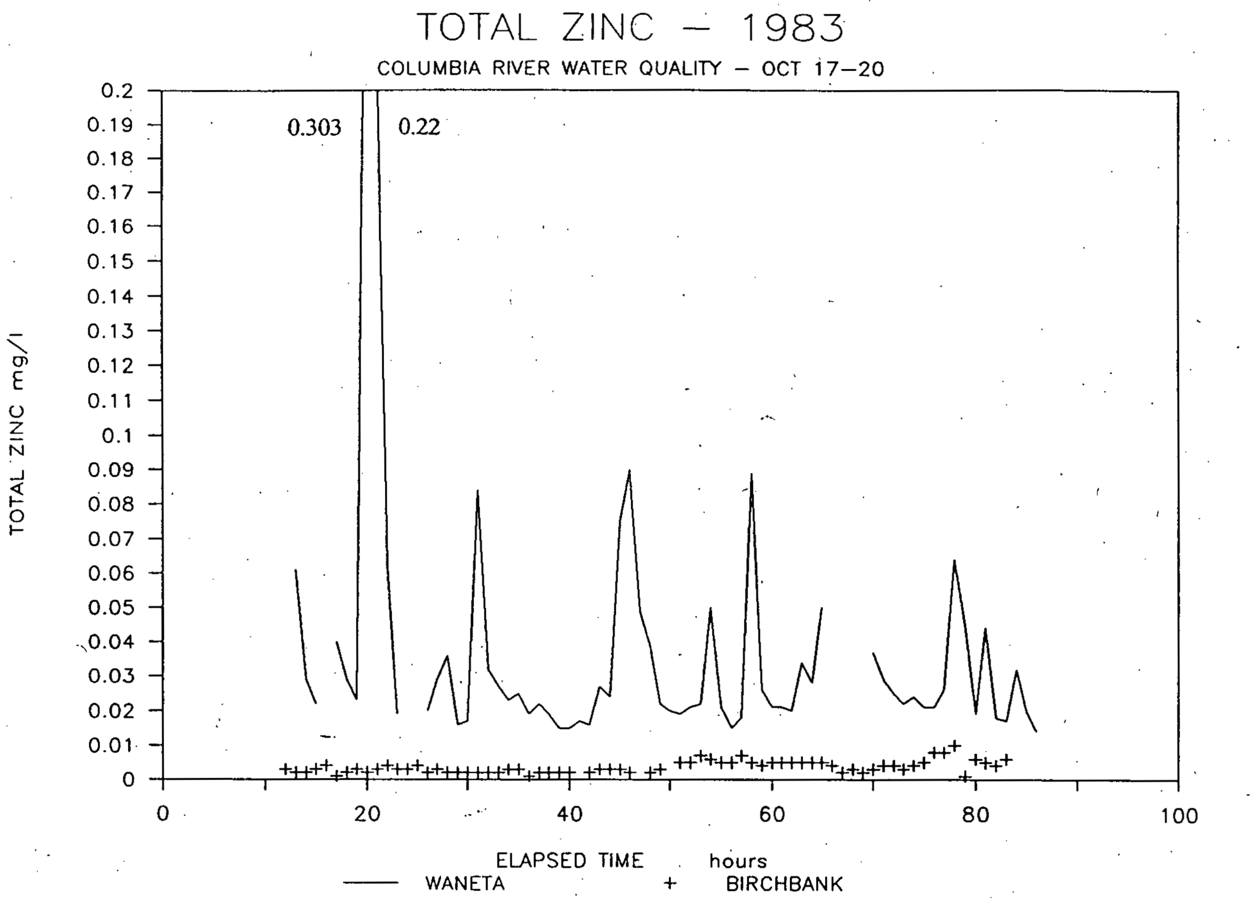
TOTAL CADMIUM – 1981
COMINCO EFFLUENTS DILUTED BY COLUMBIA RIVER – MAY 12–15
TOTAL CADMIUM mg/l
0.02
0.019
0.018
0.017
0.016
0.015
0.014
0.013
0.012
0.011
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
0
20
40
60
80
100
ELAPSED TIME hours
SINGLE POINT

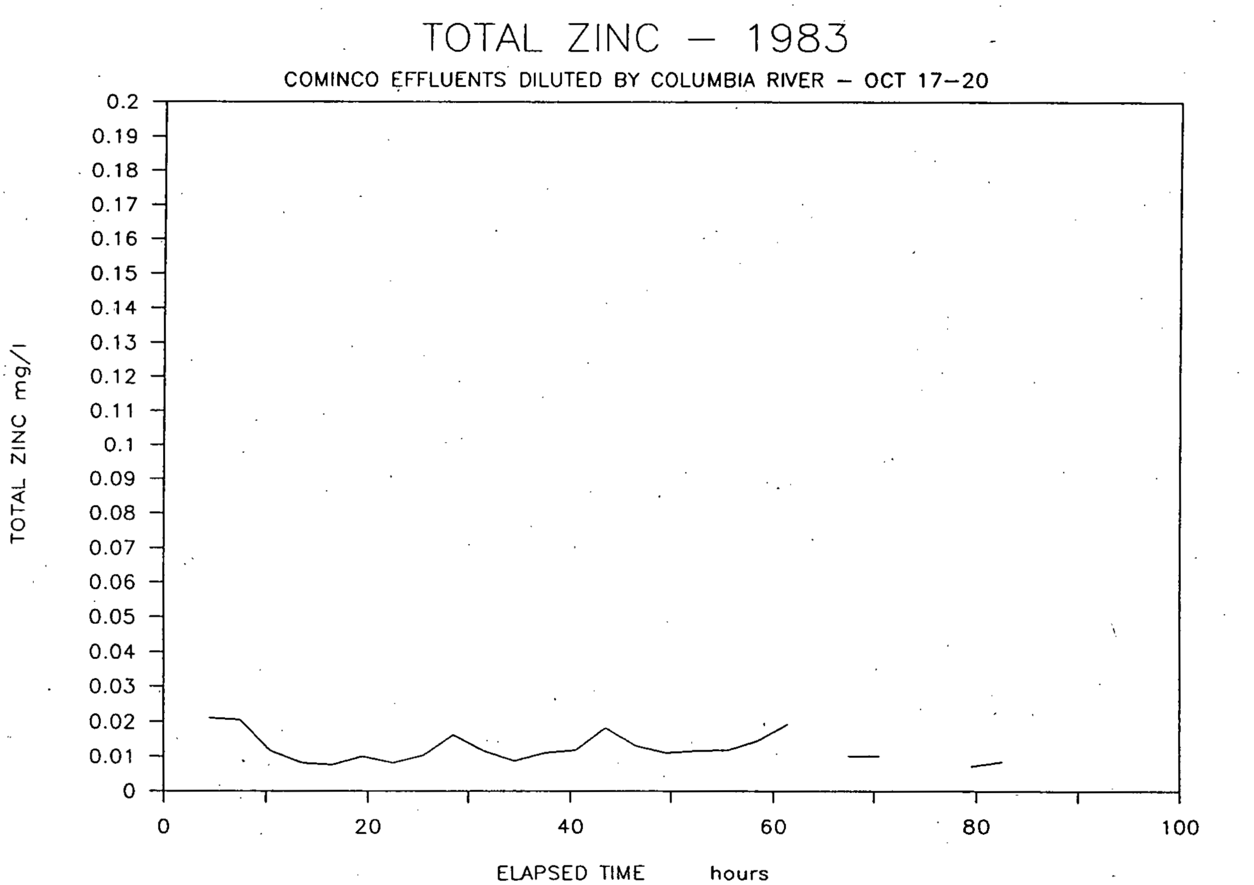


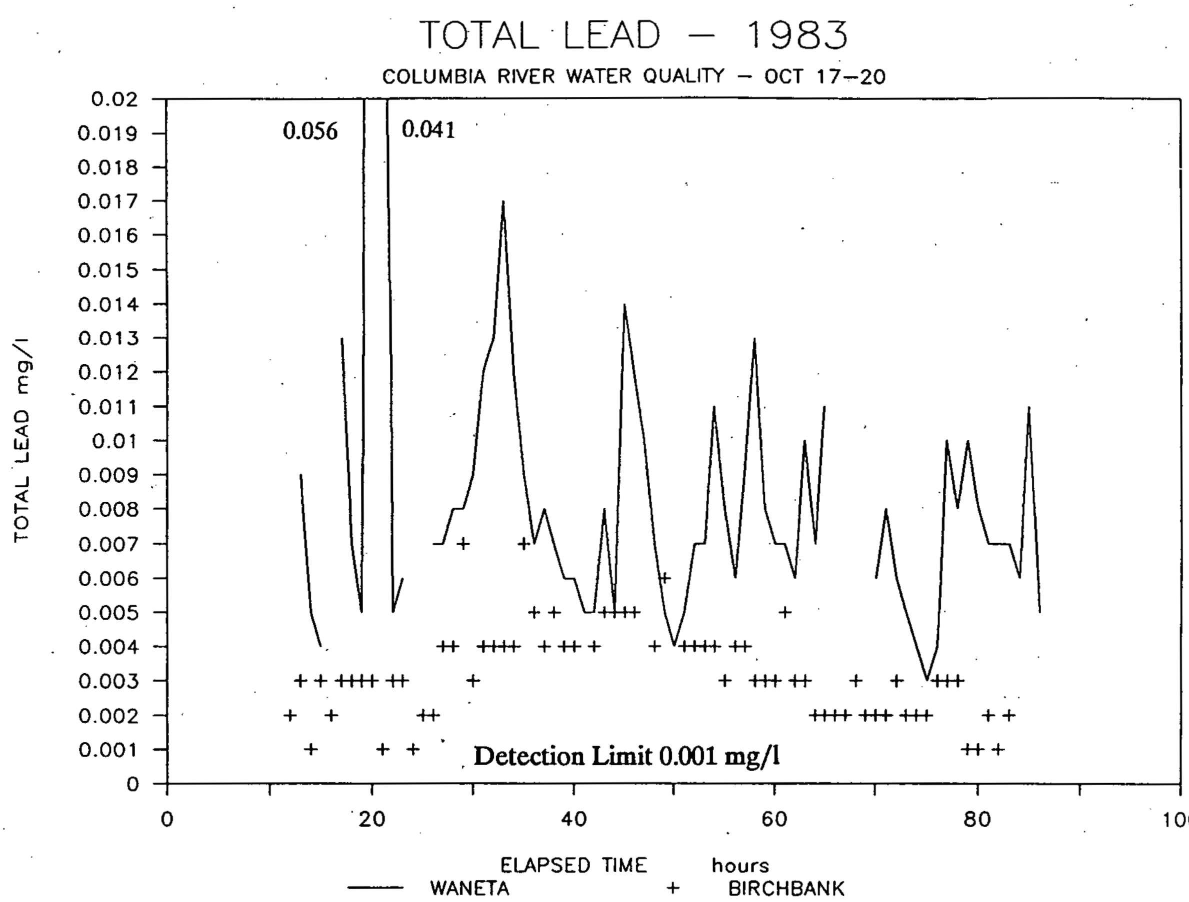
TOTAL MERCURY – 1981
COLUMBIA RIVER WATER QUALITY – MAY 12–15
WANETA 0.3
Detection Limit 0.05 ug/l
TOTAL MERCURY ug/l
0.2
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
20
40
60
80
100
ELAPSED TIME hours
WANETA
+ BIRCHBANK

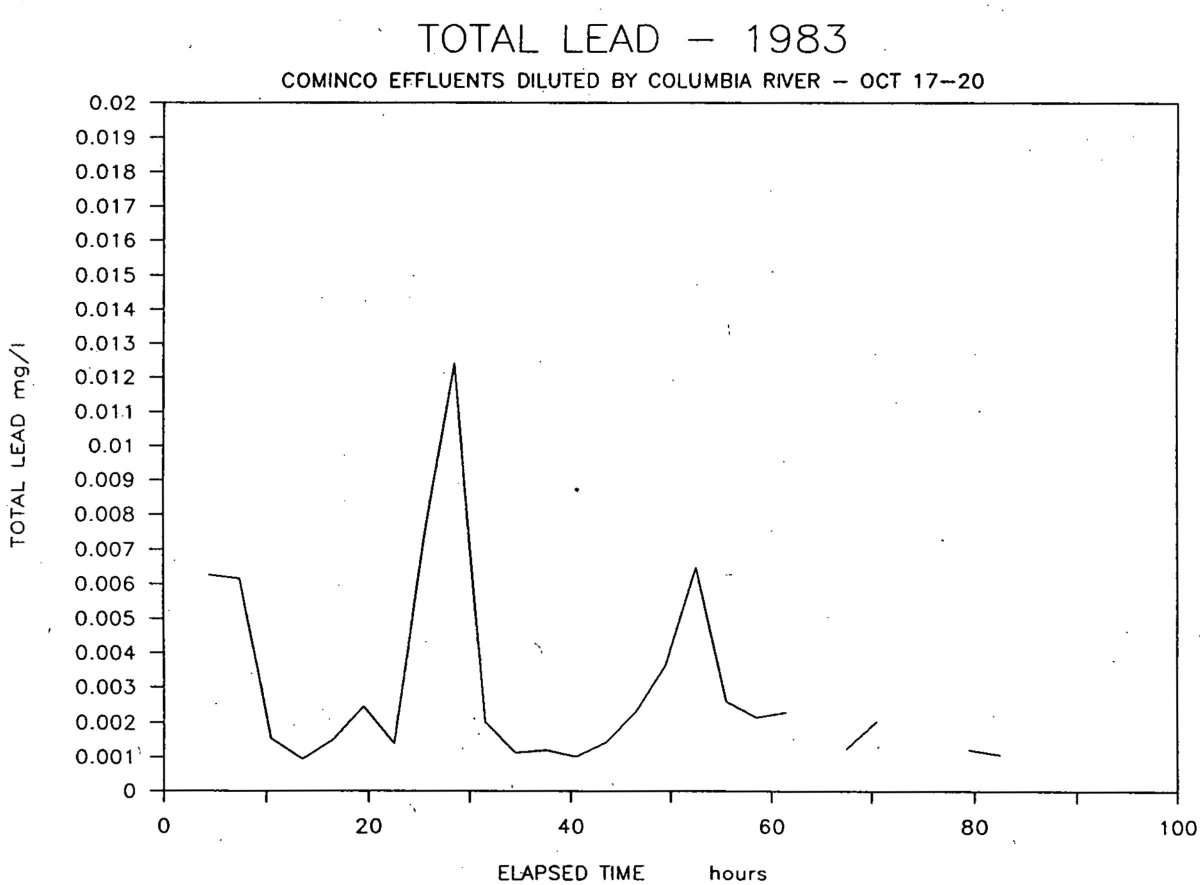


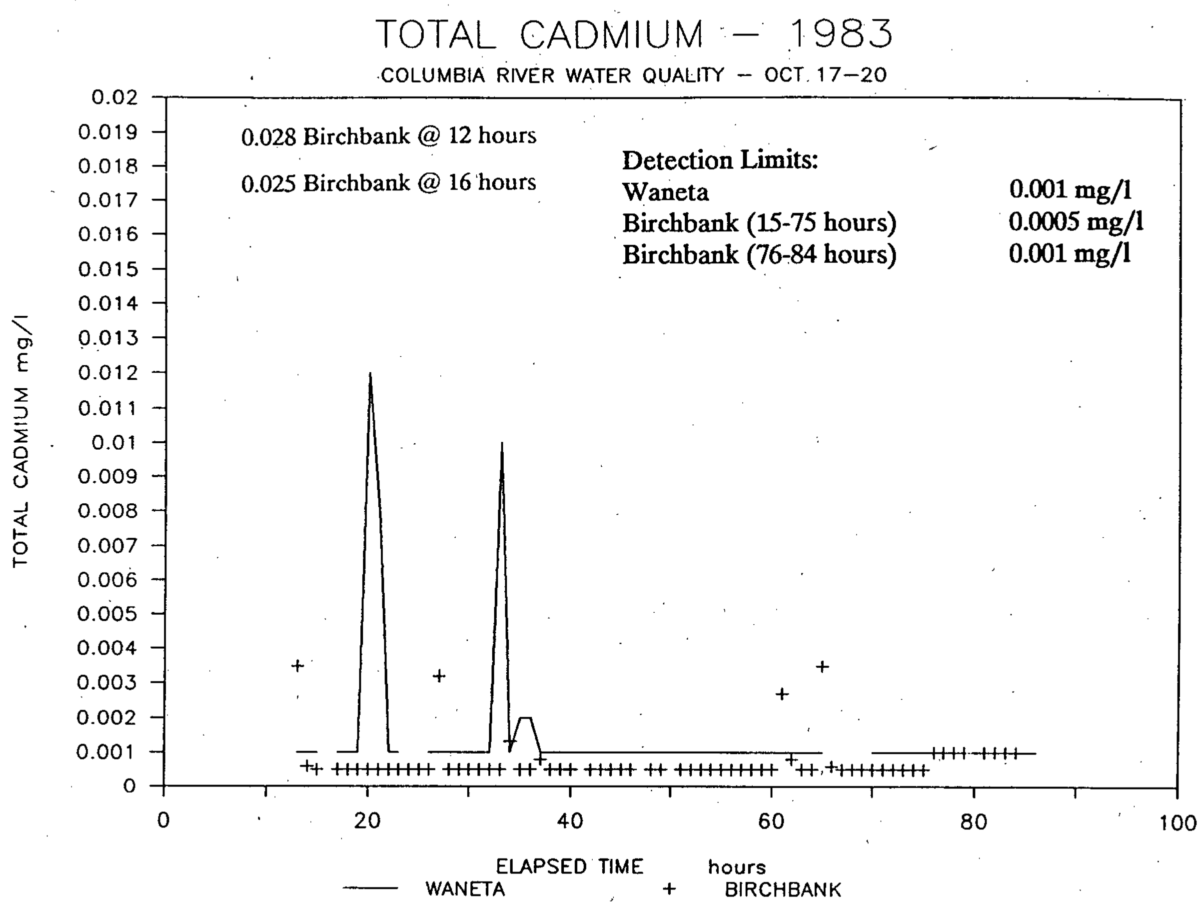
TOTAL MERCURY – 1981
COMINCO EFFLUENTS DILUTED BY COLUMBIA RIVER – MAY 12–15
TOTAL MERCURY ug/l
0.2
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
20
40
60
80
100
ELAPSED TIME hours
+ SINGLE POINTS

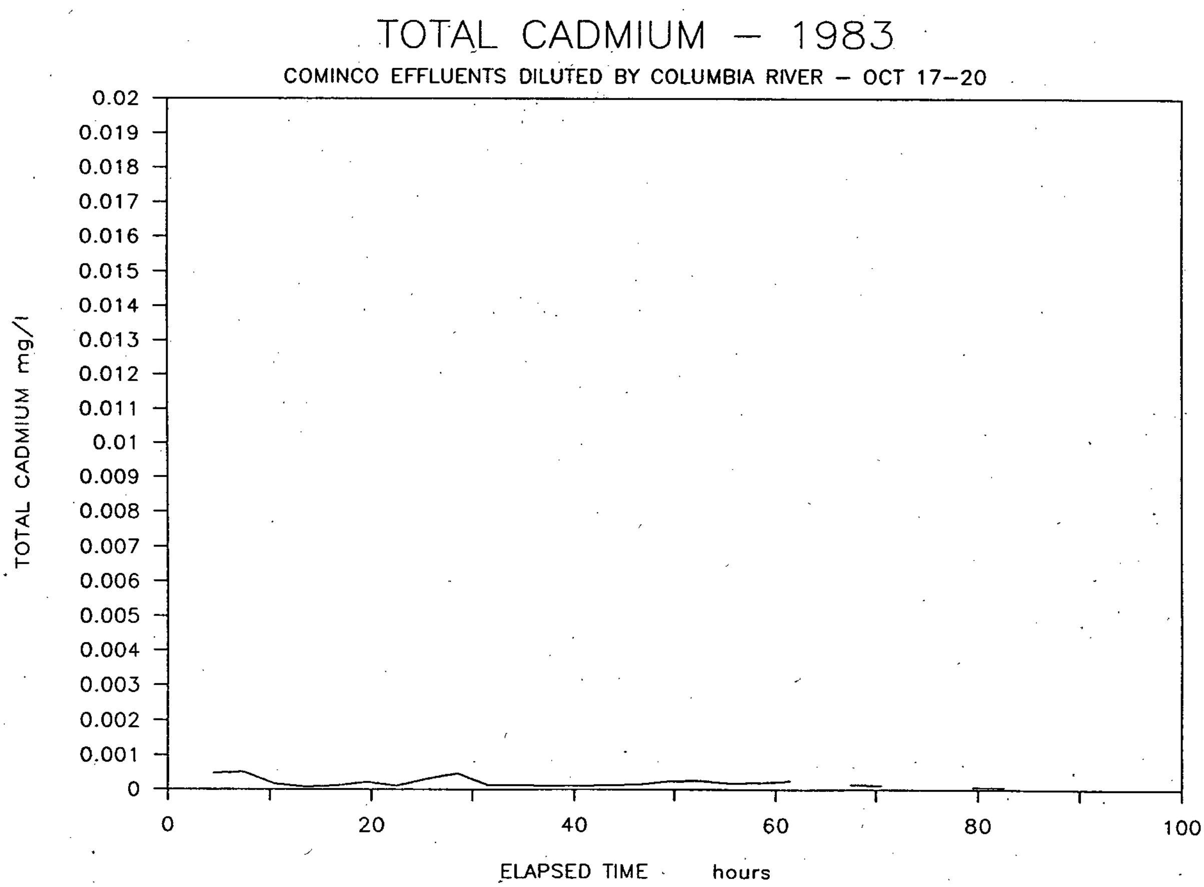

TOTAL ZINC — 1983
COLUMBIA RIVER WATER QUALITY — OCT 17–20
TOTAL ZINC mg/l
0.303
0.22
0.2
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
20
40
60
80
100
ELAPSED TIME hours
WANETA
+ BIRCHBANK

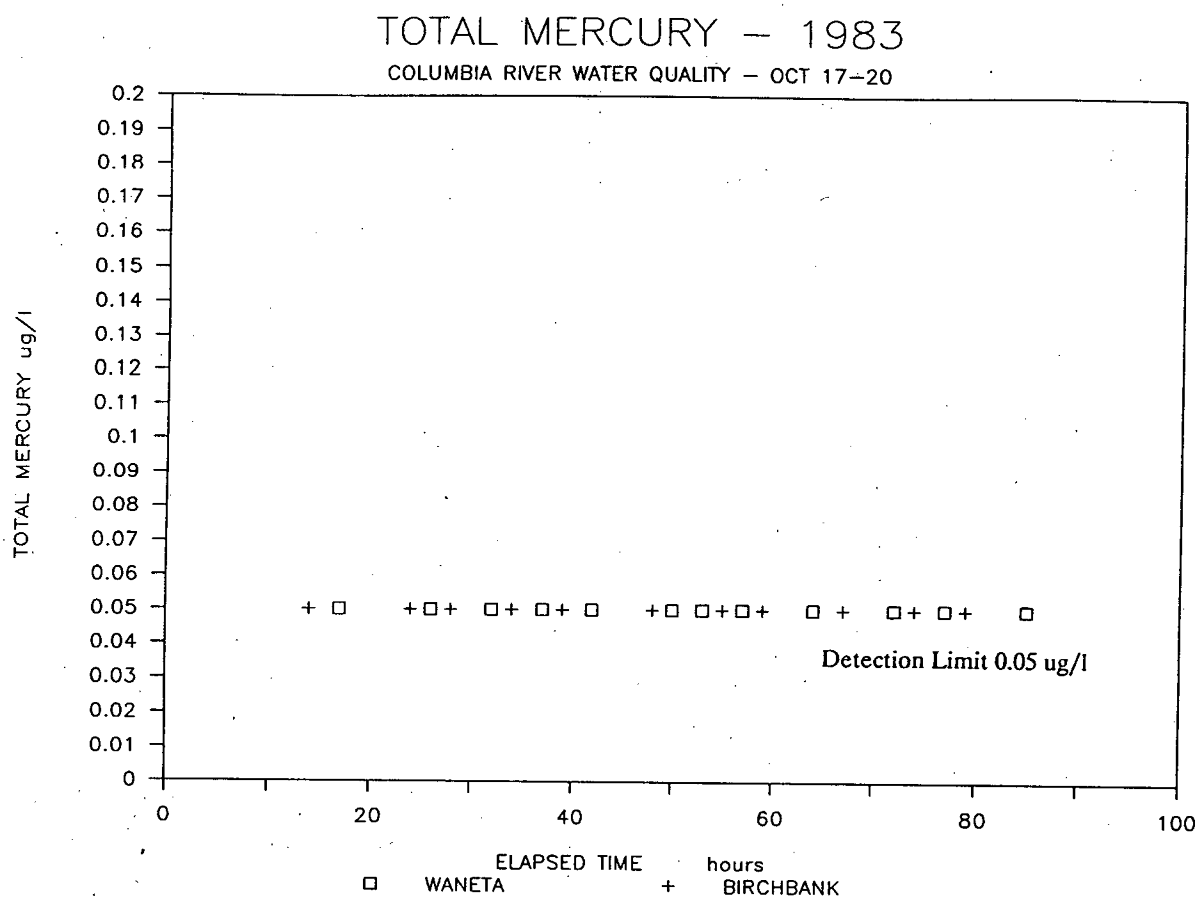

TOTAL ZINC — 1983
COMINCO EFFLUENTS DILUTED BY COLUMBIA RIVER — OCT 17–20
TOTAL ZINC mg/l
0.2
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
20
40
60
80
100
ELAPSED TIME hours


