CANADA – BRITISH COLUMBIA
WATER QUALITY MONITORING AGREEMENT

WATER QUALITY ASSESSMENT OF COLUMBIA RIVER AT WANETA (1979 – 2000)

Prepared by:
Water, Air and Climate Change Branch
Ministry of Water, Land and Air Protection

Aquatic Sciences Section
Environmental Conservation Branch
Environment Canada
Pacific and Yukon Region

February, 2002

Environment Canada **Environnement Canada**

BRITISH COLUMBIA Ministry of Environment

Executive Summary

The Columbia River watershed drains the entire southeast portion of British Columbia. It is a transboundary river, which joins its major tributary, the Kootenay River, at Castlegar and then flows into Washington State just downstream from its confluence with the Pend d'Oreille River at Waneta. The water quality sampling station on the Columbia River at Waneta is located 1.5 km upstream from the Pend d'Oreille River and 2.5 km upstream from the US border. The drainage area for the Columbia River at Waneta is about 88,800 km^2. This reach of the river is used for municipal, industrial and agricultural water supplies, and supports significant fisheries. The main human influences on water quality were the Hugh Keenleyside, Libby, Mica and Revelstoke dams, the Celgar pulp mill at Castlegar, treated sewage discharges from the Nelson-Castlegar-Trail area, and the Cominco smelter-fertilizer complex at Trail. This assessment is based on up to 22 years of water quality data collected during 1979-2000. The water quality trends identified below have not yet been confirmed by statistical analysis.

CONCLUSIONS