TOTAL LEAD — 1983
COLUMBIA RIVER WATER QUALITY — OCT 17–20
0.056
0.041
Detection Limit 0.001 mg/l
TOTAL LEAD mg/l
ELAPSED TIME hours
WANETA
BIRCHBANK

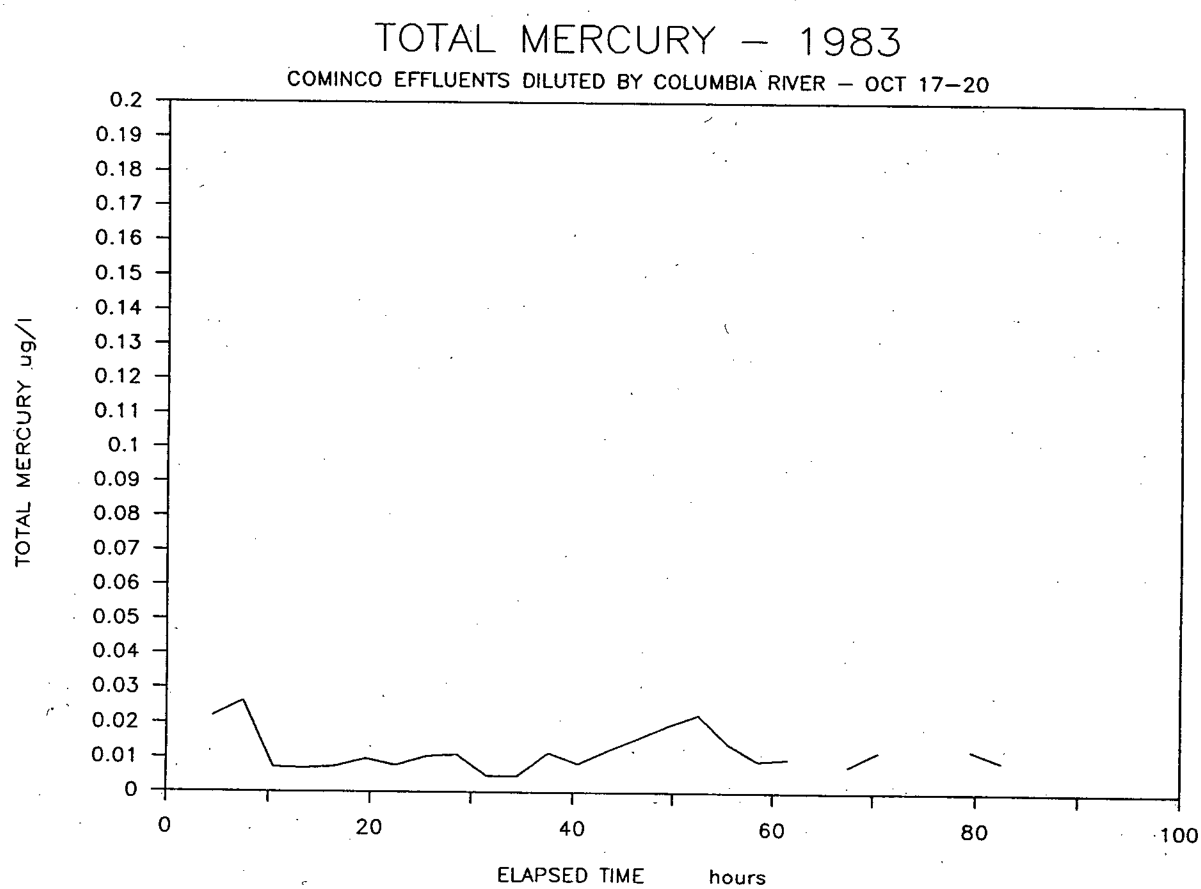

TOTAL LEAD — 1983
COMINCO EFFLUENTS DILUTED BY COLUMBIA RIVER — OCT 17–20
TOTAL LEAD mg/l
ELAPSED TIME hours


TOTAL CADMIUM — 1983
COLUMBIA RIVER WATER QUALITY — OCT. 17–20
0.028 Birchbank @ 12 hours
0.025 Birchbank @ 16 hours
Detection Limits:
Waneta 0.001 mg/l
Birchbank (15-75 hours) 0.0005 mg/l
Birchbank (76-84 hours) 0.001 mg/l
TOTAL CADMIUM mg/l
ELAPSED TIME hours
WANETA
BIRCHBANK

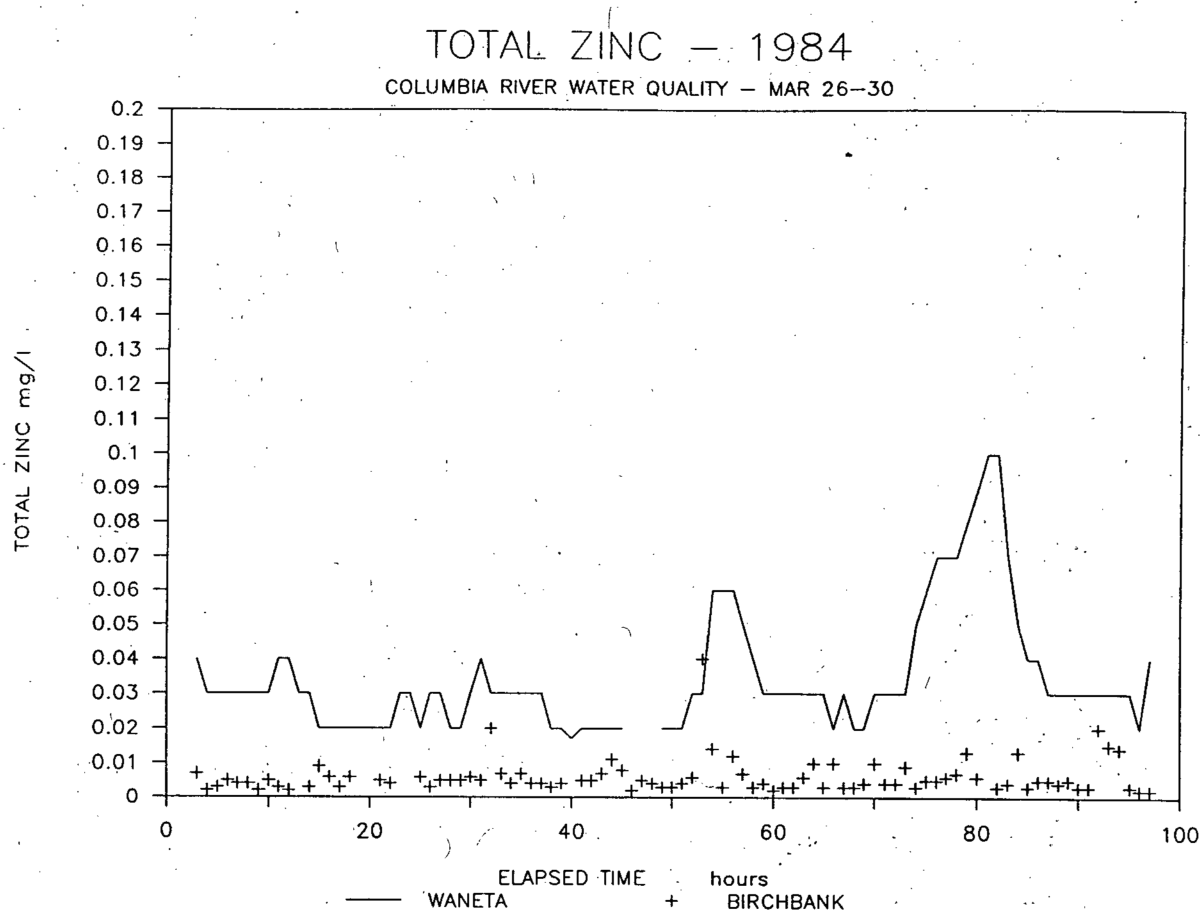

TOTAL CADMIUM — 1983
COMINCO EFFLUENTS DILUTED BY COLUMBIA RIVER — OCT 17–20
TOTAL CADMIUM mg/l
ELAPSED TIME hours

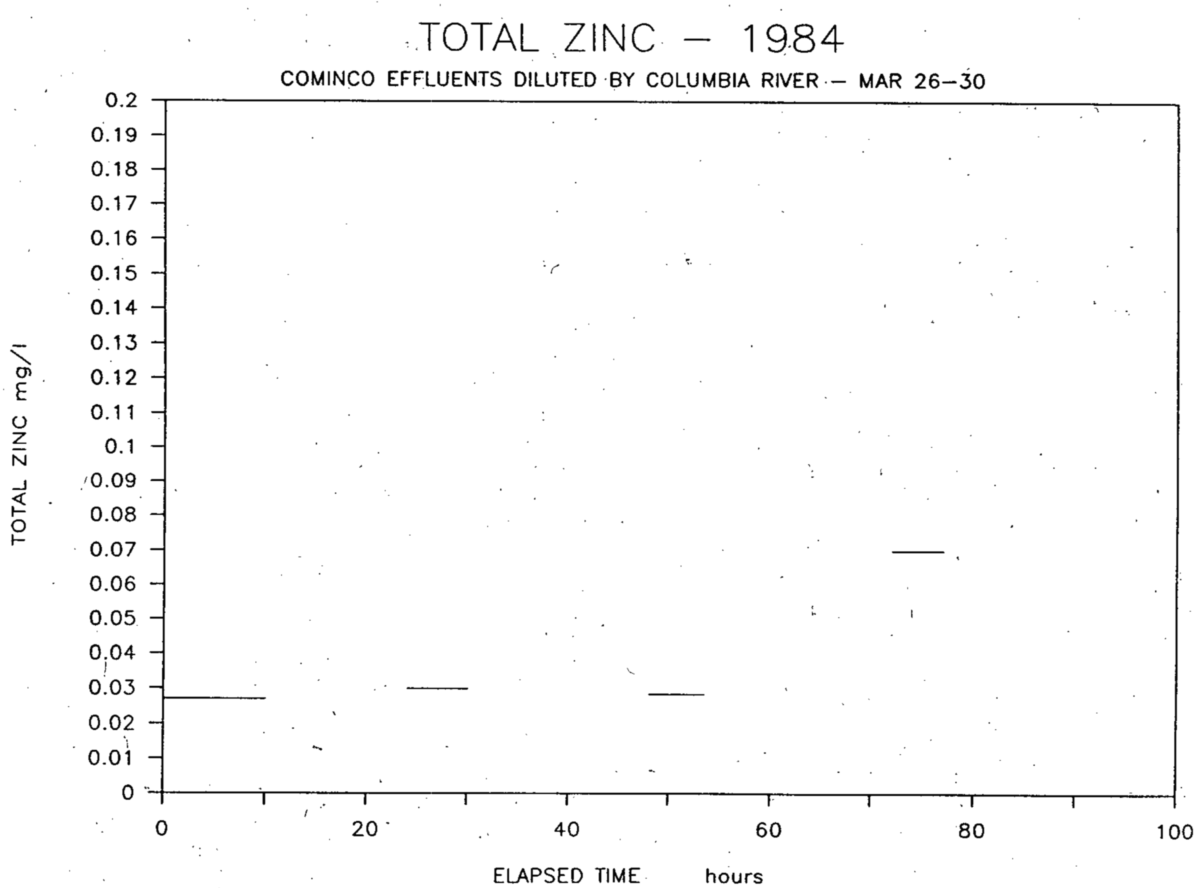


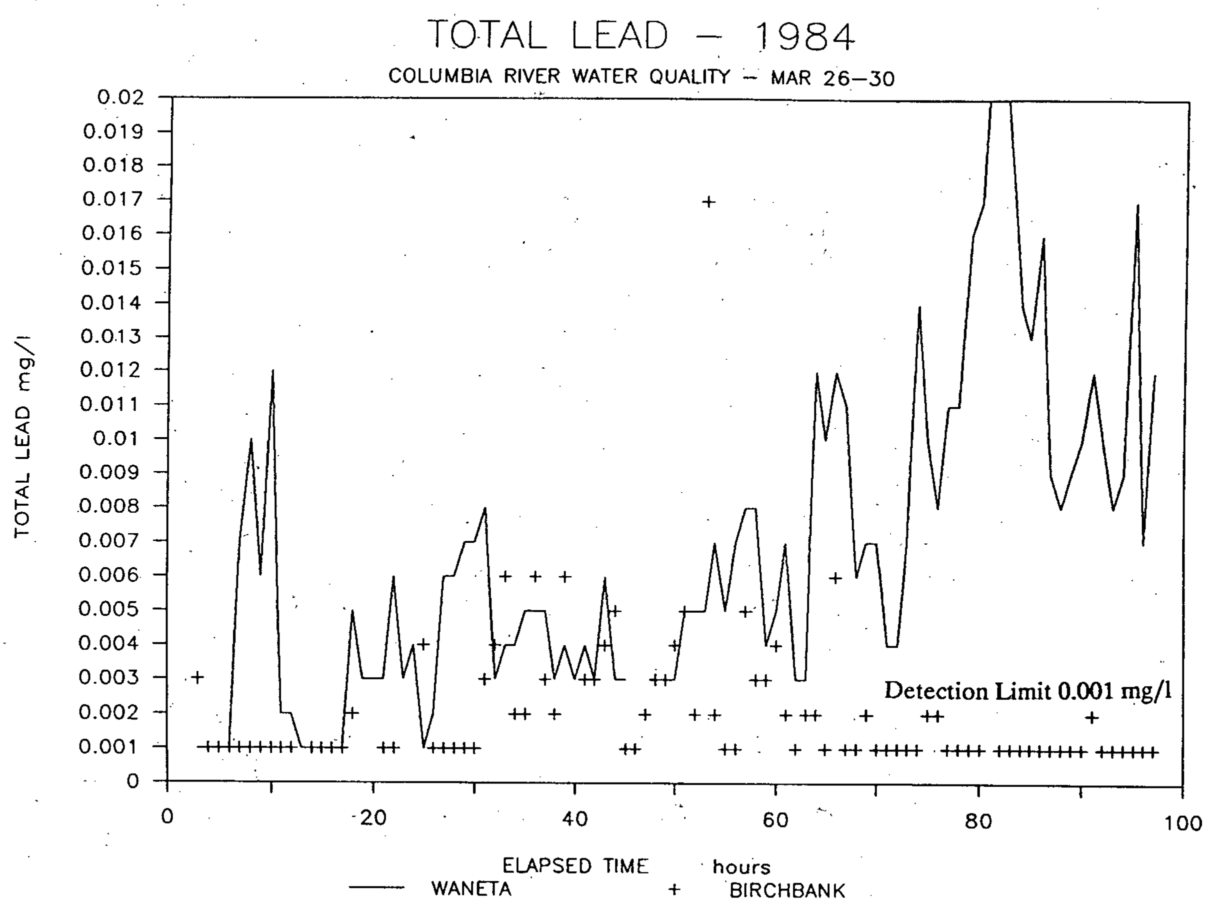
TOTAL MERCURY – 1983
COLUMBIA RIVER WATER QUALITY – OCT 17–20
TOTAL MERCURY ug/l
0.2
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
20
40
60
80
100
Detection Limit 0.05 ug/l
ELAPSED TIME hours
WANETA
BIRCHBANK

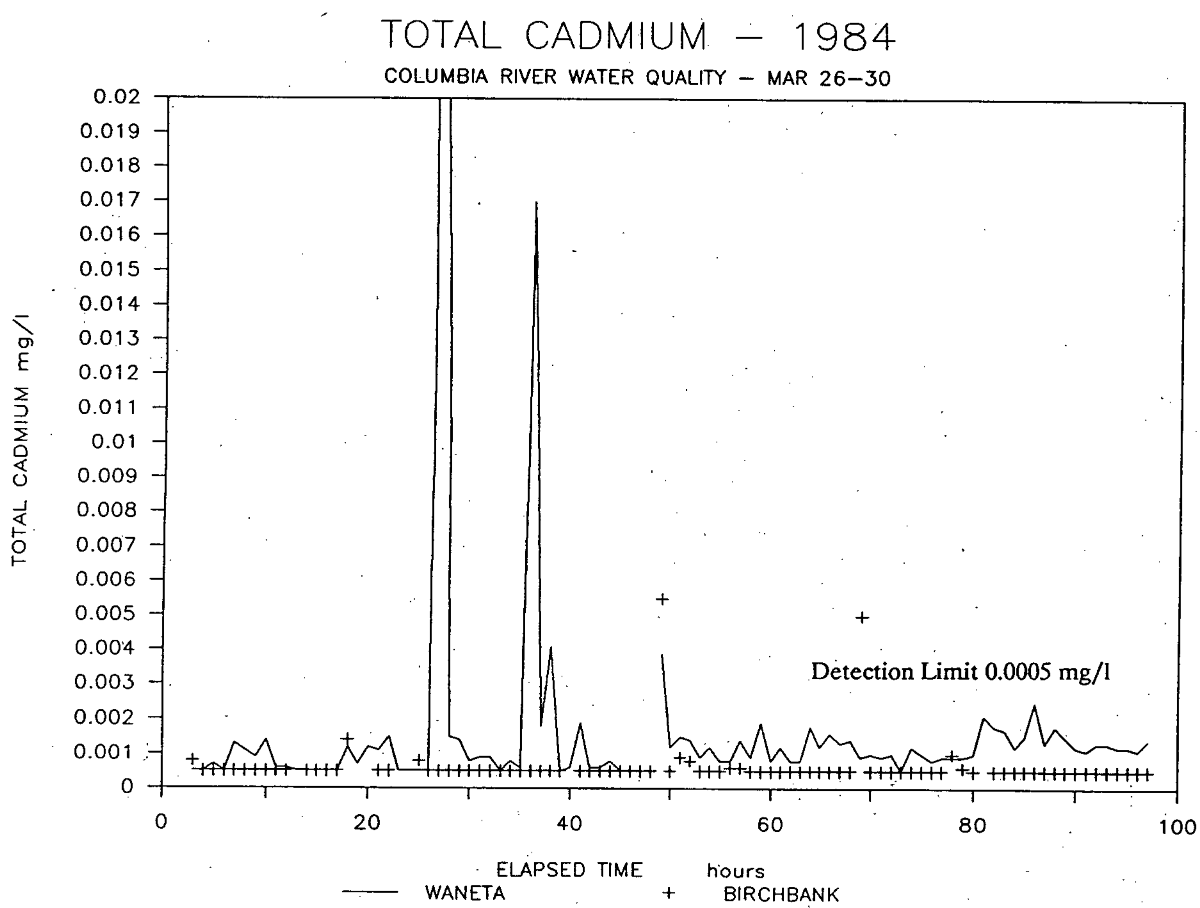


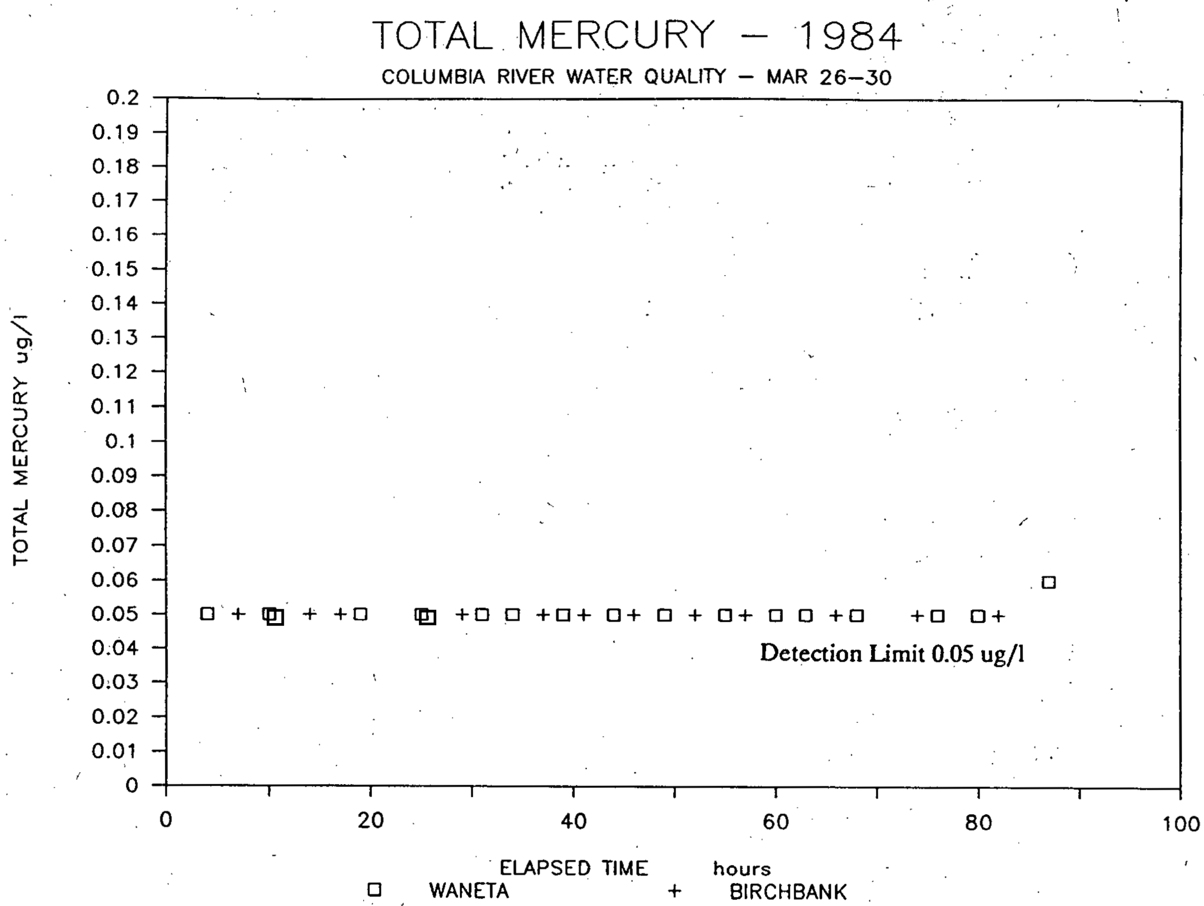
TOTAL MERCURY – 1983
COMINCO EFFLUENTS DILUTED BY COLUMBIA RIVER – OCT 17–20
TOTAL MERCURY ug/l
0.2
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
20
40
60
80
100
ELAPSED TIME hours


TOTAL ZINC – 1984
COLUMBIA RIVER WATER QUALITY – MAR 26–30
TOTAL ZINC mg/l
0.2
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
20
40
60
80
100
ELAPSED TIME hours
WANETA
BIRCHBANK

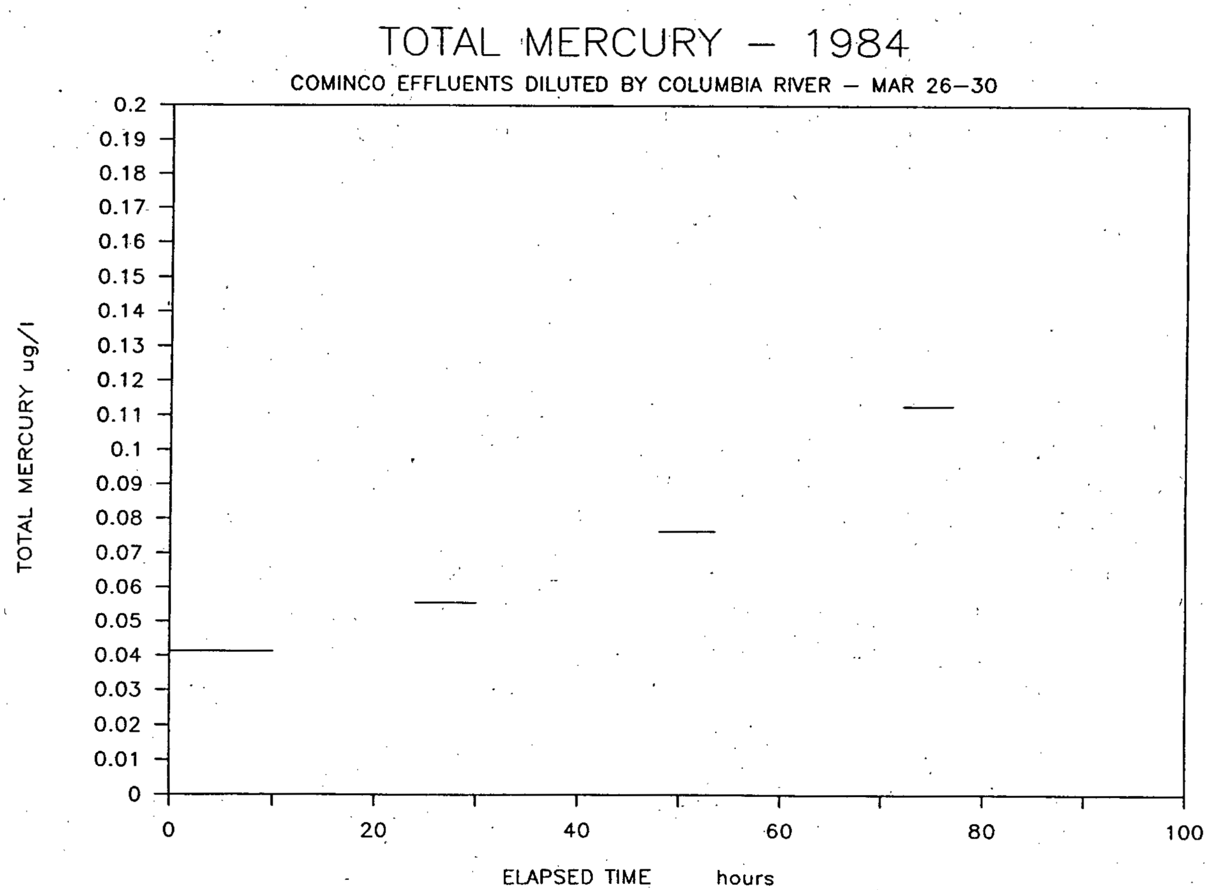

TOTAL ZINC – 1984
COMINCO EFFLUENTS DILUTED BY COLUMBIA RIVER – MAR 26–30
TOTAL ZINC mg/l
0.2
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
20
40
60
80
100
ELAPSED TIME hours


TOTAL LEAD — 1984
COLUMBIA RIVER WATER QUALITY — MAR 26–30
TOTAL LEAD mg/l
0.02
0.019
0.018
0.017
0.016
0.015
0.014
0.013
0.012
0.011
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
Detection Limit 0.001 mg/l
0
20
40
60
80
100
ELAPSED TIME hours
WANETA
BIRCHBANK


TOTAL CADMIUM — 1984
COLUMBIA RIVER WATER QUALITY — MAR 26–30
TOTAL CADMIUM mg/l
0.02
0.019
0.018
0.017
0.016
0.015
0.014
0.013
0.012
0.011
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
Detection Limit 0.0005 mg/l
0
20
40
60
80
100
ELAPSED TIME hours
WANETA
BIRCHBANK



TOTAL MERCURY – 1984
COLUMBIA RIVER WATER QUALITY – MAR 26–30
TOTAL MERCURY ug/l
Detection Limit 0.05 ug/l
ELAPSED TIME hours
WANETA
BIRCHBANK



TOTAL MERCURY – 1984
COMINCO EFFLUENTS DILUTED BY COLUMBIA RIVER – MAR 26–30
TOTAL MERCURY ug/l
ELAPSED TIME hours

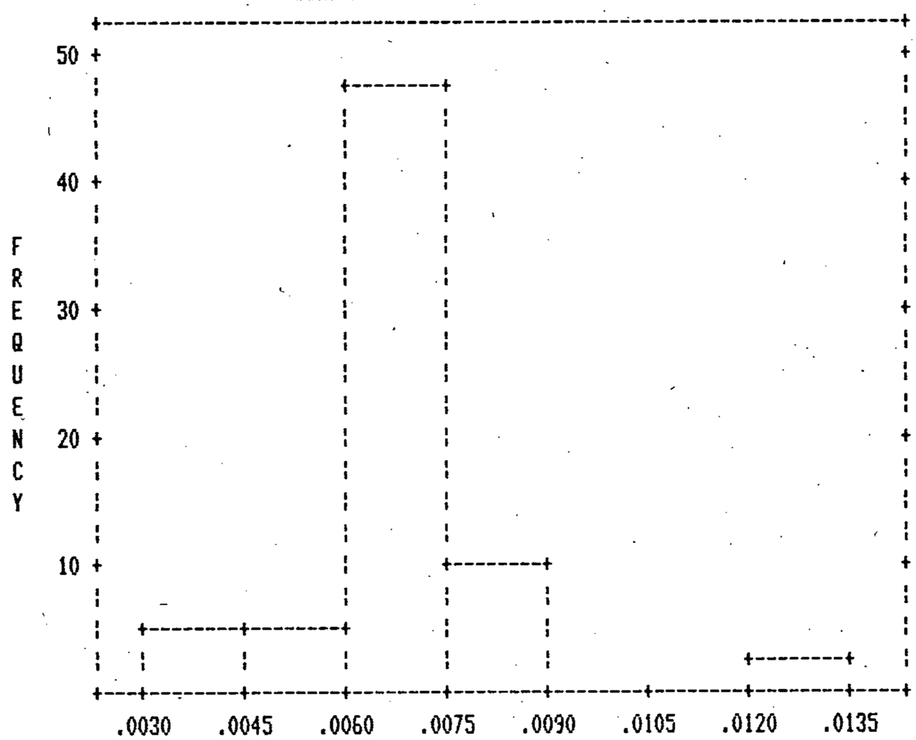
APPENDIX B - FREQUENCY DISTRIBUTION PLOTS

Note: All units are in mg/l

BIRCHBANK 1978: TOTAL PHOSPHORUS

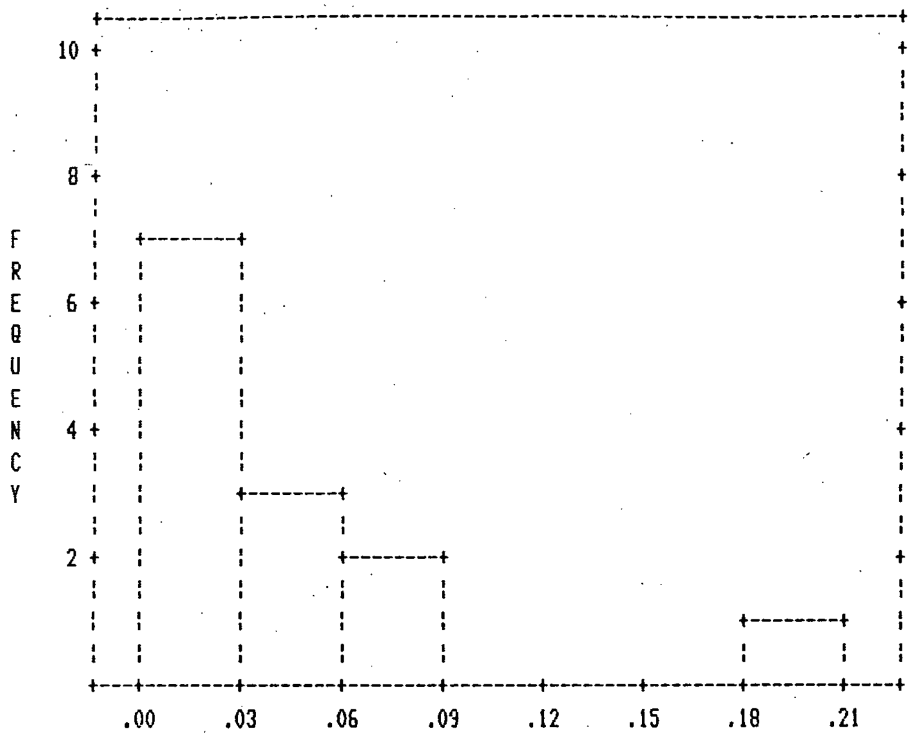
NO DATA

BIRCHBANK 1979: TOTAL PHOSPHORUS



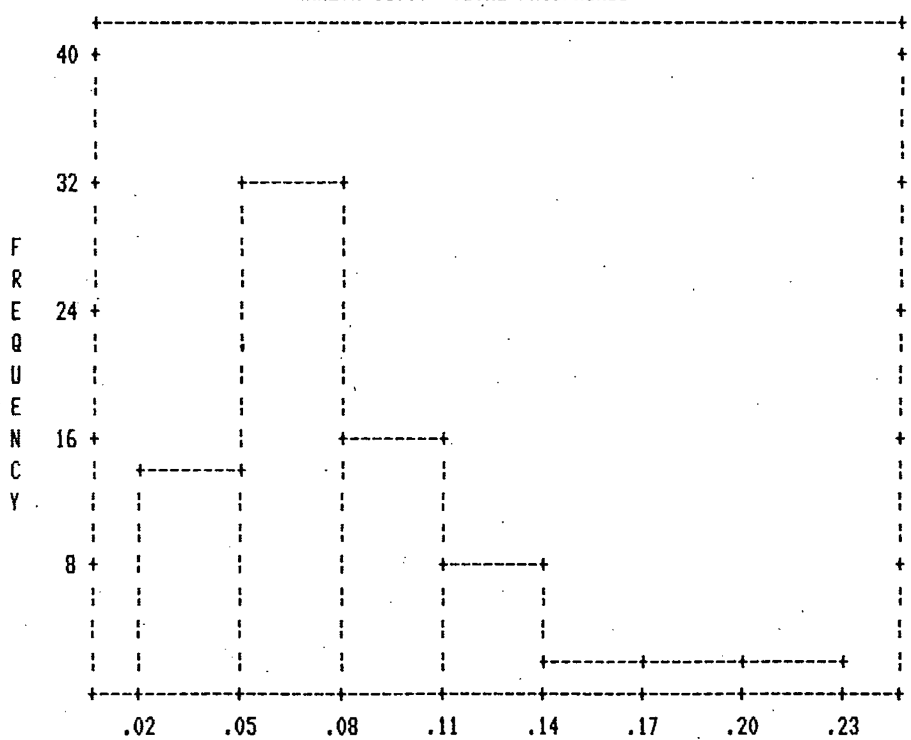
Mean = .656E-02 Standard Deviation = .173E-02 Skewness = .969E-04
Sample size = 71 Minimum = .400E-02 Maximum = .130E-01

WANETA 1978: TOTAL PHOSPHORUS



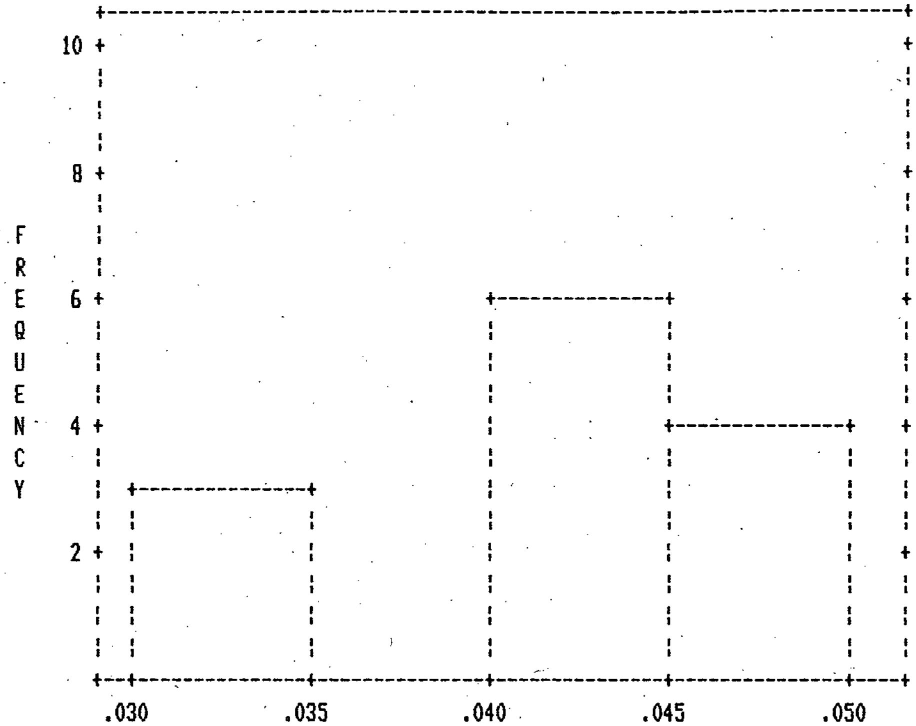
Mean = .435E-01 Standard Deviation = .516E-01 Skewness = .168E-01
Sample size = 13 Minimum = .900E-02 Maximum = .196

WANETA 1979: TOTAL PHOSPHORUS



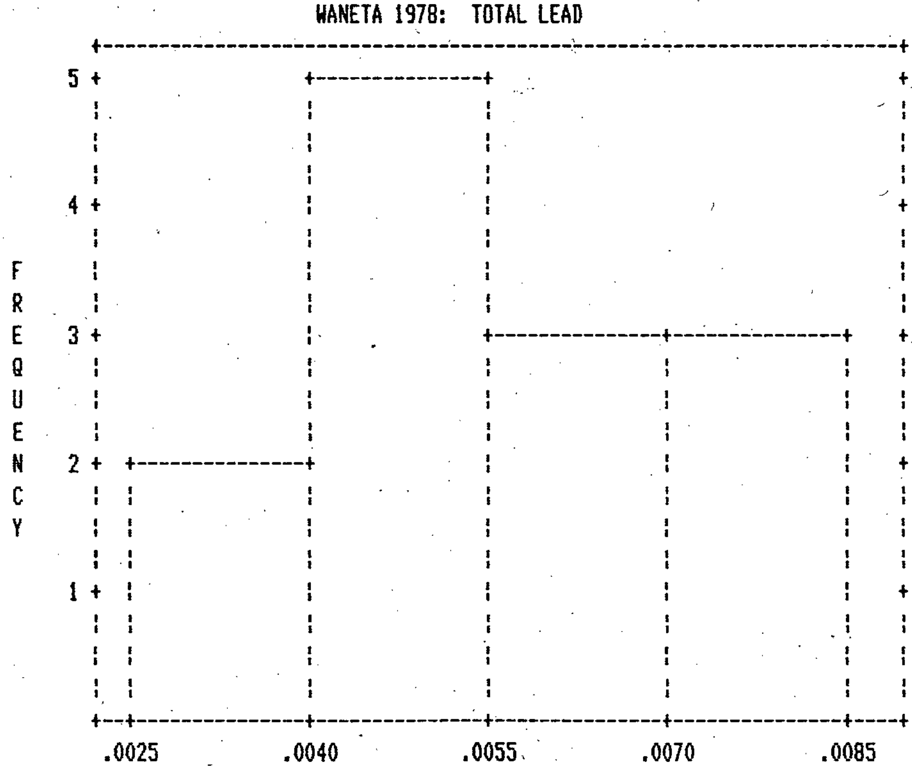
Mean = .801E-01 Standard Deviation = .373E-01 Skewness = .903E-02
Sample size = 72 Minimum = .280E-01 Maximum = .227

WANETA 1978: TOTAL ZINC



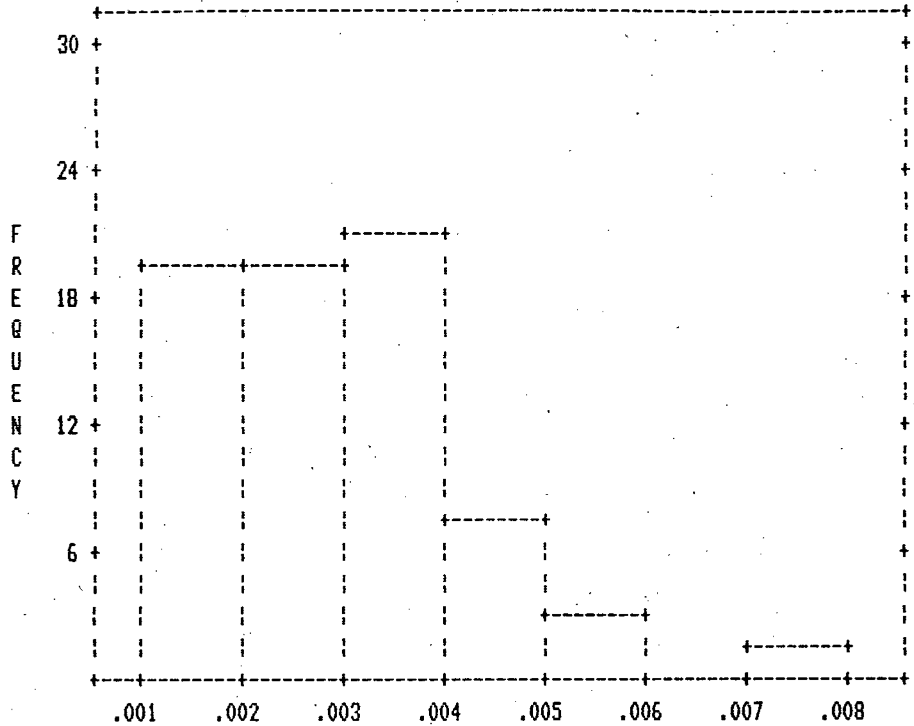
Mean = .408E-01 Standard Deviation = .760E-02 Skewness = -.224E-03
Sample size = 13 Minimum = .300E-01 Maximum = .500E-01

WANETA 1978: TOTAL LEAD



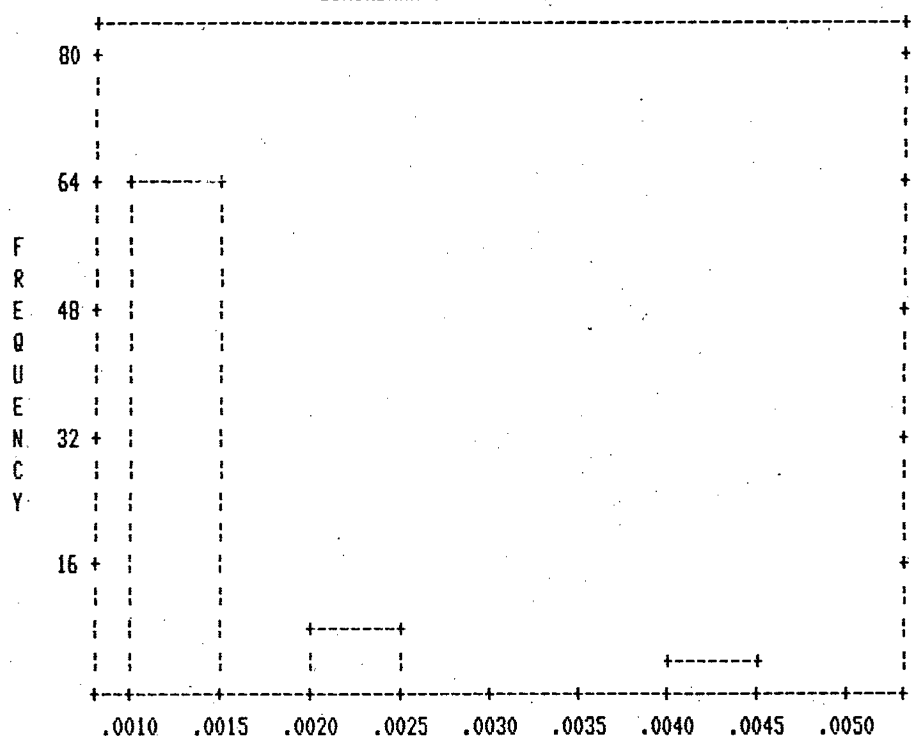
Mean = .521E-02 Standard Deviation = .163E-02 Skewness = .146E-04
Sample size = 13 Minimum = .267E-02 Maximum = .800E-02

BIRCHBANK 1981: TOTAL ZINC



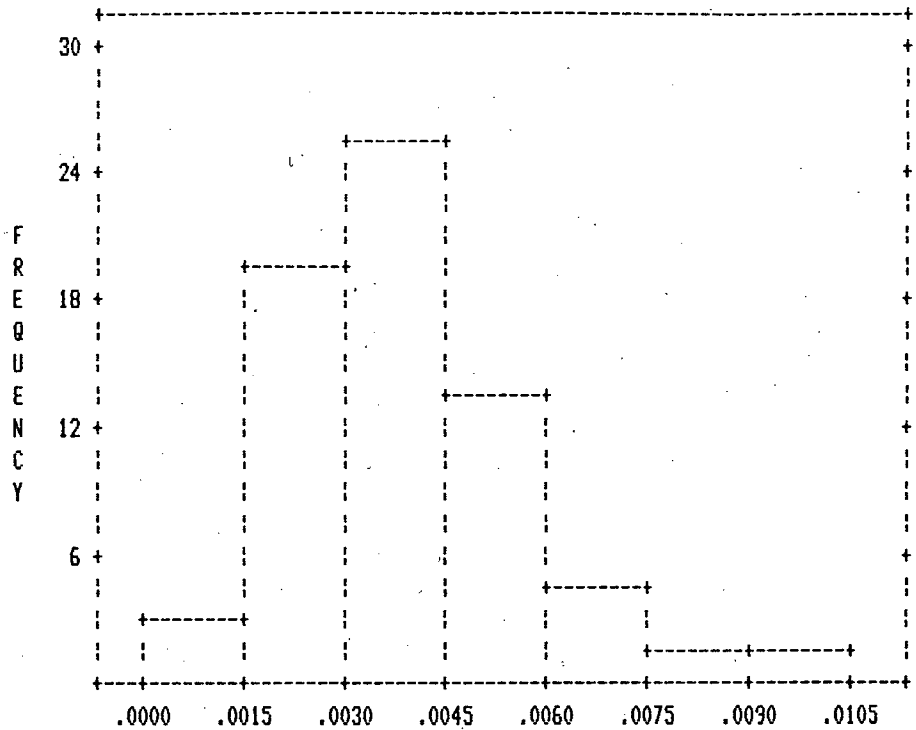
Mean = .244E-02 Standard Deviation = .124E-02 Skewness = .410E-04
Sample size = 72 Minimum = .100E-02 Maximum = .700E-02

BIRCHBANK 1981: TOTAL LEAD



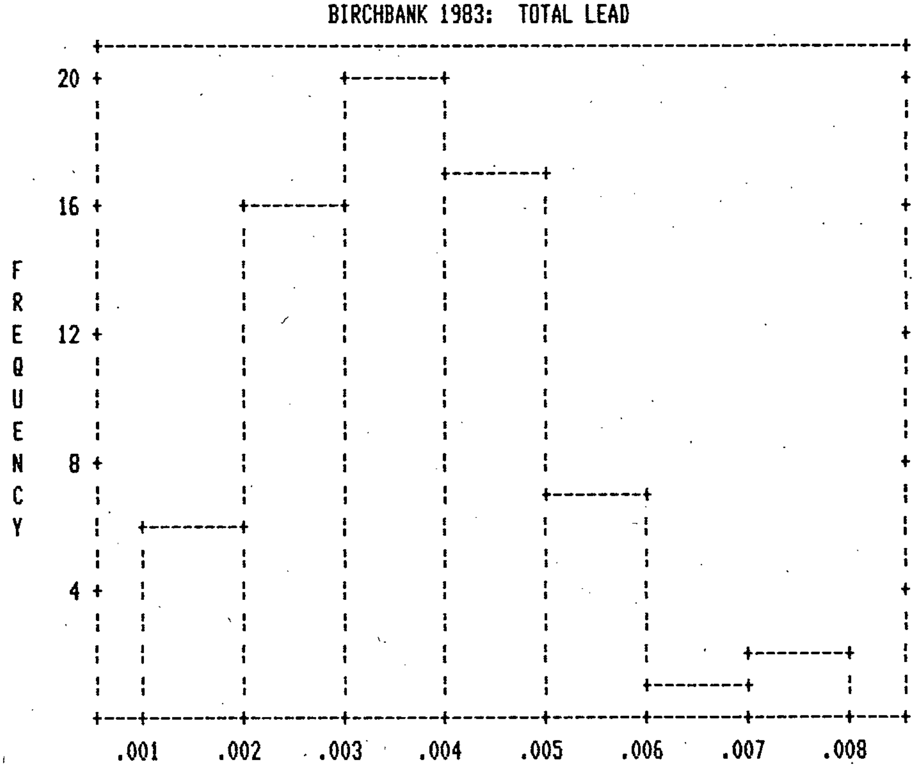
Mean = .124E-02 Standard Deviation = .722E-03 Skewness = .371E-04
Sample size = 72 Minimum = .100E-02 Maximum = .500E-02

BIRCHBANK 1983: TOTAL ZINC



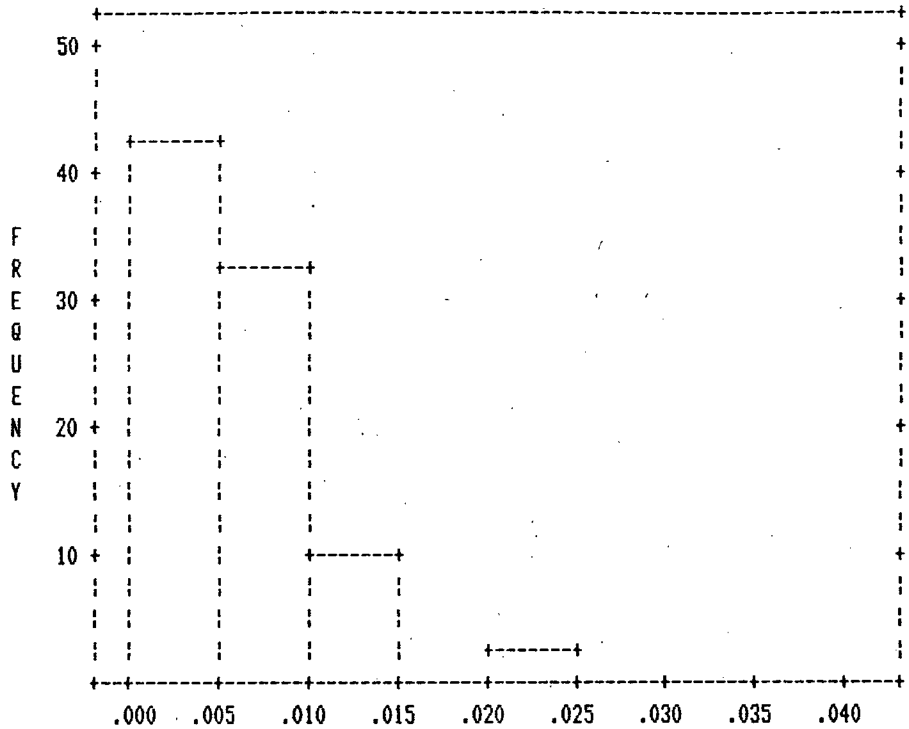
Mean =   .362E-02 Standard Deviation =   .182E-02 Skewness =   .800E-04
Sample size =   69 Minimum = .100E-02 Maximum = .100E-01

BIRCHBANK 1983: TOTAL LEAD



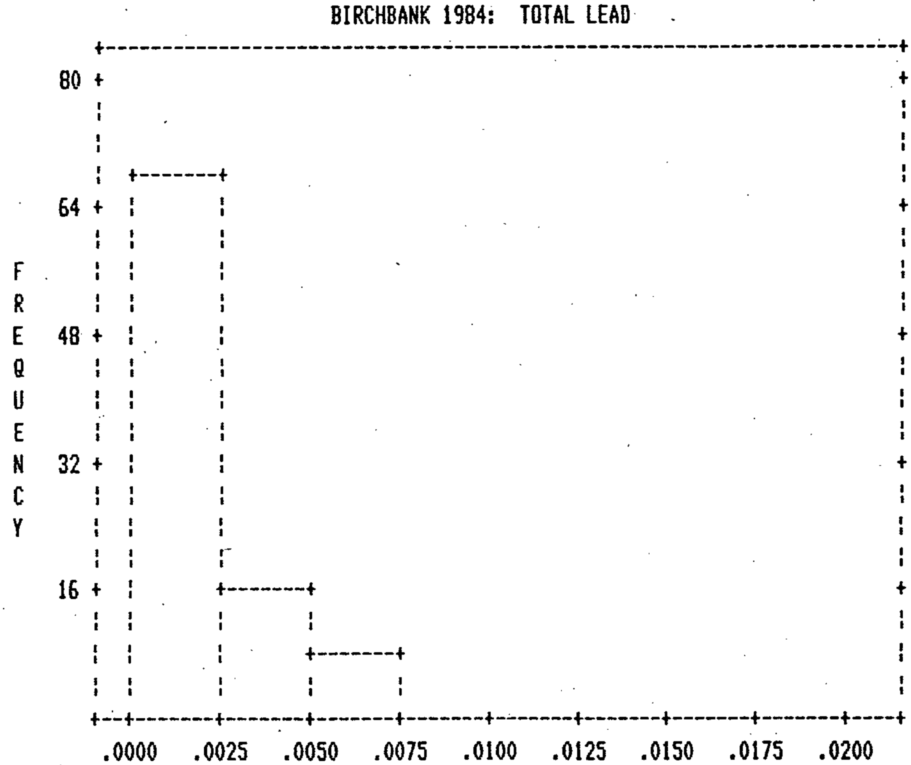
Mean =   .320E-02 Standard Deviation =   .135E-02 Skewness =   .361E-04
Sample size =   69 Minimum = .100E-02 Maximum = .700E-02

BIRCHBANK 1984: TOTAL ZINC



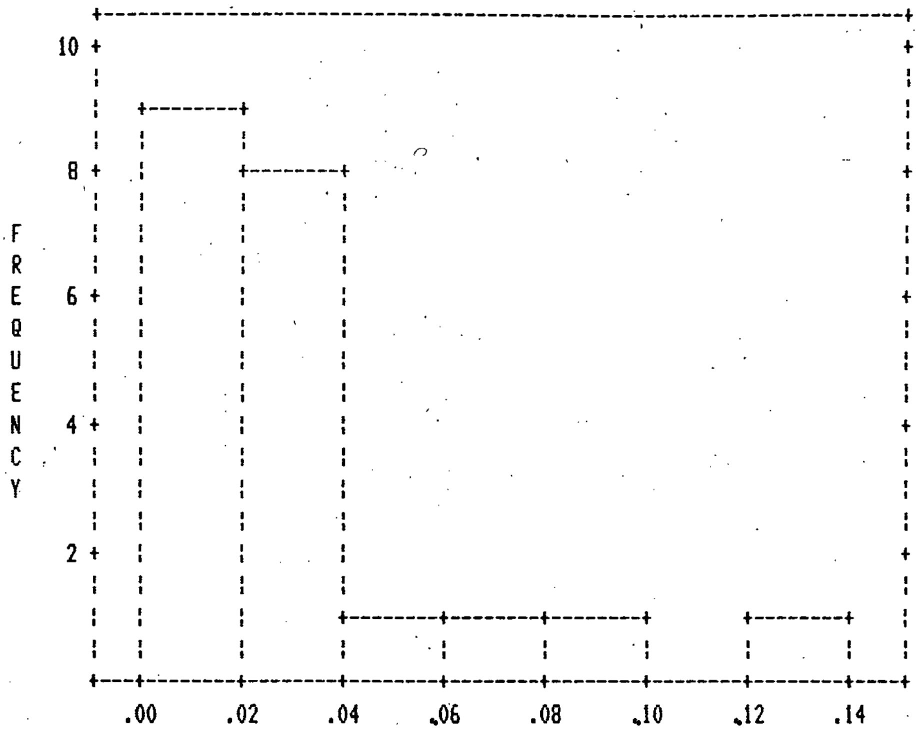
Mean = .602E-02 Standard Deviation = .522E-02 Skewness = .731E-03
Sample size = 88 Minimum = .200E-02 Maximum = .400E-01

BIRCHBANK 1984: TOTAL LEAD



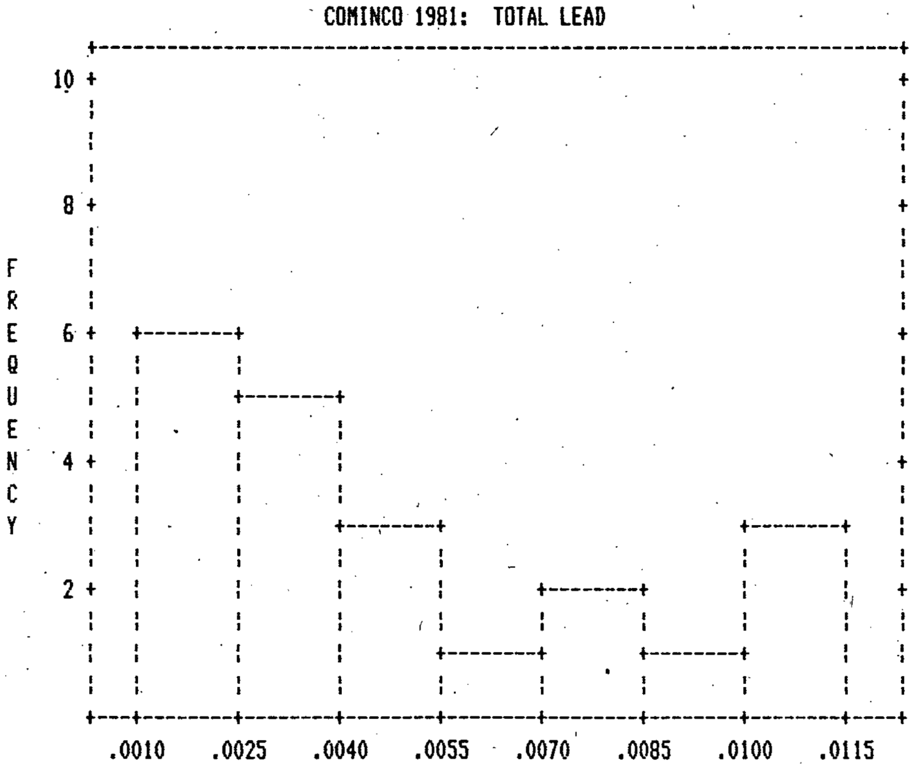
Mean = .208E-02 Standard Deviation = .213E-02 Skewness = .204E-03
Sample size = 88 Minimum = .100E-02 Maximum = .170E-01

COMINCO 1981: TOTAL ZINC



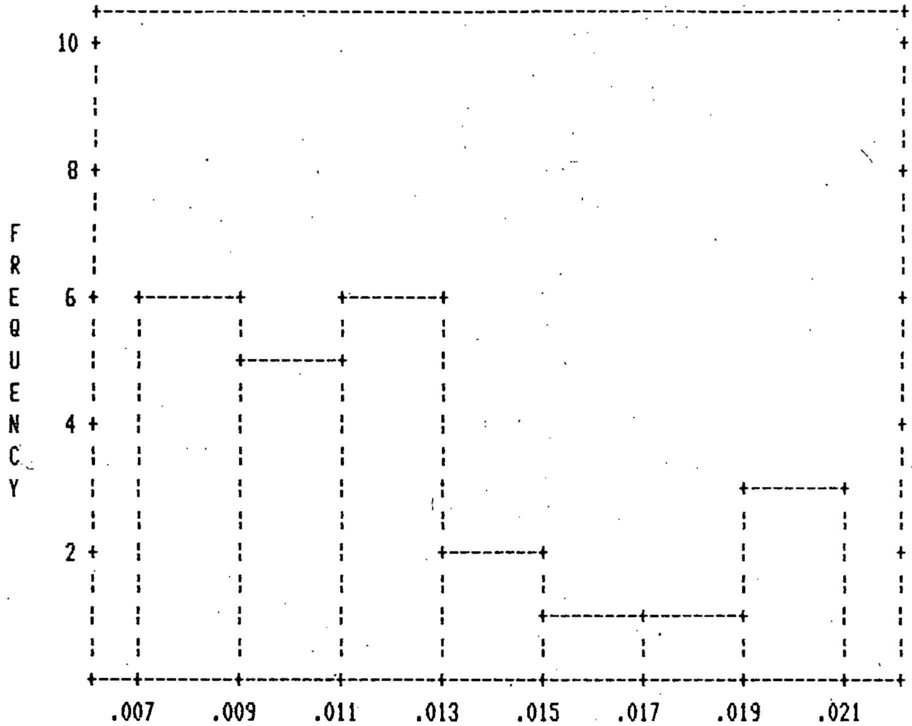
Mean = .353E-01 Standard Deviation = .307E-01 Skewness = .793E-02
Sample size = 21 Minimum = .128E-01 Maximum = .138

COMINCO 1981: TOTAL LEAD



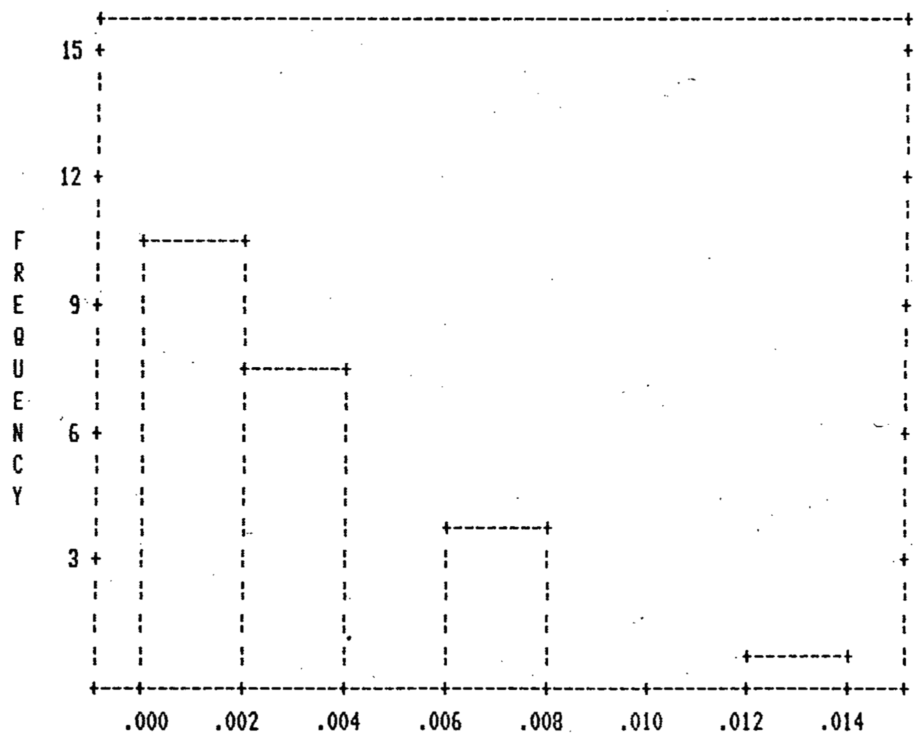
Mean = .486E-02 Standard Deviation = .320E-02 Skewness = .156E-03
Sample size = 21 Minimum = .131E-02 Maximum = .110E-01

COMINCO 1983: TOTAL ZINC



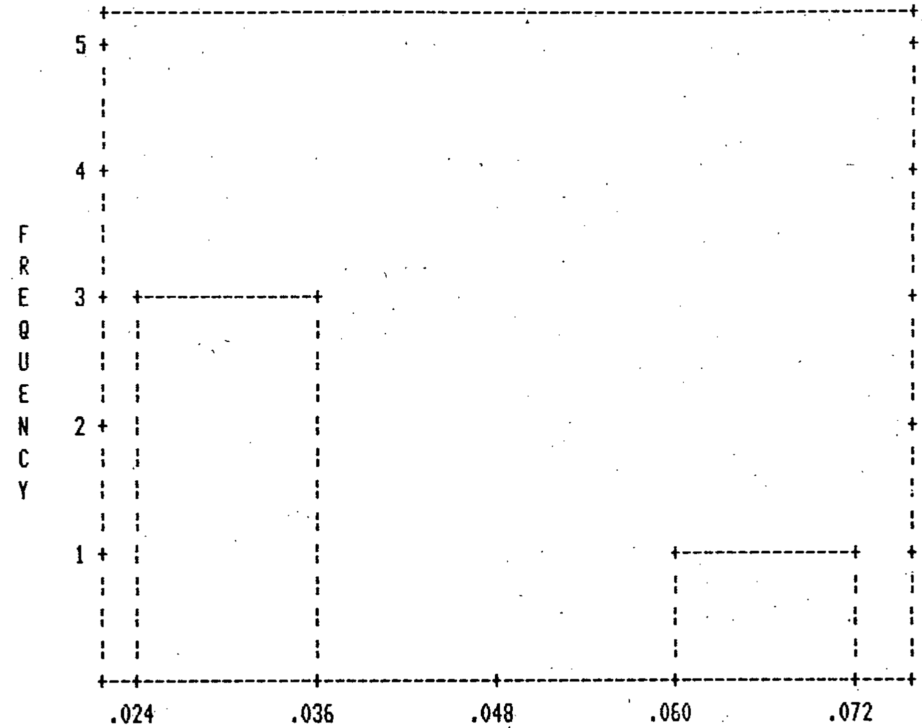
Mean = .122E-01 Standard Deviation = .408E-02 Skewness = .252E-03
Sample size = 24 Minimum = .717E-02 Maximum = .211E-01

COMINCO 1983: TOTAL LEAD



Mean = .299E-02 Standard Deviation = .279E-02 Skewness = .205E-03
Sample size = 24 Minimum = .940E-03 Maximum = .124E-01

COMINCO 1984: TOTAL ZINC

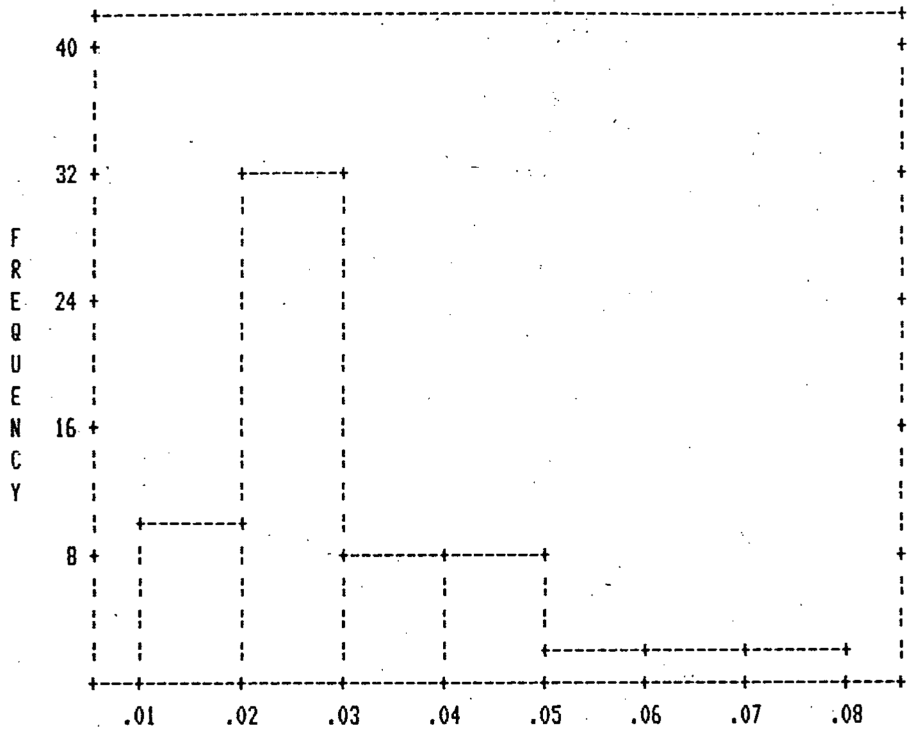


Mean = .390E-01 Standard Deviation = .208E-01 Skewness = .298E-02
Sample size = 4 Minimum = .272E-01 Maximum = .701E-01

COMINCO 1984: TOTAL LEAD

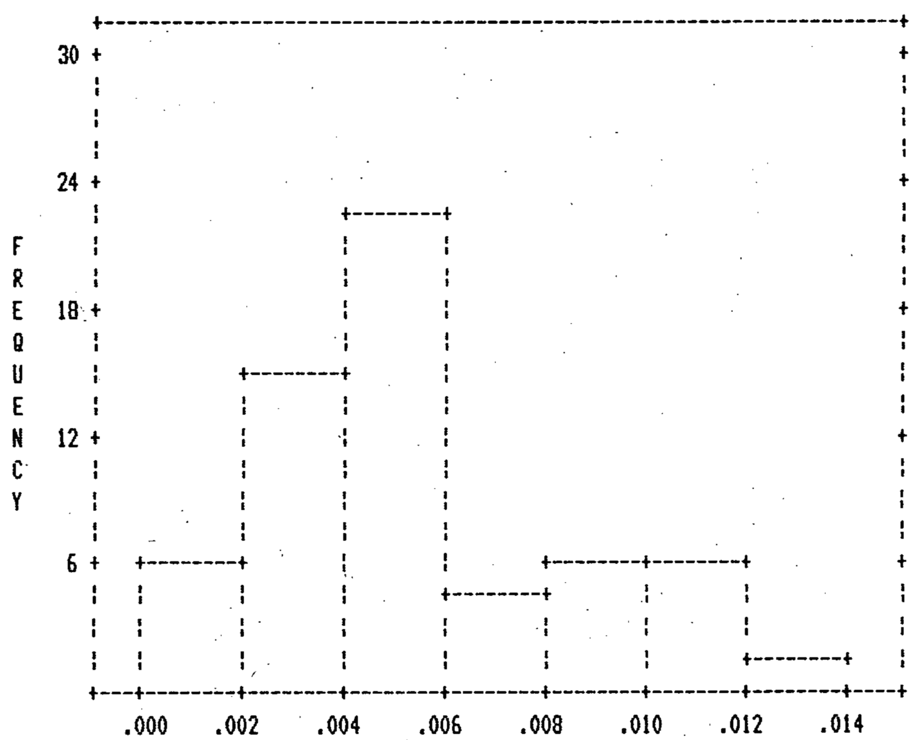
NOT MEASURED

WANETA 1981: TOTAL ZINC



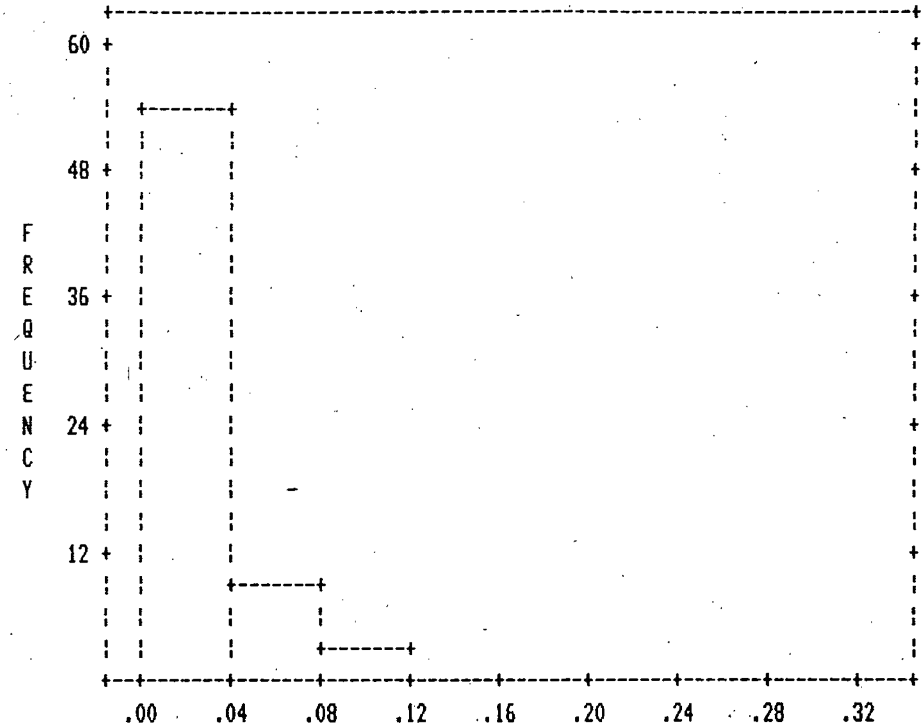
Mean = .287E-01 Standard Deviation = .117E-01 Skewness = .152E-02
Sample size = 61 Minimum = .130E-01 Maximum = .700E-01

WANETA 1981: TOTAL LEAD



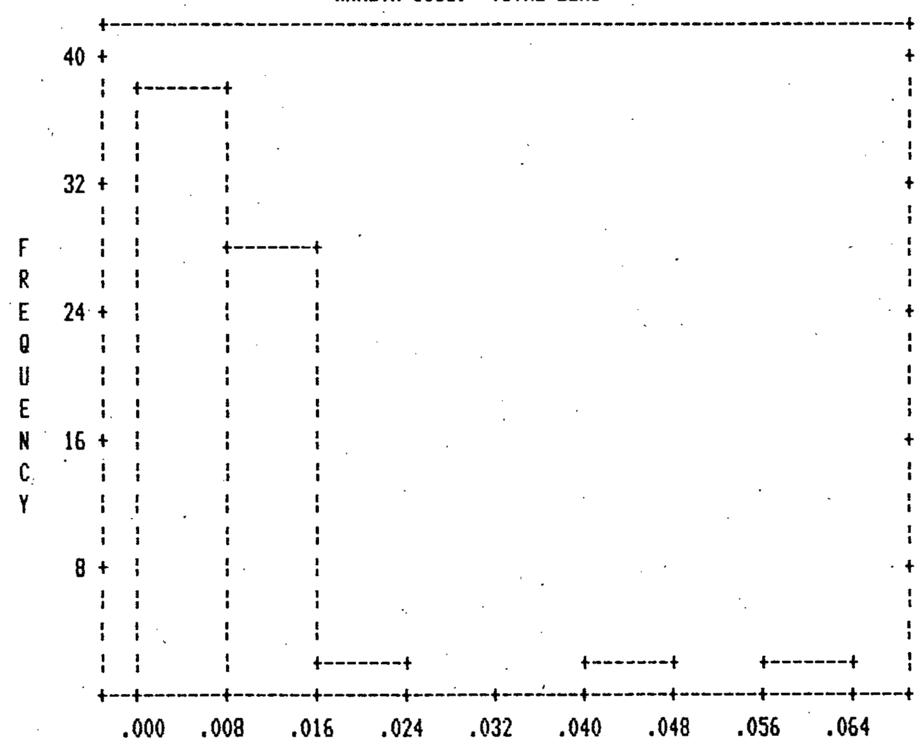
Mean = .485E-02 Standard Deviation = .289E-02 Skewness = .126E-03
Sample size = 61 Minimum = .100E-02 Maximum = .120E-01

WANETA 1983: TOTAL ZINC



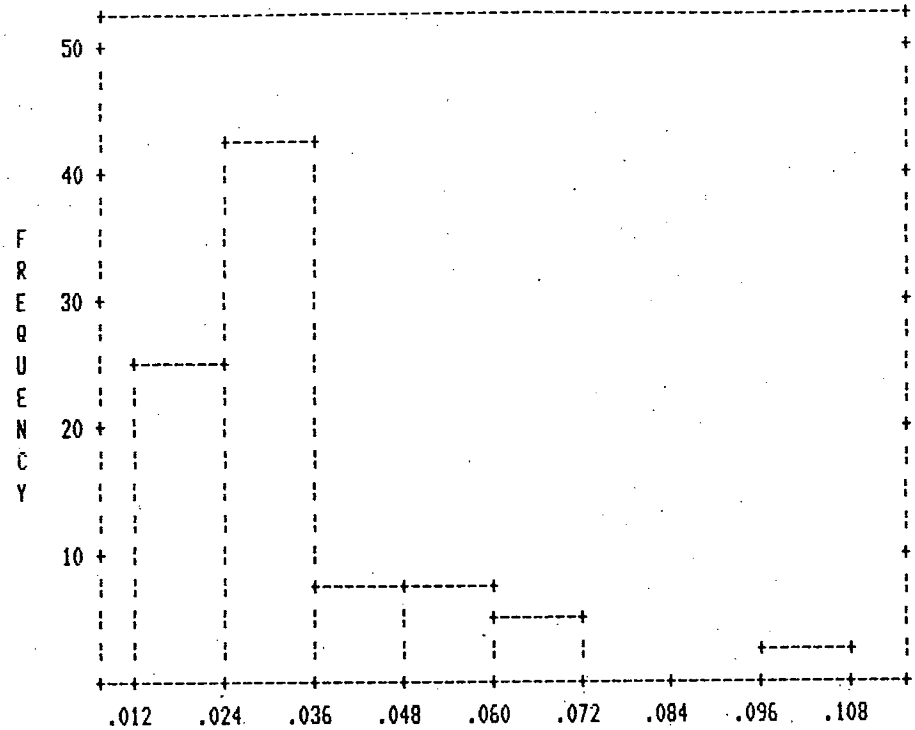
Mean = .376E-01 Standard Deviation = .440E-01 Skewness = .195E-01
Sample size = 67 Minimum = .140E-01 Maximum = .303

WANETA 1983: TOTAL LEAD



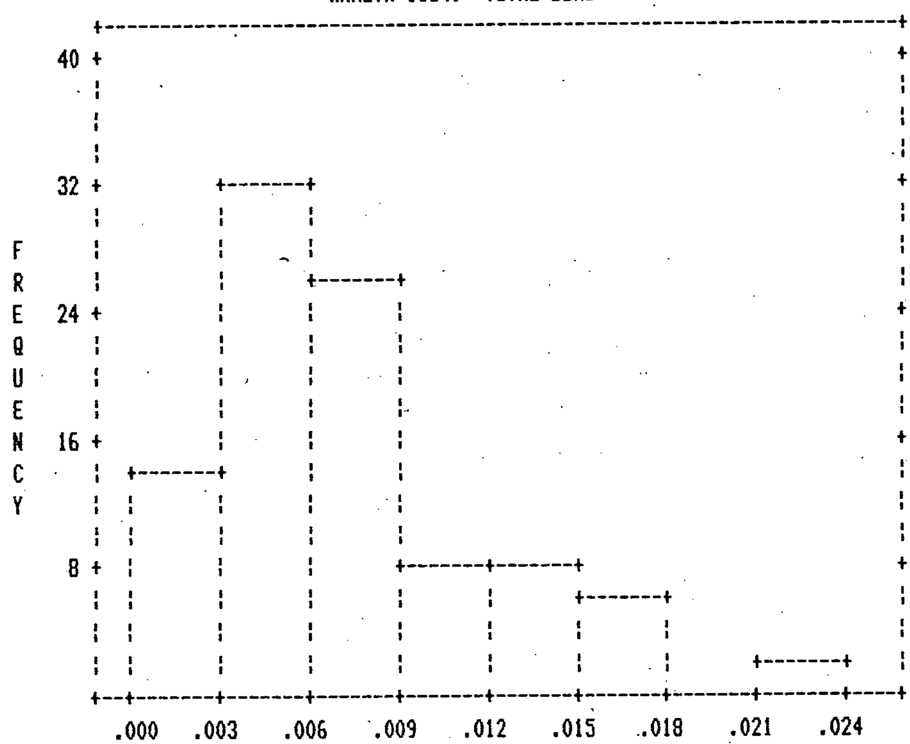
Mean = .894E-02 Standard Deviation = .763E-02 Skewness = .144E-02
Sample size = 67 Minimum = .300E-02 Maximum = .560E-01

WANETA 1984: TOTAL ZINC



Mean = .344E-01 Standard Deviation = .178E-01 Skewness = .332E-02
Sample size = 92 Minimum = .170E-01 Maximum = .100

WANETA 1984: TOTAL LEAD



Mean = .683E-02 Standard Deviation = .477E-02 Skewness = .344E-03
Sample size = 92 Minimum = .100E-02 Maximum = .220E-01

APPENDIX C - ANALYSIS OF VARIANCE RESULTS

TABLE C.1 - TWO-WAY ANOVA RESULTS

PRINTOUT FROM THE ZINC AND LEAD ANALYSES
"GENLIN" UBC PROGRAM

```
INPUT FILE=METAL FORMAT=(F1.0,F4.0,2F9.0)
VARIABLES YR,LOC,ZN,PB
LEVELS LOC=3 YR=3
MODEL ZN,PB =  LOC+YR+LOC*YR
OUTPUT FREQUENCIES HOMOGENEITY OBSERVED PREDICTED TERMS=LOC,YR,LOC*YR
MULRAN ALWAYS TYPE=NEWMAN-KEULS TERMS=LOC,YR,LOC*YR
MISSING ZN,PB=BLANK
COMPUTE

Time for control card processing was  0.44010E-01 seconds.  Cumulative time is  0.46328E-01 seconds.
/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/•/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/+/

Time for data input and correlation matrix was  0.28501     seconds.  Cumulative time is  0.33630     seconds.
Time for ANOVA table was  0.40977E-01 seconds.  Cumulative time is  0.37796     seconds.


                                                                      04:19 P.M.  NOV. 20, 1987

Analysis for ZN

              Analysis of variance table

                    Sum of                  Mean
Source              squares         DF    square      F-ratio     Probability Test term

LOC                 0.99591E-01      2.   0.49795E-01  129.45     0.00000     RESIDUAL
YR                  0.74941E-03      2.   0.37471E-03 0.97413     0.37825     RESIDUAL
LOC*YR              0.93030E-02      4.   0.23258E-02  6.0463     0.00009     RESIDUAL
Residual            0.18810        489.   0.38466E-03
Total               0.29808        497.

                                       Overall
                   Overall mean  standard deviation
ZN                  0.19247E-01      0.24490E-01

    ------------------------------------------------
    Frequencies, means, standard deviations for LOC
           1.           2.          3.

              229          49          220
   O MEAN   0.41746E-02  0.24310E-01  0.33809E-01
   P MEAN   0.41483E-02  0.25009E-01  0.33681E-01
   O STDV   0.37691E-02  0.23896E-01  0.27656E-01
   S ERR M  0.12966E-02  0.28529E-02  0.13255E-02

    Homogeneity of variance test

                   Bartlett                   Degrees    Layard                    Size
          Factors  Chi-square  Probability of freedom  Chi-square   Probability    warn
              LOC   599.57       0.0             2       22.642       0.00001

Time for homogeneity of variance test was  0.12112E-02 seconds.  Cumulative time is  0.38799     seconds.

    Multiple range tests

        Newman-Keuls test at  5% probability level
  There are 3 homogeneous subsets which are listed as follows:

   (  1. )
```

(2.)

(3.)
Time for multiple range test was 0.74873E-02 seconds. Cumulative time is 0.39622 seconds.

Frequencies, means, standard deviations for YR

	.1	.2	.3
	154	160	184
O MEAN	0.17340E-01	0.19137E-01	0.20940E-01
P MEAN	0.17896E-01	0.18740E-01	0.20820E-01
O STDV	0.19427E-01	0.32622E-01	0.19564E-01
S ERR M	0.15854E-02	0.15583E-02	0.14647E-02

Homogeneity of variance test

Factors	Bartlett Chi-square	Probability	Degrees of freedom	Layard Chi-square	Probability	Size warn
YR	61.901	0.00000	2	2.4011	0.30103	

Time for homogeneity of variance test was 0.12369E-02 seconds. Cumulative time is 0.41973 seconds.

Multiple range tests

Newman-Keuls test at 5% probability level
There is 1 homogeneous subset which is listed as follows:

(.1, .2, .3)
Time for multiple range test was 0.17576E-02 seconds. Cumulative time is 0.42215 seconds.

Frequencies, means, standard deviations for LOC*YR

	1 1	1 2	1 3	2 1	2 2	2 3	3 1	3 2	3 3
	72	69	88	21	24	4	61	67	92
O MEAN	0.24444E-02	0.36232E-02	0.60227E-02	0.35349E-01	0.12202E-01	0.39000E-01	0.28721E-01	0.37597E-01	0.34424E-01
P MEAN	0.24445E-02	0.36232E-02	0.60227E-02	0.35349E-01	0.12202E-01	0.39000E-01	0.28721E-01	0.37597E-01	0.34424E-01
O STDV	0.12434E-02	0.18158E-02	0.52171E-02	0.30654E-01	0.40794E-02	0.20765E-01	0.11658E-01	0.44039E-01	0.17780E-01
S ERR M	0.23114E-02	0.23611E-02	0.20907E-02	0.42798E-02	0.40034E-02	0.98064E-02	0.25112E-02	0.23961E-02	0.20448E-02

Homogeneity of variance test

Factors	Bartlett Chi-square	Probability	Degrees of freedom	Layard Chi-square	Probability	Size warn
LOC,YR	953.08	0.0	8	33.238	0.00006	
LOC	627.00	0.0	2	23.409	0.00001	
YR	134.58	0.00000	2	2.8636	0.23888	

Time for homogeneity of variance test was 0.24738E-02 seconds. Cumulative time is 0.44862 seconds.

Multiple range tests

Newman-Keuls test at 5% probability level
There are 2 homogeneous subsets which are listed as follows:

(1 1, 1 2, 1 3, 2 2)

(2 2, 3 1, 3 3, 2 1, 3 2, 2 3)
Time for multiple range test was 0.39978E-02 seconds. Cumulative time is 0.45322 seconds.

/+/

Analysis for PB

Analysis of variance table

Source	Sum of squares	DF	Mean square	F-ratio	Probability	Test term
LOC	0.25220E-02	2.	0.12610E-02	83.271	0.00000	RESIDUAL
YR	0.41036E-03	2.	0.20518E-03	13.549	0.00000	RESIDUAL
LOC*YR	0.30105E-03	3.	0.10035E-03	6.6268	0.00022	RESIDUAL
Residual	0.73595E-02	486.	0.15143E-04			
Total	0.10640E-01	493.				

	Overall mean	Overall standard deviation
PB	0.44328E-02	0.46456E-02

Frequencies, means, standard deviations for LOC

	1.	2.	3.
..	229	45	220
O MEAN	0.21528E-02	0.38626E-02	0.69225E-02
P MEAN	0.21842E-02	0.37537E-02	0.69124E-02
O STDV	0.17442E-02	0.31027E-02	0.56348E-02
S ERR M	0.25732E-03	0.59607E-03	0.26316E-03

Homogeneity of variance test

Factors	Bartlett Chi-square	Probability	Degrees of freedom	Layard Chi-square	Probability	Size warn
LOC	262.68	0.00000	2	11.159	0.00377	

Time for homogeneity of variance test was 0.11988E-02 seconds. Cumulative time is 0.46439 seconds.

Multiple range tests

Newman-Keuls test at 5% probability level
There are 2 homogeneous subsets which are listed as follows:

(1., 2.)

(3.)

Time for multiple range test was 0.53520E-02 seconds. Cumulative time is 0.47039 seconds.

Frequencies, means, standard deviations for YR

	.1	.2	.3
..	154	160	180
O MEAN	0.31630E-02	0.55732E-02	0.45055E-02
P MEAN	0.33247E-02	0.56065E-02	0.43376E-02
O STDV	0.28511E-02	0.58577E-02	0.44111E-02
S ERR M	0.31502E-03	0.30985E-03	0.29573E-03

Homogeneity of variance test

Bartlett Degrees Layard Size

Factors	Chi-square	Probability	of freedom	Chi-square	Probability	warn
YR	74.433	0.00000	2	4.1619	0.12481	

Time for homogeneity of variance test was 0.18216E-01 seconds. Cumulative time is 0.49264 seconds.

Multiple range tests

Newman-Keuls test at 5% probability level
There are 2 homogeneous subsets which are listed as follows:

(.1, .3)

(.3, .2)
Time for multiple range test was 0.20180E-02 seconds. Cumulative time is 0.49531 seconds.

Frequencies, means, standard deviations for LOC*YR

	1 1	1 2	1 3	2 1	2 2	2 3	3 1	3 2	3 3
..	72	69	88	21	24	0	61	67	92
O MEAN	0.12361E-02	0.32029E-02	0.20795E-02	0.48617E-02	0.29883E-02	0.0	0.48524E-02	0.89402E-02	0.68260E-02
P MEAN	0.12361E-02	0.32029E-02	0.20795E-02	0.48618E-02	0.29883E-02	0.0	0.48525E-02	0.89403E-02	0.68261E-02
O STDV	0.72175E-03	0.13458E-02	0.21347E-02	0.32016E-02	0.27919E-02	0.0	0.28858E-02	0.76334E-02	0.47731E-02
S ERR M	0.45861E-03	0.46847E-03	0.41483E-03	0.84917E-03	0.79433E-03	0.17508E-03	0.49824E-03	0.47541E-03	0.40571E-03

Homogeneity of variance test

Factors	Bartlett Chi-square	Probability	Degrees of freedom	Layard Chi-square	Probability	Size warn
LOC,YR	417.51	0.0	7	18.970	0.00828	
LOC	286.42	0.00000	2	12.441	0.00199	
YR	97.925	0.00000	2	4.0291	0.13338	

Time for homogeneity of variance test was 0.27342E-02 seconds. Cumulative time is 0.50484 seconds.

Multiple range tests
One empty cell will be ignored

Newman-Keuls test at 5% probability level
There are 5 homogeneous subsets which are listed as follows:

(1 1, 1 3, 2 2)

(1 3, 2 2, 1 2)

(2 2, 1 2, 3 1, 2 1)

(3 3)

(3 2)
Time for multiple range test was 0.44661E-02 seconds. Cumulative time is 0.51014 seconds.
STOP

TABLE C.2 - ONEWAY ANOVA RESULTS

PRINTOUT OF THE 1979 PHOPHORUS ANALYSIS
"POWERSTAT" PROGRAM

ONEWAY ANOVA - LOCATION EFFECT
PHOSPHORUS - WANETA & BIRCHBANK: 1978, 1979

Factor	Levels	Values
LOCATION	2	WANETA BIRCHBAN

Number of Cells = 2 Data Values = 143 Missing Data Values = 0

Cell Information

Factor Levels LOCATION	Cell N	Mean	Total
WANETA	72	.080097	5.767000
BIRCHBAN	71	.006563	.466000

N = 143 Mean = .043587 USS = .563925 CSS = .292245

Treatment Variable is LOCATION Response Variable is TP

Source of Variation	d.f.	Sum of Squares	Mean Square	F-Ratio	Pr > F
Between Groups	1	.193299	.193299	275.46	.0000
Within Groups	141	.098946	.000702		
Corrected Total	142	.292245			

Student-Newman-Keuls Multiple Range Test

Factor Levels LOCATION	Cell N	Mean
WANETA	72	.080097
BIRCHBAN	71	.006563

Means jointly associated with a continuous bar are not significantly different

I. STUDENT-NEWMAN-KEULS

Number of Cells	Studentized Range Statistic	Critical Difference
2	2.799738	.008771

Error MS = .7017432E-03 Std. Error of a Mean = .31329E-02 Error d.f. = 141
Type I Error Rate per Experiment = .050

TABLE C.3 - ONEWAY ANOVA RESULTS

PRINTOUT OF THE WANETA ZINC AND LEAD ANALYSIS
(1978,1981,1983,1984)
"POWERSTAT" PROGRAM

ONEWAY ANOVA - YEAR EFFECT
WANETA ZINC

Factor	Levels	Values			
YEAR	4	1981	1983	1984	1978

Number of Cells = 4 Data Values = 233 Missing Data Values = 0

Cell Information

Factor Levels YEAR	Cell N	Mean	Total
1981	61	.028721	1.752000
1983	67	.037597	2.519000
1984	92	.034424	3.167000
1978	13	.040769	.530000

N = 233 Mean = .034197 USS = .441274 CSS = .168789

Treatment Variable is YEAR Response Variable is TZN

Source of Variation	d.f.	Sum of Squares	Mean Square	F-Ratio	Pr > F
Between Groups	3	.003170	.001057	1.46	.2260
Within Groups	229	.165619	.000723		
Corrected Total	232	.168789			

Student-Newman-Keuls Multiple Range Test

Factor Levels YEAR	Cell N	Mean
1978	61	.040769 ¦
1983	67	.037597 ¦
1984	92	.034424 ¦
1981	13	.028721 ¦

Means jointly associated with a continuous bar are not significantly different

I. STUDENT-NEWMAN-KEULS

Number of Cells	Studentized Range Statistic	Critical Difference
4	3.685202	.017102
3	3.356839	.015578
2	2.799738	.012993

Error MS = .7232278E-03 Std. Error of a Mean = .46407E-02 Error d.f. = 229
Type I Error Rate per Experiment = .050

ONEWAY ANOVA - YEAR EFFECT
WANETA LEAD

Factor	Levels	Values			
YEAR	4	1981	1983	1984	1978

Number of Cells = 4 Data Values = 233 Missing Data Values = 0

Cell Information

Factor Levels YEAR	Cell N	Mean	Total
1981	61	.004852	.296000
1983	67	.008940	.599000
1984	92	.006826	.628000
1978	13	.005205	.067666

N = 233 Mean = .006827 USS = .017881 CSS = .007022

Treatment Variable is YEAR Response Variable is TPB

Source of Variation	d.f.	Sum of Squares	Mean Square	F-Ratio	Pr > F
Between Groups	3	.000571	.000190	6.76	.0002
Within Groups	229	.006451	.000028		
Corrected Total	232	.007022			

Student-Newman-Keuls Multiple Range Test

Factor Levels YEAR	Cell N	Mean	
1983	61	.008940	¦
1984	67	.006826	¦¦
1978	92	.005205	¦
1981	13	.004852	¦

Means jointly associated with a continuous bar are not significantly different

I. STUDENT-NEWMAN-KEULS

Number of Cells	Studentized Range Statistic	Critical Difference
4	3.685202	.003375
3	3.356839	.003074
2	2.799738	.002564

Error MS = .2816835E-04 Std. Error of a Mean = .91586E-03 Error d.f. = 229
Type I Error Rate per Experiment = .050

APPENDIX D - TRANSVERSE MIXING TABLES

Table D.1 SUMMER CONDITIONS

TRANSVERSE MIXING IN COLUMBIA DOWNSTREAM OF WANETA, BRITISH COLUMBIA

Transverse diffusion coeff.	Dz =	0.8 dU*	High value
	Dz =	0.6 dU*	Medium value
	Dz =	0.4 dU*	Low value

Mean depth (Waneta section, summer discharges) =	6 m
Cross-sectional Area, Waneta section, 1 June '78 =	1200 m2
Discharge, Waneta section, 1 June '78 =	3600 m3/s
Cross-sectional averaged velocity, Waneta, 1 June '78 =	3 m/s

Assume shear velocity U* = U/15

Constant in equation for diffusion coefficient	Transverse diffusion coefficient Dz	Width scale of mixing (Sz, m.) at distances specified (x m.) [Sz = (2(Dz)x/U)^0.5] 500	1000	2000	4000	8000	16000
	m2/s	m	m	m	m	m	m
0.8	0.96	17.9	25.3	35.8	50.6	71.6	101.2
0.6	0.72	15.5	21.9	31.0	43.8	62.0	87.6
0.4	0.48	12.6	17.9	25.3	35.8	50.6	71.6

Relative channel width B/Sz
for B = 240 meters

0.8	0.96	13.42	9.49	6.71	4.74	3.35	2.37
0.6	0.72	15.49	10.95	7.75	5.48	3.87	2.74
0.4	0.48	18.97	13.42	9.49	6.71	4.74	3.35

Table D.2 WINTER CONDITIONS

TRANSVERSE MIXING IN COLUMBIA DOWNSTREAM OF WANETA, BRITISH COLUMBIA

Transverse diffusion coeff.	Dz =	0.8 dU*	High value
	Dz =	0.6 dU*	Medium value
	Dz =	0.4 dU*	Low value

Mean depth (Waneta section, winter discharges) =	4.75 m
Cross-sectional Area, Waneta section, winter =	756 m2
Discharge, Waneta section, winter =	1800 m3/s
Cross-sectional averaged velocity, Waneta, winter =	2.38 m/s

Assume shear velocity U* = U/15

Constant in equation for diffusion coefficient	Transverse diffusion coefficient Dz	Width scale of mixing (Sz, m.) at distances specified (x m.) [Sz = (2(Dz)x/U)^0.5] 500	1000	2000	4000	8000	16000
	m2/s	m	m	m	m	m	m
0.8	0.60	15.9	22.5	31.8	45.0	63.7	90.0
0.6	0.45	13.8	19.5	27.6	39.0	55.1	78.0
0.4	0.30	11.3	15.9	22.5	31.8	45.0	63.7

Relative channel width B/Sz
for B = 190 meters

0.8	0.60	11.94	8.44	5.97	4.22	2.98	2.11
0.6	0.45	13.78	9.75	6.89	4.87	3.45	2.44
0.4	0.30	16.88	11.94	8.44	5.97	4.22	2.98

APPENDIX E - RAW DATA FILES

TABLE E.1 - TIME SERIES RAW DATA

BIRCHBANK, COMINCO, AND WANETA: PHOSPHORUS AND METALS
(1978,1979,1981,1983,1984)

NOTES:

1. Composite Samples: The wastewater from Cominco's lead-zinc smelter was discharged via several sewer outfalls. The sewers were sampled using 3 hr composite samples of water quality and flow.

2. Detection Limit: Samples with concentrations less than the detection limit have been plotted and analyzed at the value of the detection limit.

3. Quality Control Data: In the cases where normal data points were missing and quality data were available, the quality control data were added to the data sets used for analyses. If the quality control data were available in replicates, the first data point was used.

4. Replacement of Suspect Data: The suspiciously high zinc value of 0.03 mg/l for Birchbank 1983 was replaced with the quality control value of 0.004 mg/l.

5. Cominco Effluent

   - Transformation: The combined sewer discharge measurements were transformed to equivalent increase in water quality concentration of the Columbia River by dividing the total mass discharge by the mean daily flow of the river. For the 1984 data, the flows reported in the Cominco Report (1985) were used.

   - Missing information: In some cases, the water quality or flow information would be missing from one of the sewers. Rather than guessing at the total discharge, we excluded these data points.

   - Sewer 07, 1983: Constant flow of 734.1 m^3/3hrs recorded for the duration of the data sampling seems unlikely.

NO	YEAR	LOCATION	DATE	TIME	ELAPSED	TP mg/l	TZn mg/l	T Cd mg/l	T Hg µg/l	T Pb mg/l
1	1978	BIRCHBANK	19.09.78	*	*	*	*	*	*	*
2	1978	COMINCO	19.09.78	*	*	*	*	*	*	*
3	1978	WANETA	19.09.78	915	0	0.015	0.050	0.00050	0.05	0.004
4	1978	WANETA	19.09.78	1115	2	0.009	0.050	0.00050	0.05	0.004
5	1978	WANETA	19.09.78	1315	4	0.009	0.050	0.00050	0.05	0.008
6	1978	WANETA	19.09.78	1515	6	0.011	0.050	0.00050	0.05	0.003
7	1978	WANETA	19.09.78	1715	8	0.013	0.040	0.00050	0.05	0.005
8	1978	WANETA	19.09.78	1915	10	0.074	0.030	0.00050	0.05	0.003
9	1978	WANETA	19.09.78	2115	12	0.028	0.030	0.00050	0.05	0.005
10	1978	WANETA	19.09.78	2315	14	0.010	0.030	0.00050	0.05	0.006
11	1978	WANETA	20.09.78	115	16	0.074	0.040	0.00190	0.05	0.007
12	1978	WANETA	20.09.78	315	18	0.054	0.040	0.00050	0.05	0.006
13	1978	WANETA	20.09.78	515	20	0.034	0.040	0.00050	0.05	0.006
14	1978	WANETA	20.09.78	715	22	0.038	0.040	0.00090	0.05	0.007
15	1978	WANETA	20.09.78	915	24	0.196	0.040	0.00050	0.05	0.004
16	1979	BIRCHBANK	17.09.79	1100	0	0.007	*	*	*	*
17	1979	BIRCHBANK	17.09.79	1200	1	0.006	*	*	*	*
18	1979	BIRCHBANK	17.09.79	1300	2	0.006	*	*	*	*
19	1979	BIRCHBANK	17.09.79	1400	3	0.008	*	*	*	*
20	1979	BIRCHBANK	17.09.79	1500	4	0.006	*	*	*	*
21	1979	BIRCHBANK	17.09.79	1600	5	0.006	*	*	*	*
22	1979	BIRCHBANK	17.09.79	1700	6	0.007	*	*	*	*
23	1979	BIRCHBANK	17.09.79	1800	7	0.008	*	*	*	*
24	1979	BIRCHBANK	17.09.79	1900	8	0.012	*	*	*	*
25	1979	BIRCHBANK	17.09.79	2000	9	0.006	*	*	*	*
26	1979	BIRCHBANK	17.09.79	2100	10	0.007	*	*	*	*
27	1979	BIRCHBANK	17.09.79	2200	11	0.007	*	*	*	*
28	1979	BIRCHBANK	17.09.79	2300	12	0.013	*	*	*	*
29	1979	BIRCHBANK	17.09.79	2400	13	0.007	*	*	*	*
30	1979	BIRCHBANK	18.09.79	100	14	0.006	*	*	*	*
31	1979	BIRCHBANK	18.09.79	200	15	0.007	*	*	*	*
32	1979	BIRCHBANK	18.09.79	300	16	0.006	*	*	*	*
33	1979	BIRCHBANK	18.09.79	400	17	0.006	*	*	*	*
34	1979	BIRCHBANK	18.09.79	500	18	0.006	*	*	*	*
35	1979	BIRCHBANK	18.09.79	600	19	0.006	*	*	*	*
36	1979	BIRCHBANK	18.09.79	700	20	0.008	*	*	*	*
37	1979	BIRCHBANK	18.09.79	800	21	0.007	*	*	*	*
38	1979	BIRCHBANK	18.09.79	900	22	0.006	*	*	*	*
39	1979	BIRCHBANK	18.09.79	1000	23	0.006	*	*	*	*
40	1979	BIRCHBANK	18.09.79	1100	24	0.006	*	*	*	*
41	1979	BIRCHBANK	18.09.79	1200	25	0.007	*	*	*	*
42	1979	BIRCHBANK	18.09.79	1300	26	0.006	*	*	*	*
43	1979	BIRCHBANK	18.09.79	1400	27	0.006	*	*	*	*
44	1979	BIRCHBANK	18.09.79	1500	28	0.006	*	*	*	*
45	1979	BIRCHBANK	18.09.79	1600	29	0.006	*	*	*	*
46	1979	BIRCHBANK	18.09.79	1700	30	0.007	*	*	*	*
47	1979	BIRCHBANK	18.09.79	1800	31	0.006	*	*	*	*
48	1979	BIRCHBANK	18.09.79	1900	32	0.009	*	*	*	*

49	1979	BIRCHBANK	18.09.79	2000	33	0.009	*	*	*	*
50	1979	BIRCHBANK	18.09.79	2100	34	0.006	*	*	*	*
51	1979	BIRCHBANK	18.09.79	2200	35	0.006	*	*	*	*
52	1979	BIRCHBANK	18.09.79	2300	36	0.006	*	*	*	*
53	1979	BIRCHBANK	18.09.79	2400	37	0.006	*	*	*	*
54	1979	BIRCHBANK	19.09.79	100	38	0.006	*	*	*	*
55	1979	BIRCHBANK	19.09.79	200	39	0.006	*	*	*	*
56	1979	BIRCHBANK	19.09.79	300	40	0.007	•	*	*	*
57	1979	BIRCHBANK	19.09.79	500	42	0.006	*	*	*	*
58	1979	BIRCHBANK	19.09.79	600	43	0.006	*	*	*	*
59	1979	BIRCHBANK	19.09.79	700	44	0.006	*	*	*	*
60	1979	BIRCHBANK	19.09.79	800	45	0.006	*	*	•	*
61	1979	BIRCHBANK	19.09.79	900	46	0.006	*	*	*	*
62	1979	BIRCHBANK	19.09.79	1000	47	0.008	*	*	*	*
63	1979	BIRCHBANK	19.09.79	1100	48	0.006	*	*	*	*
64	1979	BIRCHBANK	19.09.79	1200	49	0.005	*	*	*	*
65	1979	BIRCHBANK	19.09.79	1300	50	0.004	*	*	*	*
66	1979	BIRCHBANK	19.09.79	1400	51	0.006	*	*	*	*
67	1979	BIRCHBANK	19.09.79	1500	52	0.006	•	*	*	•
68	1979	BIRCHBANK	19.09.79	1600	53	0.006	*	*	*	*
69	1979	BIRCHBANK	19.09.79	1700	54	0.005	*	*	*	*
70	1979	BIRCHBANK	19.09.79	1800	55	0.008	*	*	*	*
71	1979	BIRCHBANK	19.09.79	1900	56	0.009	*	*	*	*
72	1979	BIRCHBANK	19.09.79	2000	57	0.005	*	*	*	•
73	1979	BIRCHBANK	19.09.79	2100	58	0.007	*	*	*	*
74	1979	BIRCHBANK	19.09.79	2200	59	0.004	*	*	*	*
75	1979	BIRCHBANK	19.09.79	2300	60	0.005	*	*	*	*
76	1979	BIRCHBANK	19.09.79	2400	61	0.009	*	*	*	*
77	1979	BIRCHBANK	20.09.79	100	62	0.005	*	*	*	*
78	1979	BIRCHBANK	20.09.79	200	63	0.007	*	*	*	*
79	1979	BIRCHBANK	20.09.79	300	64	0.006	•	*	*	*
80	1979	BIRCHBANK	20.09.79	400	65	0.013	*	*	*	*
81	1979	BIRCHBANK	20.09.79	500	66	0.005	•	*	*	*
82	1979	BIRCHBANK	20.09.79	600	67	0.004	•	*	*	*
83	1979	BIRCHBANK	20.09.79	700	68	0.008	*	*	*	*
84	1979	BIRCHBANK	20.09.79	800	69	0.004	*	•	*	*
85	1979	BIRCHBANK	20.09.79	900	70	0.006	*	*	*	*
86	1979	BIRCHBANK	20.09.79	1000	71	0.004	*	•	*	*
87	1979	COMINCO	*	*	*	*	*	*	*	*
88	1979	WANETA	17.09.79	1100	0	0.117	*	*	*	*
89	1979	WANETA	17.09.79	1200	1	0.186	*	*	*	*
90	1979	WANETA	17.09.79	1300	2	0.118	*	*	*	*
91	1979	WANETA	17.09.79	1400	3	0.064	*	*	*	*
92	1979	WANETA	17.09.79	1500	4	0.054	*	*	*	*
93	1979	WANETA	17.09.79	1600	5	0.047	*	*	*	*
94	1979	WANETA	17.09.79	1700	6	0.059	*	*	*	*
95	1979	WANETA	17.09.79	1800	7	0.06	*	*	*	*
96	1979	WANETA	17.09.79	1900	8	0.066	•	*	*	*
97	1979	WANETA	17.09.79	2000	9	0.047	•	*	*	*
98	1979	WANETA	17.09.79	2100	10	0.048	*	*	*	*

99	1979	WANETA	17.09.79	2200	11	0.053	*	•	*	•
100	1979	WANETA	17.09.79	2300	12	0.06	*	*	•	*
101	1979	WANETA	17.09.79	2400	13	0.051	*	*	*	•
102	1979	WANETA	18.09.79	100	14	0.064	*	*	*	*
103	1979	WANETA	18.09.79	200	15	0.071	*	•	*	*
104	1979	WANETA	18.09.79	300	16	0.071	*	*	*	•
105	1979	WANETA	18.09.79	400	17	0.077	*	*	*	*
106	1979	WANETA	18.09.79	500	18	0.078	*	•	•	•
107	1979	WANETA	18.09.79	600	19	0.108	*	•	*	*
108	1979	WANETA	18.09.79	700	20	0.086	*	•	*	*
109	1979	WANETA	18.09.79	800	21	0.096	*	*	*	•
110	1979	WANETA	18.09.79	900	22	0.121	*	*	*	*
111	1979	WANETA	18.09.79	1000	23	0.094	•	•	•	*
112	1979	WANETA	18.09.79	1100	24	0.099	*	•	•	•
113	1979	WANETA	18.09.79	1200	25	0.062	*	*	*	*
114	1979	WANETA	18.09.79	1300	26	0.075	*	*	*	•
115	1979	WANETA	18.09.79	1400	27	0.047	*	*	*	*
116	1979	WANETA	18.09.79	1500	28	0.054	*	*	*	•
117	1979	WANETA	18.09.79	1600	29	0.042	*	*	*	*
118	1979	WANETA	18.09.79	1700	30	0.033	•	•	•	•
119	1979	WANETA	18.09.79	1800	31	0.028	*	*	*	*
120	1979	WANETA	18.09.79	1900	32	0.039	*	*	*	*
121	1979	WANETA	18.09.79	2000	33	0.038	•	•	*	•
122	1979	WANETA	18.09.79	2100	34	0.097	•	*	*	*
123	1979	WANETA	18.09.79	2200	35	0.044	*	*	*	*
124	1979	WANETA	18.09.79	2300	36	0.098	*	*	*	*
125	1979	WANETA	18.09.79	2400	37	0.087	*	*	*	*
126	1979	WANETA	19.09.79	100	38	0.061	*	*	*	*
127	1979	WANETA	19.09.79	200	39	0.089	*	*	*	*
128	1979	WANETA	19.09.79	300	40	0.092	*	*	*	•
129	1979	WANETA	19.09.79	400	41	0.079	*	*	*	*
130	1979	WANETA	19.09.79	500	42	0.063	*	•	*	*
131	1979	WANETA	19.09.79	600	43	0.067	*	*	•	*
132	1979	WANETA	19.09.79	700	44	0.051	*	•	*	*
133	1979	WANETA	19.09.79	800	45	0.043	*	*	*	•
134	1979	WANETA	19.09.79	900	46	0.047	•	•	*	*
135	1979	WANETA	19.09.79	1000	47	0.057	*	*	*	•
136	1979	WANETA	19.09.79	1100	48	0.077	*	•	*	*
137	1979	WANETA	19.09.79	1200	49	0.072	*	*	•	*
138	1979	WANETA	19.09.79	1300	50	0.095	*	*	•	*
139	1979	WANETA	19.09.79	1400	51	0.059	•	*	*	*
140	1979	WANETA	19.09.79	1500	52	0.062	*	•	•	*
141	1979	WANETA	19.09.79	1600	53	0.056	*	*	*	*
142	1979	WANETA	19.09.79	1700	54	0.056	*	*	*	*
143	1979	WANETA	19.09.79	1800	55	0.069	*	*	*	*
144	1979	WANETA	19.09.79	1900	56	0.115	*	*	*	*
145	1979	WANETA	19.09.79	2000	57	0.131	*	*	*	*
146	1979	WANETA	19.09.79	2100	58	0.102	*	*	*	*
147	1979	WANETA	19.09.79	2200	59	0.108	*	*	*	*
148	1979	WANETA	19.09.79	2300	60	0.227	*	*	*	*

149	1979	WANETA	19.09.79	2400	61	0.134	*	*	*	*
150	1979	WANETA	20.09.79	100	62	0.135	*	*	*	*
151	1979	WANETA	20.09.79	200	63	0.119	*	*	*	*
152	1979	WANETA	20.09.79	300	64	0.089	*	*	*	*
153	1979	WANETA	20.09.79	400	65	0.072	*	*	*	*
154	1979	WANETA	20.09.79	500	66	0.068	*	*	*	*
155	1979	WANETA	20.09.79	600	67	0.082	*	*	*	*
156	1979	WANETA	20.09.79	700	68	0.060	*	*	*	*
157	1979	WANETA	20.09.79	800	69	0.049	*	*	*	*
158	1979	WANETA	20.09.79	900	70	0.158	*	*	*	*
159	1979	WANETA	20.09.79	1000	71	0.184	*	*	*	*
160	1981	BIRCHBANK	12.05.81	900	0	*	0.002	0.0024	0.05	0.001
161	1981	BIRCHBANK	12.05.81	1000	1	*	0.003	0.0011	0.05	0.001
162	1981	BIRCHBANK	12.05.81	1100	2	*	0.001	0.0007	0.05	0.001
163	1981	BIRCHBANK	12.05.81	1200	3	*	0.002	0.0011	0.05	0.004
164	1981	BIRCHBANK	12.05.81	1300	4	*	0.002	0.0005	0.05	0.001
165	1981	BIRCHBANK	12.05.81	1400	5	*	0.001	0.0005	0.05	0.002
166	1981	BIRCHBANK	12.05.81	1500	6	*	0.001	0.0013	0.05	0.001
167	1981	BIRCHBANK	12.05.81	1600	7	*	0.001	0.0008	0.05	0.001
168	1981	BIRCHBANK	12.05.81	1700	8	*	0.001	0.0008	0.05	0.001
169	1981	BIRCHBANK	12.05.81	1800	9	*	0.003	0.0006	0.05	0.001
170	1981	BIRCHBANK	12.05.81	1900	10	*	0.003	0.0005	0.05	0.001
171	1981	BIRCHBANK	12.05.81	2000	11	*	0.003	0.0005	0.05	0.001
172	1981	BIRCHBANK	12.05.81	2100	12	*	0.002	0.0005	0.05	0.001
173	1981	BIRCHBANK	12.05.81	2200	13	*	0.004	0.0005	0.05	0.001
174	1981	BIRCHBANK	12.05.81	2300	14	*	0.003	0.0005	0.05	0.001
175	1981	BIRCHBANK	12.05.81	2400	15	*	0.001	0.0005	0.05	0.001
176	1981	BIRCHBANK	13.05.81	100	16	*	0.003	0.0006	0.05	0.002
177	1981	BIRCHBANK	13.05.81	200	17	*	0.004	0.0005	0.05	0.001
178	1981	BIRCHBANK	13.05.81	300	18	*	0.003	0.0005	0.05	0.001
179	1981	BIRCHBANK	13.05.81	400	19	*	0.005	0.0008	0.05	0.001
180	1981	BIRCHBANK	13.05.81	500	20	*	0.002	0.0005	0.05	0.001
181	1981	BIRCHBANK	13.05.81	600	21	*	0.004	0.0005	0.05	0.001
182	1981	BIRCHBANK	13.05.81	700	22	*	0.002	0.0005	0.05	0.001
183	1981	BIRCHBANK	13.05.81	900	24	*	0.003	0.0005	0.05	0.001
184	1981	BIRCHBANK	13.05.81	1000	25	*	0.003	0.0005	0.05	0.001
185	1981	BIRCHBANK	13.05.81	1100	26	*	0.004	0.0005	0.05	0.001
186	1981	BIRCHBANK	13.05.81	1200	27	*	0.003	0.0008	0.05	0.001
187	1981	BIRCHBANK	13.05.81	1300	28	*	0.004	0.0005	0.05	0.001
188	1981	BIRCHBANK	13.05.81	1400	29	*	0.003	0.0005	0.05	0.001
189	1981	BIRCHBANK	13.05.81	1500	30	*	0.001	0.0005	0.05	0.001
190	1981	BIRCHBANK	13.05.81	1600	31	*	0.003	0.0005	0.05	0.001
191	1981	BIRCHBANK	13.05.81	1700	32	*	0.002	0.0005	0.05	0.002
192	1981	BIRCHBANK	13.05.81	1800	33	*	0.002	0.0005	0.05	0.001
193	1981	BIRCHBANK	13.05.81	1900	34	*	0.002	0.0005	0.05	0.001
194	1981	BIRCHBANK	13.05.81	2000	35	*	0.003	0.0005	0.05	0.001
195	1981	BIRCHBANK	13.05.81	2100	36	*	0.003	0.0005	0.05	0.001
196	1981	BIRCHBANK	13.05.81	2200	37	*	0.004	0.0006	0.05	0.001
197	1981	BIRCHBANK	13.05.81	2300	38	*	0.002	0.0005	0.05	0.001
198	1981	BIRCHBANK	13.05.81	2400	39	*	0.003	0.0005	0.05	0.001

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199	1981	BIRCHBANK	14.05.81	100	40	*	0.002	0.0005	0.05	0.001
200	1981	BIRCHBANK	14.05.81	200	41	*	0.005	0.0005	0.05	0.001
201	1981	BIRCHBANK	14.05.81	300	42	*	0.003	0.0005	0.05	0.001
202	1981	BIRCHBANK	14.05.81	400	43	*	0.003	0.0005	0.05	0.001
203	1981	BIRCHBANK	14.05.81	500	44	*	0.001	0.0005	0.05	0.002
204	1981	BIRCHBANK	14.05.81	600	45	•	0.007	0.0005	0.05	0.001
205	1981	BIRCHBANK	14.05.81	700	46	•	0.001	0.0005	0.05	0.001
206	1981	BIRCHBANK	14.05.81	800	47	*	0.002	0.0005	0.05	0.001
207	1981	BIRCHBANK	14.05.81	900	48	*	0.002	0.0005	0.05	0.001
208	1981	BIRCHBANK	14.05.81	1000	49	•	0.001	0.0005	0.05	0.001
209	1981	BIRCHBANK	14.05.81	1100	50	•	0.004	0.0005	0.05	0.001
210	1981	BIRCHBANK	14.05.81	1200	51	*	0.005	0.0005	0.05	0.005
211	1981	BIRCHBANK	14.05.81	1300	52	*	0.004	0.0005	0.05	0.002
212	1981	BIRCHBANK	14.05.81	1400	53	•	0.001	0.0005	0.05	0.002
213	1981	BIRCHBANK	14.05.81	1500	54	•	0.001	0.0005	0.05	0.004
214	1981	BIRCHBANK	14.05.81	1600	55	•	0.003	0.0005	0.05	0.001
215	1981	BIRCHBANK	14.05.81	1700	56	*	0.001	0.0005	0.05	0.001
216	1981	BIRCHBANK	14.05.81	1800	57	*	0.003	0.0005	0.05	0.002
217	1981	BIRCHBANK	14.05.81	1900	58	•	0.001	0.0005	0.05	0.001
218	1981	BIRCHBANK	14.05.81	2000	59	*	0.002	0.0005	0.05	0.001
219	1981	BIRCHBANK	14.05.81	2100	60	*	0.002	0.0005	0.05	0.001
220	1981	BIRCHBANK	14.05.81	2200	61	*	0.003	0.0005	0.17	0.001
221	1981	BIRCHBANK	14.05.81	2300	62	*	0.002	0.0005	0.05	0.001
222	1981	BIRCHBANK	14.05.81	2400	63	*	0.002	0.0005	0.05	0.001
223	1981	BIRCHBANK	15.05.81	100	64	•	0.001	0.0005	0.05	0.001
224	1981	BIRCHBANK	15.05.81	200	65	*	0.001	0.0005	0.05	0.001
225	1981	BIRCHBANK	15.05.81	300	66	*	0.003	0.0005	0.05	0.001
226	1981	BIRCHBANK	15.05.81	400	67	•	0.002	0.0005	0.05	0.001
227	1981	BIRCHBANK	15.05.81	500	68	*	0.002	0.0005	0.05	0.001
228	1981	BIRCHBANK	15.05.81	600	69	*	0.001	0.0005	0.05	0.001
229	1981	BIRCHBANK	15.05.81	700	70	*	0.001	0.0005	0.05	0.001
230	1981	BIRCHBANK	15.05.81	800	71	•	0.002	0.0005	0.05	0.001
231	1981	BIRCHBANK	15.05.81	900	72	*	0.001	0.0005	0.05	0.001
232	1981	COMINCO	12.05.81	1030	1.5	•	*	•	*	*
233	1981	COMINCO	12.05.81	1330	4.5	*	0.0303	0.0004	0.0034	0.0059
234	1981	COMINCO	12.05.81	1630	7.5	*	*	•	*	*
235	1981	COMINCO	12.05.81	1930	10.5	*	0.0284	0.0003	0.0052	0.0021
236	1981	COMINCO	12.05.81	2230	13.5	*	0.0353	0.0006	*	0.0019
237	1981	COMINCO	13.05.81	130	16.5	•	•	*	*	•
238	1981	COMINCO	13.05.81	430	19.5	*	0.0351	0.0005	0.0059	0.0028
239	1981	COMINCO	13.05.81	730	22.5	*	0.0382	0.0008	0.0134	0.0050
240	1981	COMINCO	13.05.81	1030	25.5	•	0.0260	0.0005	0.0113	0.0101
241	1981	COMINCO	13.05.81	1330	28.5	*	0.0197	0.0004	0.0084	0.0078
242	1981	COMINCO	13.05.81	1630	31.5	*	0.0140	0.0004	0.0098	0.0043
243	1981	COMINCO	13.05.81	1930	34.5	*	0.0128	0.0005	0.0074	0.0034
244	1981	COMINCO	13.05.81	2230	37.5	*	0.0151	0.0004	0.0097	0.0020
245	1981	COMINCO	14.05.81	130	40.5	*	0.0133	0.0004	0.0099	0.0013
246	1981	COMINCO	14.05.81	430	43.5	*	0.0145	0.0004	0.0067	0.0015
247	1981	COMINCO	14.05.81	730	46.5	*	0.0164	0.0004	0.0207	0.0039
248	1981	COMINCO	14.05.81	1030	49.5	*	0.0319	0.0011	0.0363	0.0110

249	1981	COMINCO	14.05.81	1330	52.5	*	0.0437	0.0005	0.0068	0.0034
250	1981	COMINCO	14.05.81	1630	55.5	*	0.0358	0.0002	0.0061	0.0043
251	1981	COMINCO	14.05.81	1930	58.5	*	0.0188	0.0003	0.0062	0.0016
252	1981	COMINCO	14.05.81	2230	61.5	*	0.0167	0.0003	0.0073	0.0028
253	1981	COMINCO	15.05.81	130	64.5	*	0.0980	0.0007	0.0205	0.0109
254	1981	COMINCO	15.05.81	430	67.5	•	0.1376	0.0008	0.0102	0.0087
255	1981	COMINCO	15.05.81	730	70.5	*	0.0607	0.0009	0.0073	0.0072
256	1981	WANETA	12.05.81	922	0.37	*	0.018	0.0009	0.05	0.003
257	1981	WANETA	12.05.81	1001	1.02	*	0.04	0.0008	0.3	0.004
258	1981	WANETA	12.05.81	1100	2	*	0.026	0.0005	0.05	0.002
259	1981	WANETA	12.05.81	1200	3	*	0.020	0.0005	0.05	0.002
260	1981	WANETA	12.05.81	1300	4	•	0.016	0.0005	0.05	0.001
261	1981	WANETA	12.05.81	1400	5	•	0.05	0.0005	0.05	0.004
262	1981	WANETA	12.05.81	1500	6	*	0.04	0.0005	0.05	0.003
263	1981	WANETA	12.05.81	1600	7	*	0.04	0.0005	0.05	0.004
264	1981	WANETA	12.05.81	1700	8	*	0.028	0.0005	0.05	0.005
265	1981	WANETA	12.05.81	1800	9	*	0.019	0.0005	0.05	0.002
266	1981	WANETA	12.05.81	1900	10	*	0.021	0.0005	0.05	0.005
267	1981	WANETA	12.05.81	2000	11	*	0.030	0.0005	0.05	0.005
268	1981	WANETA	12.05.81	2100	12	*	0.023	0.0005	0.05	0.002
269	1981	WANETA	12.05.81	2200	13	•	0.023	0.0006	0.05	0.003
270	1981	WANETA	12.05.81	2300	14	*	0.022	0.0005	0.05	0.002
271	1981	WANETA	12.05.81	2400	15	*	0.031	0.0007	0.05	0.002
272	1981	WANETA	13.05.81	100	16	•	0.04	0.0005	0.05	0.003
273	1981	WANETA	13.05.81	200	17	*	0.04	0.0007	0.05	0.001
274	1981	WANETA	13.05.81	300	18	*	0.04	0.0007	0.05	0.006
275	1981	WANETA	13.05.81	400	19	*	0.07	0.0009	0.05	0.011
276	1981	WANETA	13.05.81	500	20	*	0.05	0.0007	0.05	0.012
277	1981	WANETA	13.05.81	600	21	*	0.04	0.0005	0.05	0.005
278	1981	WANETA	13.05.81	700	22	*	0.030	0.0005	0.05	0.006
279	1981	WANETA	13.05.81	800	23	*	0.025	0.0005	0.05	0.005
280	1981	WANETA	13.05.81	900	24	*	0.024	0.0005	0.05	0.001
281	1981	WANETA	13.05.81	1000	25	*	0.027	0.0005	0.05	0.002
282	1981	WANETA	13.05.81	1100	26	*	0.032	0.0005	0.05	0.004
283	1981	WANETA	13.05.81	1200	27	*	0.023	0.0008	0.05	0.001
284	1981	WANETA	13.05.81	1225	27.42	*	0.019	0.0005	0.05	0.001
285	1981	WANETA	13.05.81	1300	28	*	0.019	0.0006	0.05	0.005
286	1981	WANETA	13.05.81	1400	29	*	0.029	0.0007	0.05	0.006
287	1981	WANETA	13.05.81	1500	30	*	0.036	0.0007	0.05	0.010
288	1981	WANETA	13.05.81	1600	31	*	0.013	0.0005	0.05	0.009
289	1981	WANETA	13.05.81	1700	32	*	0.024	0.0007	0.05	0.009
290	1981	WANETA	13.05.81	1800	33	*	0.032	0.0007	0.05	0.010
291	1981	WANETA	13.05.81	2100	36	•	0.023	0.0007	0.05	0.005
292	1981	WANETA	13.05.81	2200	37	*	0.023	0.0006	0.05	0.004
293	1981	WANETA	13.05.81	2325	38.42	*	0.029	0.0007	0.05	0.008
294	1981	WANETA	14.05.81	25	39.42	*	0.020	0.0005	0.05	0.008
295	1981	WANETA	14.05.81	125	40.42	*	0.028	0.0005	0.05	0.005
296	1981	WANETA	14.05.81	225	41.42	*	0.028	0.0005	0.05	0.005
297	1981	WANETA	14.05.81	325	42.42	*	0.014	0.0005	0.05	0.005
298	1981	WANETA	14.05.81	425	43.42	*	0.023	0.0005	0.05	0.005

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299	1981	WANETA	14.05.81	525	44.42	*	0.020	0.0005	0.05	0.004
300	1981	WANETA	14.05.81	625	45.42	*	0.020	0.0005	0.05	0.004
301	1981	WANETA	14.05.81	725	46.42	*	0.024	0.0006	0.05	0.002
302	1981	WANETA	14.05.81	825	47.42	*	0.018	0.0007	0.05	0.005
303	1981	WANETA	14.05.81	900	48	*	0.020	0.0005	0.05	0.004
304	1981	WANETA	14.05.81	1000	49	*	0.031	0.0007	0.05	0.007
305	1981	WANETA	14.05.81	1100	50	*	0.022	0.0005	0.05	0.004
306	1981	WANETA	14.05.81	1200	51	*	0.021	0.0005	0.05	0.006
307	1981	WANETA	14.05.81	1300	52	*	0.014	0.0005	0.05	0.001
308	1981	WANETA	14.05.81	1400	53	*	0.025	0.0008	0.05	0.010
309	1981	WANETA	14.05.81	1500	54	*	0.026	0.0005	0.05	0.008
310	1981	WANETA	14.05.81	1600	55	*	0.021	0.0005	0.05	0.005
311	1981	WANETA	14.05.81	1700	56	*	0.041	0.0005	0.05	0.002
312	1981	WANETA	14.05.81	1800	57	*	0.036	0.0005	0.05	0.008
313	1981	WANETA	14.05.81	1900	58	*	0.025	0.0005	0.05	0.003
314	1981	WANETA	14.05.81	2000	59	*	0.020	0.0005	0.05	0.002
315	1981	WANETA	15.05.81	800	71	*	0.06	0.0007	0.05	0.010
316	1981	WANETA	15.05.81	900	72	*	0.06	0.0005	0.05	0.010
317	1983	BIRCHBANK	17.10.83	2100	12	*	0.003	0.028	*	0.002
318	1983	BIRCHBANK	17.10.83	2200	13	*	0.002	0.0035	*	0.003
319	1983	BIRCHBANK	17.10.83	2300	14	*	0.002	0.0006	0.05	0.001
320	1983	BIRCHBANK	17.10.83	2400	15	*	0.003	0.0005	*	0.003
321	1983	BIRCHBANK	18.10.83	100	16	*	0.004	0.025	*	0.002
322	1983	BIRCHBANK	18.10.83	200	17	*	0.001	0.0005	*	0.003
323	1983	BIRCHBANK	18.10.83	300	18	*	0.002	0.0005	*	0.003
324	1983	BIRCHBANK	18.10.83	400	19	*	0.003	0.0005	*	0.003
325	1983	BIRCHBANK	18.10.83	500	20	*	0.002	0.0005	*	0.003
326	1983	BIRCHBANK	18.10.83	600	21	*	0.003	0.0005	*	0.001
327	1983	BIRCHBANK	18.10.83	700	22	*	0.004	0.0005	*	0.003
328	1983	BIRCHBANK	18.10.83	800	23	*	0.003	0.0005	*	0.003
329	1983	BIRCHBANK	18.10.83	900	24	*	0.003	0.0005	0.05	0.001
330	1983	BIRCHBANK	18.10.83	1000	25	*	0.004	0.0005	*	0.002
331	1983	BIRCHBANK	18.10.83	1100	26	*	0.002	0.0005	*	0.002
332	1983	BIRCHBANK	18.10.83	1200	27	*	0.003	0.0032	*	0.004
333	1983	BIRCHBANK	18.10.83	1300	28	*	0.002	0.0005	0.05	0.004
334	1983	BIRCHBANK	18.10.83	1400	29	*	0.002	0.0005	*	0.007
335	1983	BIRCHBANK	18.10.83	1500	30	*	0.002	0.0005	*	0.003
336	1983	BIRCHBANK	18.10.83	1600	31	*	0.002	0.0005	*	0.004
337	1983	BIRCHBANK	18.10.83	1700	32	*	0.002	0.0005	*	0.004
338	1983	BIRCHBANK	18.10.83	1800	33	*	0.002	0.0005	*	0.004
339	1983	BIRCHBANK	18.10.83	1900	34	*	0.003	0.0013	0.05	0.004
340	1983	BIRCHBANK	18.10.83	2000	35	*	0.003	0.0005	*	0.007
341	1983	BIRCHBANK	18.10.83	2100	36	*	0.001	0.0005	*	0.005
342	1983	BIRCHBANK	18.10.83	2200	37	*	0.002	0.0008	*	0.004
343	1983	BIRCHBANK	18.10.83	2300	38	*	0.002	0.0005	*	0.005
344	1983	BIRCHBANK	18.10.83	2400	39	*	0.002	0.0005	0.05	0.004
345	1983	BIRCHBANK	19.10.83	100	40	*	0.002	0.0005	*	0.004
346	1983	BIRCHBANK	19.10.83	300	42	*	0.002	0.0005	*	0.004
347	1983	BIRCHBANK	19.10.83	400	43	*	0.003	0.0005	*	0.005
348	1983	BIRCHBANK	19.10.83	500	44	*	0.003	0.0005	*	0.005

349	1983	BIRCHBANK	19.10.83	600	45	*	0.003	0.0005	•	0.005
350	1983	BIRCHBANK	19.10.83	700	46	•	0.002	0.0005	•	0.005
351	1983	BIRCHBANK	19.10.83	900	48	*	0.002	0.0005	0.05	0.004
352	1983	BIRCHBANK	19.10.83	1000	49	•	0.003	0.0005	•	0.006
353	1983	BIRCHBANK	19.10.83	1200	51	•	0.005	0.0005	*	0.004
354	1983	BIRCHBANK	19.10.83	1300	52	•	0.005	0.0005	•	0.004
355	1983	BIRCHBANK	19.10.83	1400	53	*	0.007	0.0005	*	0.004
356	1983	BIRCHBANK	19.10.83	1500	54	*	0.006	0.0005	*	0.004
357	1983	BIRCHBANK	19.10.83	1600	55	*	0.005	0.0005	0.05	0.003
358	1983	BIRCHBANK	19.10.83	1700	56	*	0.005	0.0005	*	0.004
359	1983	BIRCHBANK	19.10.83	1800	57	*	0.007	0.0005	*	0.004
360	1983	BIRCHBANK	19.10.83	1900	58	*	0.005	0.0005	•	0.003
361	1983	BIRCHBANK	19.10.83	2000	59	*	0.004	0.0005	0.05	0.003
362	1983	BIRCHBANK	19.10.83	2100	60	*	0.005	0.0005	*	0.003
363	1983	BIRCHBANK	19.10.83	2200	61	*	0.005	0.0027	*	0.005
364	1983	BIRCHBANK	19.10.83	2300	62	*	0.005	0.0008	*	0.003
365	1983	BIRCHBANK	19.10.83	2400	63	*	0.005	0.0005	*	0.003
366	1983	BIRCHBANK	20.10.83	100	64	*	0.005	0.0005	*	0.002
367	1983	BIRCHBANK	20.10.83	200	65	*	0.005	0.0035	*	0.002
368	1983	BIRCHBANK	20.10.83	300	66	*	0.004	0.0006	*	0.002
369	1983	BIRCHBANK	20.10.83	400	67	*	0.002	0.0005	0.05	0.002
370	1983	BIRCHBANK	20.10.83	500	68	*	0.003	0.0005	*	0.003
371	1983	BIRCHBANK	20.10.83	600	69	*	0.002	0.0005	*	0.002
372	1983	BIRCHBANK	20.10.83	700	70	*	0.003	0.0005	*	0.002
373	1983	BIRCHBANK	20.10.83	800	71	*	0.004	0.0005	*	0.002
374	1983	BIRCHBANK	20.10.83	900	72	*	0.004	0.0005	*	0.003
375	1983	BIRCHBANK	20.10.83	1000	73	*	0.003	0.0005	*	0.002
376	1983	BIRCHBANK	20.10.83	1100	74	*	0.004	0.0005	0.05	0.002
377	1983	BIRCHBANK	20.10.83	1200	75	*	0.005	0.0005	•	0.002
378	1983	BIRCHBANK	20.10.83	1300	76	*	0.008	0.001	*	0.003
379	1983	BIRCHBANK	20.10.83	1400	77	*	0.008	0.001	*	0.003
380	1983	BIRCHBANK	20.10.83	1500	78	*	0.010	0.001	*	0.003
381	1983	BIRCHBANK	20.10.83	1600	79	*	0.001	0.001	0.05	0.001
382	1983	BIRCHBANK	20.10.83	1800	81	*	0.006	0.001	*	0.001
383	1983	BIRCHBANK	20.10.83	1900	82	•	0.005	0.001	*	0.002
384	1983	BIRCHBANK	20.10.83	2000	83	*	0.004	0.001	*	0.001
385	1983	BIRCHBANK	20.10.83	2100	84	*	0.006	0.001	*	0.002
386	1983	COMINCO	17.10.83	1030	1.5	•	*	*	*	•
387	1983	COMINCO	17.10.83	1330	4.5	*	0.0211	0.00046	0.0219	0.0062
388	1983	COMINCO	17.10.83	1630	7.5	*	0.0205	0.00049	0.0262	0.0061
389	1983	COMINCO	17.10.83	1930	10.5	•	0.0117	0.00017	0.0073	0.0015
390	1983	COMINCO	17.10.83	2230	13.5	*	0.0082	0.00008	0.0068	0.0009
391	1983	COMINCO	18.10.83	130	16.5	•	0.0077	0.00011	0.0074	0.0015
392	1983	COMINCO	18.10.83	430	19.5	*	0.0100	0.00023	0.0097	0.0024
393	1983	COMINCO	18.10.83	730	22.5	*	0.0082	0.00011	0.0078	0.0014
394	1983	COMINCO	18.10.83	1030	25.5	•	0.0103	0.00032	0.0103	0.0074
395	1983	COMINCO	18.10.83	1330	28.5	*	0.0162	0.00047	0.0109	0.0124
396	1983	COMINCO	18.10.83	1630	31.5	*	0.0116	0.00013	0.0047	0.0020
397	1983	COMINCO	18.10.83	1930	34.5	*	0.0087	0.00013	0.0047	0.0011
398	1983	COMINCO	18.10.83	2230	37.5	*	0.0110	0.00011	0.0115	0.0012

399	1983	COMINCO	19.10.83	130	40.5	*	0.0118	0.00011	0.0083	0.0010
400	1983	COMINCO	19.10.83	430	43.5	*	0.0183	0.00013	0.0123	0.0014
401	1983	COMINCO	19.10.83	730	46.5	*	0.0131	0.00016	0.0157	0.0023
402	1983	COMINCO	19.10.83	1030	49.5	*	0.0110	0.00024	0.0193	0.0036
403	1983	COMINCO	19.10.83	1330	52.5	*	0.0115	0.00027	0.0225	0.0065
404	1983	COMINCO	19.10.83	1630	55.5	*	0.0118	0.00019	0.0143	0.0026
405	1983	COMINCO	19.10.83	1930	58.5	*	0.0147	0.00020	0.0093	0.0021
406	1983	COMINCO	19.10.83	2230	61.5	*	0.0193	0.00027	0.0098	0.0023
407	1983	COMINCO	20.10.83	130	64.5	*	*	*	*	*
408	1983	COMINCO	20.10.83	430	67.5	*	0.0102	0.00015	0.0079	0.0012
409	1983	COMINCO	20.10.83	730	70.5	*	0.0102	0.00013	0.0121	0.0020
410	1983	COMINCO	20.10.83	1030	73.5	*	*	*	*	*
411	1983	COMINCO	20.10.83	1330	76.5	*	*	*	*	*
412	1983	COMINCO	20.10.83	1630	79.5	*	0.0072	0.00008	0.0126	0.0012
413	1983	COMINCO	20.10.83	1930	82.5	*	0.0086	0.00008	0.0093	0.0011
414	1983	WANETA	17.10.83	2200	13	*	0.061	0.001	*	0.009
415	1983	WANETA	17.10.83	2300	14	*	0.029	0.001	*	0.005
416	1983	WANETA	17.10.83	2400	15	*	0.022	0.001	*	0.004
417	1983	WANETA	18.10.83	200	17	*	0.04	0.001	0.05	0.013
418	1983	WANETA	18.10.83	300	18	*	0.029	0.001	*	0.007
419	1983	WANETA	18.10.83	400	19	*	0.023	0.001	*	0.005
420	1983	WANETA	18.10.83	500	20	*	0.303	0.012	*	0.056
421	1983	WANETA	18.10.83	600	21	*	0.22	0.008	*	0.041
422	1983	WANETA	18.10.83	700	22	*	0.062	0.001	*	0.005
423	1983	WANETA	18.10.83	800	23	*	0.019	0.001	*	0.006
424	1983	WANETA	18.10.83	1102	26.03	*	0.020	0.001	0.05	0.007
425	1983	WANETA	18.10.83	1200	27	*	0.029	0.001	*	0.007
426	1983	WANETA	18.10.83	1300	28	*	0.036	0.001	*	0.008
427	1983	WANETA	18.10.83	1400	29	*	0.016	0.001	*	0.008
428	1983	WANETA	18.10.83	1500	30	*	0.017	0.001	*	0.009
429	1983	WANETA	18.10.83	1600	31	*	0.084	0.001	*	0.012
430	1983	WANETA	18.10.83	1700	32	*	0.032	0.001	0.05	0.013
431	1983	WANETA	18.10.83	1800	33	*	0.027	0.01	*	0.017
432	1983	WANETA	18.10.83	1900	34	*	0.023	0.001	*	0.012
433	1983	WANETA	18.10.83	2000	35	*	0.025	0.002	*	0.009
434	1983	WANETA	18.10.83	2100	36	*	0.019	0.002	*	0.007
435	1983	WANETA	18.10.83	2200	37	*	0.022	0.001	0.05	0.008
436	1983	WANETA	18.10.83	2300	38	*	0.019	0.001	*	0.007
437	1983	WANETA	18.10.83	2400	39	*	0.015	0.001	*	0.006
438	1983	WANETA	19.10.83	100	40	*	0.015	0.001	*	0.006
439	1983	WANETA	19.10.83	200	41	*	0.017	0.001	*	0.005
440	1983	WANETA	19.10.83	300	42	*	0.016	0.001	0.05	0.005
441	1983	WANETA	19.10.83	400	43	*	0.027	0.001	*	0.008
442	1983	WANETA	19.10.83	500	44	*	0.024	0.001	*	0.005
443	1983	WANETA	19.10.83	600	45	*	0.075	0.001	*	0.014
444	1983	WANETA	19.10.83	700	46	*	0.090	0.001	*	0.012
445	1983	WANETA	19.10.83	800	47	*	0.049	0.001	*	0.010
446	1983	WANETA	19.10.83	900	48	*	0.039	0.001	*	0.007
447	1983	WANETA	19.10.83	1000	49	*	0.022	0.001	*	0.005
448	1983	WANETA	19.10.83	1100	50	*	0.020	0.001	0.05	0.004

449	1983	WANETA	19.10.83	1200	51	*	0.019	0.001	*	0.005
450	1983	WANETA	19.10.83	1300	52	*	0.021	0.001	*	0.007
451	1983	WANETA	19.10.83	1400	53	*	0.022	0.001	0.05	0.007
452	1983	WANETA	19.10.83	1500	54	*	0.050	0.001	*	0.011
453	1983	WANETA	19.10.83	1600	55	*	0.021	0.001	*	0.008
454	1983	WANETA	19.10.83	1700	56	*	0.015	0.001	*	0.006
455	1983	WANETA	19.10.83	1800	57	*	0.018	0.001	0.05	0.009
456	1983	WANETA	19.10.83	1900	58	*	0.089	0.001	*	0.013
457	1983	WANETA	19.10.83	2000	59	*	0.026	0.001	*	0.008
458	1983	WANETA	19.10.83	2100	60	*	0.021	0.001	*	0.007
459	1983	WANETA	19.10.83	2200	61	*	0.021	0.001	*	0.007
460	1983	WANETA	19.10.83	2300	62	*	0.020	0.001	*	0.006
461	1983	WANETA	19.10.83	2400	63	*	0.034	0.001	*	0.010
462	1983	WANETA	20.10.83	100	64	*	0.028	0.001	0.05	0.007
463	1983	WANETA	20.10.83	200	65	*	0.050	0.001	*	0.011
464	1983	WANETA	20.10.83	700	70	*	0.037	0.001	*	0.006
465	1983	WANETA	20.10.83	800	71	*	0.029	0.001	*	0.008
466	1983	WANETA	20.10.83	900	72	*	0.025	0.001	0.05	0.006
467	1983	WANETA	20.10.83	1000	73	*	0.022	0.001	*	0.005
468	1983	WANETA	20.10.83	1100	74	*	0.024	0.001	*	0.004
469	1983	WANETA	20.10.83	1200	75	*	0.021	0.001	*	0.003
470	1983	WANETA	20.10.83	1300	76	*	0.021	0.001	*	0.004
471	1983	WANETA	20.10.83	1400	77	*	0.026	0.001	0.05	0.010
472	1983	WANETA	20.10.83	1500	78	*	0.064	0.001	*	0.008
473	1983	WANETA	20.10.83	1600	79	*	0.045	0.001	*	0.010
474	1983	WANETA	20.10.83	1700	80	*	0.019	0.001	*	0.008
475	1983	WANETA	20.10.83	1800	81	*	0.044	0.001	*	0.007
476	1983	WANETA	20.10.83	1900	82	*	0.018	0.001	*	0.007
477	1983	WANETA	20.10.83	2000	83	*	0.017	0.001	*	0.007
478	1983	WANETA	20.10.83	2100	84	*	0.032	0.001	*	0.006
479	1983	WANETA	20.10.83	2200	85	*	0.020	0.001	0.05	0.011
480	1983	WANETA	20.10.83	2300	86	*	0.014	0.001	*	0.005
481	1984	BIRCHBANK	26.03.84	1100	3	*	0.007	0.0008	*	0.003
482	1984	BIRCHBANK	26.03.84	1200	4	*	0.002	0.0005	*	0.001
483	1984	BIRCHBANK	26.03.84	1300	5	*	0.003	0.0005	*	0.001
484	1984	BIRCHBANK	26.03.84	1400	6	*	0.005	0.0005	*	0.001
485	1984	BIRCHBANK	26.03.84	1500	7	*	0.004	0.0005	0.05	0.001
486	1984	BIRCHBANK	26.03.84	1600	8	*	0.004	0.0005	*	0.001
487	1984	BIRCHBANK	26.03.84	1700	9	*	0.002	0.0005	*	0.001
488	1984	BIRCHBANK	26.03.84	1800	10	*	0.005	0.0005	*	0.001
489	1984	BIRCHBANK	26.03.84	1900	11	*	0.003	0.0005	*	0.001
490	1984	BIRCHBANK	26.03.84	2000	12	*	0.002	0.0005	*	0.001
491	1984	BIRCHBANK	26.03.84	2200	14	*	0.003	0.0005	0.05	0.001
492	1984	BIRCHBANK	26.03.84	2300	15	*	0.009	0.0005	*	0.001
493	1984	BIRCHBANK	26.03.84	2400	16	*	0.006	0.0005	*	0.001
494	1984	BIRCHBANK	27.03.84	100	17	*	0.003	0.0005	0.05	0.001
495	1984	BIRCHBANK	27.03.84	200	18	*	0.006	0.0014	*	0.002
496	1984	BIRCHBANK	27.03.84	500	21	*	0.005	0.0005	*	0.001
497	1984	BIRCHBANK	27.03.84	600	22	*	0.004	0.0005	*	0.001
498	1984	BIRCHBANK	27.03.84	900	25	*	0.006	0.0008	*	0.004

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499	1984	BIRCHBANK	27.03.84	1000	26	*	0.003	0.0005	*	0.001
500	1984	BIRCHBANK	27.03.84	1100	27	*	0.005	0.0005	*	0.001
501	1984	BIRCHBANK	27.03.84	1200	28	*	0.005	0.0005	*	0.001
502	1984	BIRCHBANK	27.03.84	1300	29	*	0.005	0.0005	0.05	0.001
503	1984	BIRCHBANK	27.03.84	1400	30	*	0.006	0.0005	*	0.001
504	1984	BIRCHBANK	27.03.84	1500	31	*	0.005	0.0005	*	0.003
505	1984	BIRCHBANK	27.03.84	1600	32	*	0.02	0.0005	*	0.004
506	1984	BIRCHBANK	27.03.84	1700	33	*	0.007	0.0005	*	0.006
507	1984	BIRCHBANK	27.03.84	1800	34	*	0.004	0.0005	*	0.002
508	1984	BIRCHBANK	27.03.84	1900	35	*	0.007	0.0005	*	0.002
509	1984	BIRCHBANK	27.03.84	2000	36	*	0.004	0.0005	*	0.006
510	1984	BIRCHBANK	27.03.84	2100	37	*	0.004	0.0005	0.05	0.003
511	1984	BIRCHBANK	27.03.84	2200	38	*	0.003	0.0005	*	0.002
512	1984	BIRCHBANK	27.03.84	2300	39	*	0.004	0.0005	*	0.006
513	1984	BIRCHBANK	28.03.84	100	41	*	0.005	0.0005	0.05	0.003
514	1984	BIRCHBANK	28.03.84	200	42	*	0.005	0.0005	*	0.003
515	1984	BIRCHBANK	28.03.84	300	43	*	0.007	0.0005	*	0.004
516	1984	BIRCHBANK	28.03.84	400	44	*	0.011	0.0005	*	0.005
517	1984	BIRCHBANK	28.03.84	500	45	*	0.008	0.0005	*	0.001
518	1984	BIRCHBANK	28.03.84	600	46	*	0.002	0.0005	0.05	0.001
519	1984	BIRCHBANK	28.03.84	700	47	*	0.005	0.0005	*	0.002
520	1984	BIRCHBANK	28.03.84	800	48	*	0.004	0.0005	*	0.003
521	1984	BIRCHBANK	28.03.84	900	49	*	0.003	0.0055	*	0.003
522	1984	BIRCHBANK	28.03.84	1000	50	*	0.003	0.0005	*	0.004
523	1984	BIRCHBANK	28.03.84	1100	51	*	0.004	0.0009	*	0.005
524	1984	BIRCHBANK	28.03.84	1200	52	*	0.006	0.0008	0.05	0.002
525	1984	BIRCHBANK	28.03.84	1300	53	*	0.04	0.0005	*	0.017
526	1984	BIRCHBANK	28.03.84	1400	54	*	0.014	0.0005	*	0.002
527	1984	BIRCHBANK	28.03.84	1500	55	*	0.003	0.0005	*	0.001
528	1984	BIRCHBANK	28.03.84	1600	56	*	0.012	0.0006	*	0.001
529	1984	BIRCHBANK	28.03.84	1700	57	*	0.007	0.0006	0.05	0.005
530	1984	BIRCHBANK	28.03.84	1800	58	*	0.003	0.0005	*	0.003
531	1984	BIRCHBANK	28.03.84	1900	59	*	0.004	0.0005	*	0.003
532	1984	BIRCHBANK	28.03.84	2000	60	*	0.002	0.0005	*	0.004
533	1984	BIRCHBANK	28.03.84	2100	61	*	0.003	0.0005	*	0.002
534	1984	BIRCHBANK	28.03.84	2200	62	*	0.003	0.0005	*	0.001
535	1984	BIRCHBANK	28.03.84	2300	63	*	0.006	0.0005	*	0.002
536	1984	BIRCHBANK	28.03.84	2400	64	*	0.01	0.0005	*	0.002
537	1984	BIRCHBANK	29.03.84	100	65	*	0.003	0.0005	*	0.001
538	1984	BIRCHBANK	29.03.84	200	66	*	0.01	0.0005	0.05	0.006
539	1984	BIRCHBANK	29.03.84	300	67	*	0.003	0.0005	*	0.001
540	1984	BIRCHBANK	29.03.84	400	68	*	0.003	0.0005	*	0.001
541	1984	BIRCHBANK	29.03.84	500	69	*	0.004	0.0050	*	0.002
542	1984	BIRCHBANK	29.03.84	600	70	*	0.01	0.0005	*	0.001
543	1984	BIRCHBANK	29.03.84	700	71	*	0.004	0.0005	*	0.001
544	1984	BIRCHBANK	29.03.84	800	72	*	0.004	0.0005	*	0.001
545	1984	BIRCHBANK	29.03.84	900	73	*	0.009	0.0005	*	0.001
546	1984	BIRCHBANK	29.03.84	1000	74	*	0.003	0.0005	0.05	0.001
547	1984	BIRCHBANK	29.03.84	1100	75	*	0.005	0.0005	*	0.002
548	1984	BIRCHBANK	29.03.84	1200	76	*	0.005	0.0005	*	0.002

549	1984	BIRCHBANK	29.03.84	1300	77	*	0.006	0.0005	*	0.001
550	1984	BIRCHBANK	29.03.84	1400	78	*	0.007	0.0010	*	0.001
551	1984	BIRCHBANK	29.03.84	1500	79	*	0.013	0.0006	*	0.001
552	1984	BIRCHBANK	29.03.84	1600	80	•	0.006	0.0005	*	0.001
553	1984	BIRCHBANK	29.03.84	1800	82	•	0.003	0.0005	0.05	0.001
554	1984	BIRCHBANK	29.03.84	1900	83	•	0.004	0.0005	*	0.001
555	1984	BIRCHBANK	29.03.84	2000	84	*	0.013	0.0005	*	0.001
556	1984	BIRCHBANK	29.03.84	2100	85	*	0.003	0.0005	*	0.001
557	1984	BIRCHBANK	29.03.84	2200	86	•	0.005	0.0005	*	0.001
558	1984	BIRCHBANK	29.03.84	2300	87	*	0.005	0.0005	*	0.001
559	1984	BIRCHBANK	29.03.84	2400	88	*	0.004	0.0005	•	0.001
560	1984	BIRCHBANK	30.03.84	100	89	*	0.005	0.0005	*	0.001
561	1984	BIRCHBANK	30.03.84	200	90	•	0.003	0.0005	*	0.001
562	1984	BIRCHBANK	30.03.84	300	91	•	0.003	0.0005	*	0.002
563	1984	BIRCHBANK	30.03.84	400	92	•	0.02	0.0005	*	0.001
564	1984	BIRCHBANK	30.03.84	500	93	•	0.015	0.0005	*	0.001
565	1984	BIRCHBANK	30.03.84	600	94	•	0.014	0.0005	*	0.001
566	1984	BIRCHBANK	30.03.84	700	95	*	0.003	0.0005	*	0.001
567	1984	BIRCHBANK	30.03.84	800	96	*	0.002	0.0005	*	0.001
568	1984	BIRCHBANK	30.03.84	900	97	*	0.002	0.0005	*	0.001
569	1984	COMINCO	26.03.84	800-1800	0	*	0.0272	*	0.0414	•
570	1984	COMINCO	27.03.84	800-1400	24	*	0.0300	*	0.0557	*
571	1984	COMINCO	28.03.84	800-1330	48	*	0.0287	*	0.0766	*
572	1984	COMINCO	29.03.84	800-1300	72	*	0.0701	•	0.1129	*
573	1984	WANETA	26.03.84	1100	3	*	0.04	0.0005	*	0.001
574	1984	WANETA	26.03.84	1200	4	*	0.03	0.0005	0.05	0.001
575	1984	WANETA	26.03.84	1300	5	*	0.03	0.0007	*	0.001
576	1984	WANETA	26.03.84	1400	6	•	0.03	0.0005	*	0.001
577	1984	WANETA	26.03.84	1500	7	*	0.03	0.0013	*	0.007
578	1984	WANETA	26.03.84	1600	8	*	0.03	0.0011	*	0.010
579	1984	WANETA	26.03.84	1700	9	•	0.03	0.0009	*	0.006
580	1984	WANETA	26.03.84	1800	10	*	0.03	0.0014	0.05	0.012
581	1984	WANETA	26.03.84	1900	11	*	0.04	0.0006	*	0.002
582	1984	WANETA	26.03.84	2000	12	*	0.04	0.0006	*	0.002
583	1984	WANETA	26.03.84	2100	13	•	0.03	0.0005	*	0.001
584	1984	WANETA	26.03.84	2200	14	*	0.03	0.0005	*	0.001
585	1984	WANETA	26.03.84	2300	15	*	0.02	0.0005	•	0.001
586	1984	WANETA	26.03.84	2400	16	*	0.02	0.0005	•	0.001
587	1984	WANETA	27.03.84	100	17	*	0.02	0.0005	*	0.001
588	1984	WANETA	27.03.84	200	18	*	0.02	0.0012	*	0.005
589	1984	WANETA	27.03.84	300	19	*	0.02	0.0007	0.05	0.003
590	1984	WANETA	27.03.84	400	20	*	0.02	0.0012	*	0.003
591	1984	WANETA	27.03.84	500	21	*	0.02	0.0011	*	0.003
592	1984	WANETA	27.03.84	600	22	*	0.02	0.0015	*	0.006
593	1984	WANETA	27.03.84	700	23	*	0.03	0.0005	*	0.003
594	1984	WANETA	27.03.84	800	24	•	0.03	0.0005	*	0.004
595	1984	WANETA	27.03.84	900	25	*	0.02	0.0005	0.05	0.001
596	1984	WANETA	27.03.84	1000	26	*	0.03	0.0005	*	0.002
597	1984	WANETA	27.03.84	1100	27	*	0.03	0.046	*	0.006
598	1984	WANETA	27.03.84	1200	28	*	0.02	0.0015	*	0.006

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T Cd mg/l

599	1984	WANETA	27.03.84	1300	29	*	0.02	0.0014	*	0.007
600	1984	WANETA	27.03.84	1400	30	*	0.03	0.0008	*	0.007
601	1984	WANETA	27.03.84	1500	31	*	0.04	0.0009	0.05	0.008
602	1984	WANETA	27.03.84	1600	32	*	0.03	0.0009	*	0.003
603	1984	WANETA	27.03.84	1700	33	*	0.03	0.0005	*	0.004
604	1984	WANETA	27.03.84	1800	34	*	0.03	0.0008	0.05	0.004
605	1984	WANETA	27.03.84	1900	35	*	0.03	0.0006	*	0.005
606	1984	WANETA	27.03.84	2000	36	*	0.03	0.017	*	0.005
607	1984	WANETA	27.03.84	2100	37	*	0.03	0.0018	*	0.005
608	1984	WANETA	27.03.84	2200	38	*	0.02	0.0041	*	0.003
609	1984	WANETA	27.03.84	2300	39	*	0.02	0.0005	0.05	0.004
610	1984	WANETA	27.03.84	2400	40	*	0.017	0.0006	*	0.003
611	1984	WANETA	28.03.84	100	41	*	0.02	0.0019	*	0.004
612	1984	WANETA	28.03.84	200	42	*	0.02	0.0006	*	0.003
613	1984	WANETA	28.03.84	300	43	*	0.02	0.0006	*	0.006
614	1984	WANETA	28.03.84	400	44	*	0.02	0.0008	0.05	0.003
615	1984	WANETA	28.03.84	500	45	*	0.02	0.0005	*	0.003
616	1984	WANETA	28.03.84	900	49	*	0.02	0.0039	0.05	0.003
617	1984	WANETA	28.03.84	1000	50	*	0.02	0.0012	*	0.003
618	1984	WANETA	28.03.84	1100	51	*	0.02	0.0015	*	0.005
619	1984	WANETA	28.03.84	1200	52	*	0.03	0.0014	*	0.005
620	1984	WANETA	28.03.84	1300	53	*	0.03	0.0009	*	0.005
621	1984	WANETA	28.03.84	1400	54	*	0.06	0.0012	*	0.007
622	1984	WANETA	28.03.84	1500	55	*	0.06	0.0008	0.05	0.005
623	1984	WANETA	28.03.84	1600	56	*	0.06	0.0008	*	0.007
624	1984	WANETA	28.03.84	1700	57	*	0.05	0.0014	*	0.008
625	1984	WANETA	28.03.84	1800	58	*	0.04	0.0009	*	0.008
626	1984	WANETA	28.03.84	1900	59	*	0.03	0.0019	*	0.004
627	1984	WANETA	28.03.84	2000	60	*	0.03	0.0008	0.05	0.005
628	1984	WANETA	28.03.84	2100	61	*	0.03	0.0012	*	0.007
629	1984	WANETA	28.03.84	2200	62	*	0.03	0.0008	*	0.003
630	1984	WANETA	28.03.84	2300	63	*	0.03	0.0008	0.05	0.003
631	1984	WANETA	28.03.84	2400	64	*	0.03	0.0018	*	0.012
632	1984	WANETA	29.03.84	100	65	*	0.03	0.0012	*	0.010
633	1984	WANETA	29.03.84	200	66	*	0.02	0.0016	*	0.012
634	1984	WANETA	29.03.84	300	67	*	0.03	0.0013	*	0.011
635	1984	WANETA	29.03.84	400	68	*	0.02	0.0014	0.05	0.006
636	1984	WANETA	29.03.84	500	69	*	0.02	0.0009	*	0.007
637	1984	WANETA	29.03.84	600	70	*	0.03	0.0010	*	0.007
638	1984	WANETA	29.03.84	700	71	*	0.03	0.0009	*	0.004
639	1984	WANETA	29.03.84	800	72	*	0.03	0.0010	*	0.004
640	1984	WANETA	29.03.84	900	73	*	0.03	0.0005	*	0.007
641	1984	WANETA	29.03.84	1000	74	*	0.05	0.0012	*	0.014
642	1984	WANETA	29.03.84	1100	75	*	0.06	0.0010	*	0.010
643	1984	WANETA	29.03.84	1200	76	*	0.07	0.0008	0.05	0.008
644	1984	WANETA	29.03.84	1300	77	*	0.07	0.0009	*	0.011
645	1984	WANETA	29.03.84	1400	78	*	0.07	0.0009	*	0.011
646	1984	WANETA	29.03.84	1500	79	*	0.08	0.0009	*	0.016
647	1984	WANETA	29.03.84	1600	80	*	0.09	0.0010	0.05	0.017
648	1984	WANETA	29.03.84	1700	81	*	0.10	0.0021	*	0.022

								T Cd mg/l		
649	1984	WANETA	29.03.84	1800	82	*	0.10	0.0018	*	0.022
650	1984	WANETA	29.03.84	1900	83	*	0.07	0.0017	•	0.018
651	1984	WANETA	29.03.84	2000	84	*	0.05	0.0012	*	0.014
652	1984	WANETA	29.03.84	2100	85	*	0.04	0.0015	*	0.013
653	1984	WANETA	29.03.84	2200	86	*	0.04	0.0025	•	0.016
654	1984	WANETA	29.03.84	2300	87	*	0.03	0.0013	0.06	0.009
655	1984	WANETA	29.03.84	2400	88	*	0.03	0.0018	*	0.008
656	1984	WANETA	30.03.84	100	89	*	0.03	0.0015	*	0.009
657	1984	WANETA	30.03.84	200	90	*	0.03	0.0012	*	0.010
658	1984	WANETA	30.03.84	300	91	*	0.03	0.0011	*	0.012
659	1984	WANETA	30.03.84	400	92	*	0.03	0.0013	*	0.010
660	1984	WANETA	30.03.84	500	93	*	0.03	0.0013	*	0.008
661	1984	WANETA	30.03.84	600	94	•	0.03	0.0012	*	0.009
662	1984	WANETA	30.03.84	700	95	*	0.03	0.0012	*	0.017
663	1984	WANETA	30.03.84	800	96	•	0.02	0.0011	*	0.007
664	1984	WANETA	30.03.84	900	97	•	0.04	0.0014	*	0.012

TABLE E.2 - SHORT TERM VARIABILITY DATA

WANETA AND PEND D'OREILLE RIVER
APRIL, 1978

NOTES:

1. Normalized data: The raw data were subtracted by the mean for each depth shifting all the data sets to a common reference point with means equal to zero.

2. Treatment (Trt):

   1 = "Quick" = much less than 1 minute between sample collections.

   2 = 1 minute interval between sample collection.

Station	Depth	Trt	TP	NO3	NH4	TN	Fe	Pb	Zn
Waneta	7.6	1	0.006	0.0281	0.0091	0.074	-0.071	0.0021	-0.003
Waneta	7.6	1	-0.002	0.0081	0.0031	0.064	-0.041	0.0011	0.007
Waneta	7.6	1	-0.001	-0.0069	-0.0009	-0.016	0.089	0.0001	-0.003
Waneta	7.6	1	0.002	-0.0159	-0.0009	-0.036	-0.021	-0.0009	-0.003
Waneta	7.6	1	0.000	-0.0129	-0.0079	-0.036	0.049	0.0011	0.007
Waneta	7.6	1	-0.001	0.0221	0.0081	0.034	0.039	0.0001	0.007
Waneta	7.6	1	-0.004	0.0111	-0.0009	-0.006	-0.041	-0.0009	-0.003
Waneta	7.6	1		-0.0099	-0.0079	-0.036	-0.031	-0.0009	-0.003
Waneta	7.6	1		-0.0129	-0.0049	-0.036	0.089	-0.0009	-0.003
Waneta	7.6	1		-0.0109	0.0031	-0.006	-0.061	-0.0009	-0.003
Waneta	6.1	1	-0.005	0.021	0.0142	0.055			
Waneta	6.1	1	0.000	0.011	-0.0048	-0.015			
Waneta	6.1	1	0.005	0.031	0.0682	0.165			
Waneta	6.1	1	0.002	-0.019	-0.0198	-0.055			
Waneta	6.1	1	0.002	0.001	-0.0158	-0.025			
Waneta	6.1	1	-0.001	-0.019	-0.0138	-0.045			
Waneta	6.1	1	0.000	-0.019	-0.0278	-0.065			
Waneta	6.1	1		-0.009	-0.0258	-0.045			
Waneta	6.1	1		-0.009	0.0192	0.015			
Waneta	6.1	1		0.011	0.0062	0.015			
Waneta	4.6	1	-0.001	0.0018	-0.0013	-0.003	0.01	-0.0018	-6.9E-19
Waneta	4.6	1	0.000	-0.0012	-0.0003	-0.003	0.01	0.0002	-6.9E-19
Waneta	4.6	1	0.000	0.0028	0.0047	0.007	0.09	0.0002	0.01
Waneta	4.6	1	0.001	-0.0002	-0.0003	-0.003	8.3E-18	0.0002	-6.9E-19
Waneta	4.6	1	0.002	-0.0002	-0.0023	-0.003	-0.02	0.0002	-6.9E-19
Waneta	4.6	1	-0.001	-0.0012	-0.0033	-0.003	-0.04	0.0002	-0.01
Waneta	4.6	1	0.001	-0.0002	-0.0003	-0.003	-0.01	0.0012	-6.9E-19
Waneta	4.6	1		-0.0022	-0.0003	-0.003	-0.01	0.0002	-6.9E-19
Waneta	4.6	1		0.0008	-0.0003	0.007	-0.02	-0.0008	-6.9E-19
Waneta	4.6	1		-0.0002	0.0037	0.007	-0.01	0.0002	-6.9E-19
Waneta	3	1	0.001	0.001	-0.0061	-0.013			
Waneta	3	1	0.001	-0.009	0.0019	-0.003			
Waneta	3	1	0.000	0.001	-0.0131	-0.003			
Waneta	3	1	0.000	0.041	-0.0031	0.037			
Waneta	3	1	0.000	-0.029	0.0169	-0.013			
Waneta	3	1	0.001	0.001	0.0139	0.027			
Waneta	3	1	0.000	0.011	-0.0101	-0.003			
Waneta	3	1		0.001	-0.0131	-0.013			
Waneta	3	1		0.001	-0.0121	-0.013			
Waneta	3	1		-0.019	0.0249	-0.003			
Waneta	1.5	1	-0.001	-0.0077	0.0012	-0.055	-0.079	0.0006	0.001
Waneta	1.5	1	0.002	-0.0027	0.0102	-0.045	0.411	-0.0004	0.001
Waneta	1.5	1	-0.002	-0.0087	0.0022	-0.055	-0.059	-0.0004	0.001
Waneta	1.5	1	0.000	0.0143	0.0052	0.025	-0.039	0.0006	0.001
Waneta	1.5	1	-0.001	0.0043	-0.0038	0.025	-0.069	-0.0004	0.001
Waneta	1.5	1	0.000	-0.0057	0.0002	-0.045	-0.059	0.0006	0.001
Waneta	1.5	1		-0.0057	0.0022	-0.035	-0.079	-0.0004	0.001
Waneta	1.5	1		-0.0087	0.0002	-0.055	-0.059	-0.0004	0.001
Waneta	1.5	1		0.0053	0.0002	0.025	0.051	-0.0004	-0.009
Waneta	1.5	1		0.0153	-0.0178	0.215	-0.019	0.0006	0.001
Pend d'Oreille	0.1	1	-0.001	0.0004	0.0004	-0.012	-0.024	0.0004	-0.0026
Pend d'Oreille	0.1	1	-0.001	0.0094	0.0174	0.078	-0.004	-0.0006	-0.0016
Pend d'Oreille	0.1	1	0.001	-0.0036	-0.0056	-0.022	-0.014	-0.0006	-0.0006
Pend d'Oreille	0.1	1	0.001	-0.0046	-0.0056	-0.032	0.016	-0.0006	0.0134
Pend d'Oreille	0.1	1	0.001	-0.0036	-0.0046	-0.022	-0.014	0.0004	0.0004
Pend d'Oreille	0.1	1	0.000	0.0004	0.0024	-0.012	-0.014	0.0004	-0.0036
Pend d'Oreille	0.1	1	0.000	-0.0036	-0.0036	-0.022	-0.024	0.0004	-0.0006
Pend d'Oreille	0.1	1		-0.0006	-0.0056	0.008	0.076	0.0004	-0.0026
Pend d'Oreille	0.1	1		0.0084	0.0054	0.058	-0.004	0.0004	-0.0006

Pend d'Oreille	0.1	1		-0.0026	-0.0006	-0.022	0.006	-0.0006	-0.0016
Waneta	7.6	2	0.000	-0.0092	-0.0037	-0.015	-0.02	-0.0007	-0.005
Waneta	7.6	2	0.003	-0.0092	0.0003	-0.015	-0.02	-0.0007	-0.005
Waneta	7.6	2	0.000	0.0028	-0.0017	0.005	2.2E-17	0.0003	-0.005
Waneta	7.6	2	-0.001	-0.0122	-0.0057	-0.025	0.08	0.0003	0.005
Waneta	7.6	2	-0.001	-0.0092	-0.0047	-0.015	0.01	0.0003	0.005
Waneta	7.6	2	-0.002	-0.0152	-0.0067	-0.035	-0.02	0.0003	0.005
Waneta	7.6	2	0.001	0.0078	0.0153	0.065	0.2	0.0003	0.015
Waneta	7.6	2		-0.0042	0.0033	-0.005	0.05	-0.0017	0.005
Waneta	7.6	2		0.0308	0.0023	0.055	-0.14	0.0023	-0.015
Waneta	7.6	2		0.0178	0.0013	-0.015	-0.14	-0.0007	-0.005
Waneta	6.1	2	-0.002	-0.026	-0.0156	-0.02			
Waneta	6.1	2	-0.002	-0.066	0.0054	-0.08			
Waneta	6.1	2	0.002	-0.046	-0.0016	-0.07			
Waneta	6.1	2	-0.001	0.114	0.0014	0.12			
Waneta	6.1	2	0.001	-0.016	0.0154	0.03			
Waneta	6.1	2	0.001	-0.036	-0.0356	-0.08			
Waneta	6.1	2	0.001	0.104	0.0064	0.09			
Waneta	6.1	2		-0.056	0.0284	-0.04			
Waneta	6.1	2		-0.006	0.0154	0.04			
Waneta	6.1	2		0.034	-0.0196	0.01			
Waneta	4.6	2	0.001	0.0079	0.0012	0.033	-0.018	0.0003	-0.003
Waneta	4.6	2	0.000	0.0019	0.0012	0.003	0.022	0.0003	-0.003
Waneta	4.6	2	0.000	-0.0021	0.0012	-0.007	0.012	-0.0007	-0.003
Waneta	4.6	2	0.000	-0.0011	-0.0028	0.003	-0.048	0.0013	-0.003
Waneta	4.6	2	-0.002	-0.0011	-0.0048	0.003	0.012	-0.0007	-0.003
Waneta	4.6	2	-0.001	-0.0061	-0.0058	-0.017	0.032	0.0003	-0.003
Waneta	4.6	2		0.0059	0.0082	0.013	0.062	0.0003	0.007
Waneta	4.6	2		-0.0041	-0.0078	-0.017	-0.048	-0.0007	-0.003
Waneta	4.6	2		-0.0011	0.0052	-0.007	-0.008	0.0003	0.007
Waneta	4.6	2		-0.0001	0.0042	-0.007	-0.018	-0.0007	0.007
Waneta	3	2	-0.003	0.012	0.0035	-0.021			
Waneta	3	2	-0.002	0.092	-0.0215	0.119			
Waneta	3	2	0.000	0.042	0.0135	0.019			
Waneta	3	2	0.000	0.102	-0.0185	0.029			
Waneta	3	2	-0.001	0.002	-0.0025	-0.051			
Waneta	3	2	0.000	-0.028	0.0325	-0.021			
Waneta	3	2	0.004	0.022	-0.0085	-0.031			
Waneta	3	2		-0.008	0.0385	-0.011			
Waneta	3	2		-0.268	-0.0225	-0.051			
Waneta	3	2		0.032	-0.0145	0.019			
Waneta	1.5	2	-0.001	-0.0012	0.0007	-0.015	-0.027	-0.0014	-0.006
Waneta	1.5	2	0.001	0.0058	0.0087	0.025	0.013	-0.0014	-0.006
Waneta	1.5	2	-0.001	-0.0032	-0.0033	-0.005	-0.057	0.0006	-0.006
Waneta	1.5	2	0.001	-0.0022	-0.0003	-0.015	-0.077	-0.0004	0.004
Waneta	1.5	2	0.000	-0.0022	0.0017	-0.005	-0.017	-0.0004	0.004
Waneta	1.5	2	0.001	0.0028	0.0047	0.015	-0.027	0.0016	0.004
Waneta	1.5	2	-0.002	-0.0022	0.0037	-0.015	0.053	0.0006	0.004
Waneta	1.5	2		0.0058	-0.0113	0.035	0.043	0.0006	0.004
Waneta	1.5	2		-0.0022	-0.0013	-0.015	0.033	-0.0004	-0.006
Waneta	1.5	2		-0.0012	-0.0033	-0.005	0.063	0.0006	0.004
Pend d'Oreille	0.1	2	-0.004	-0.0004	-0.0007	0.022	-0.015	-0.0003	-0.0036
Pend d'Oreille	0.1	2	-0.003	-0.0044	-0.0047	-0.018	-0.005	-0.0003	0.0064
Pend d'Oreille	0.1	2	-0.004	-0.0024	-0.0067	-0.018	-0.055	0.0007	0.0004
Pend d'Oreille	0.1	2	-0.004	-0.0004	-0.0037	-0.018	-0.025	0.0007	0.0004
Pend d'Oreille	0.1	2	0.007	0.0076	0.0083	0.042	-0.015	0.0007	0.0004
Pend d'Oreille	0.1	2	0.008	-0.0034	-0.0027	-0.028	0.015	-0.0003	-0.0026
Pend d'Oreille	0.1	2		-0.0014	0.0003	-0.018	0.025	0.0007	0.0154
Pend d'Oreille	0.1	2		0.0016	0.0063	0.032	0.005	-0.0013	-0.0076
Pend d'Oreille	0.1	2		-0.0024	0.0003	-0.008	0.015	-0.0003	-0.0026
Pend d'Oreille	0.1	2		0.0056	0.0033	0.012	0.055	-0.0003	-0.0066

APPENDIX F - TERMS OF REFERENCE

DSS FILE NO.: 10SB.KW601-7-9046
CONTRACT SERIAL NO.:
APPENDIX "A"

TITLE: STATISTICAL ANALYSIS OF WATER CHEMISTRY DATA FROM THE COLUMBIA AND PEND D'OREILLE RIVERS

STATEMENT OF WORK:

The Contractor is required to conduct statistical tests on water chemistry data from the Columbia and Pend D'Oreille Rivers. Specifically, the contractor must:

1. Determine if peaks in concentration of selected chemicals at Waneta, a site on the Columbia River upstream of the International border, are related to discharges at Cominco, the smelter and fertilizer complex near Trail. Data from four intensive 72 - 94 hour surveys in September, 1979, May, 1981, October, 1983 and March, 1984, will be used.

   Receiving water data (approximately 10,000 values) from Birchbank and Waneta have been published in a data report and are available on diskettes or magnetic tapes.

   Effluent loading data (approximately 7,000 values) were collected concurrently by the B.C. Waste Management Branch and will be provided in the form of data sheets.

2. Using the data from Birchbank and Waneta, choose and apply the appropriate statistical techniques to determine whether there has been any change in concentration or frequency distribution at Waneta for selected variables.

3. Determine the diluting affect of Pend D'Oreille River water on the Columbia River downstream of Waneta by:

   a) Calculating the loading for selected parameters from the Pend D'Orielle and Columbia River at Waneta.

   b) Providing a table on concentration ratios at different discharges for selected parameters.

   * Nutrient, metal and major ion data covering 8 samplings at both sites is to be used. (See data report).

4. Statistically test for differences between concentrations of chemicals at Birchbank and Waneta stations by:

   a) Comparing data sets taken at the same time from the two sites.

   b) If applicable, illustrating graphically the differences between the two sites.

5. Conduct statistical tests on sets of data from the Columbia River to determine the degree of short term variability. (see Data Report pages 18 - 31).

   Receiving Water Data Source: Water Chemistry of the Columbia and Pend D'Oreille Rivers near the International Boundary (Data Report) by S. W. Sheehan and M. Lamb, March, 1987.

Note: The selection and implementation of statistical tests will be done in consultation with the Scientific Authority.

Output:

The contractor will provide to the Scientific Authority:

a) Tables and/or graphs presenting the results of the calculations and statistical analyses;

b) A description of the limitations of the statistics used with regard to the data sets described above.

All the data, if not already on existing diskettes or magnetic tapes will be provided to the Scientific Authority in a magnetic machine - readable form either MS DOS or on magnetic tape.

This contract requires that up to 15% of the contractor's time may be spent on site because of system access requirements for data transfer (i.e., data must be transferred from in-house computers to computer to be used for the analyses).

REQUIRED QUALIFICATIONS:

1. Postgraduate degree in a scientific discipline.

2. Demonstrated knowledge in and experience of manipulating and formatting data on computers and conducting sophisticated statistical analysis of large data sets. The contractor must have evidence of this capability in the form of publications of reports and/or articles in recognized scientific journals.

3. Demonstrated understanding and knowledge of physical processes such as dilution and dispersion of substances in rivers. The contractor must have evidence of this capability in the form of publications of reports and/or articles in recognized scientific journals.

4. Knowledge and demonstrated experience in transferring data from diskettes on microcomputers to computers to be used for analyses.

5. Basic knowledge and understanding of water chemistry data such that errors in data can be easily detected.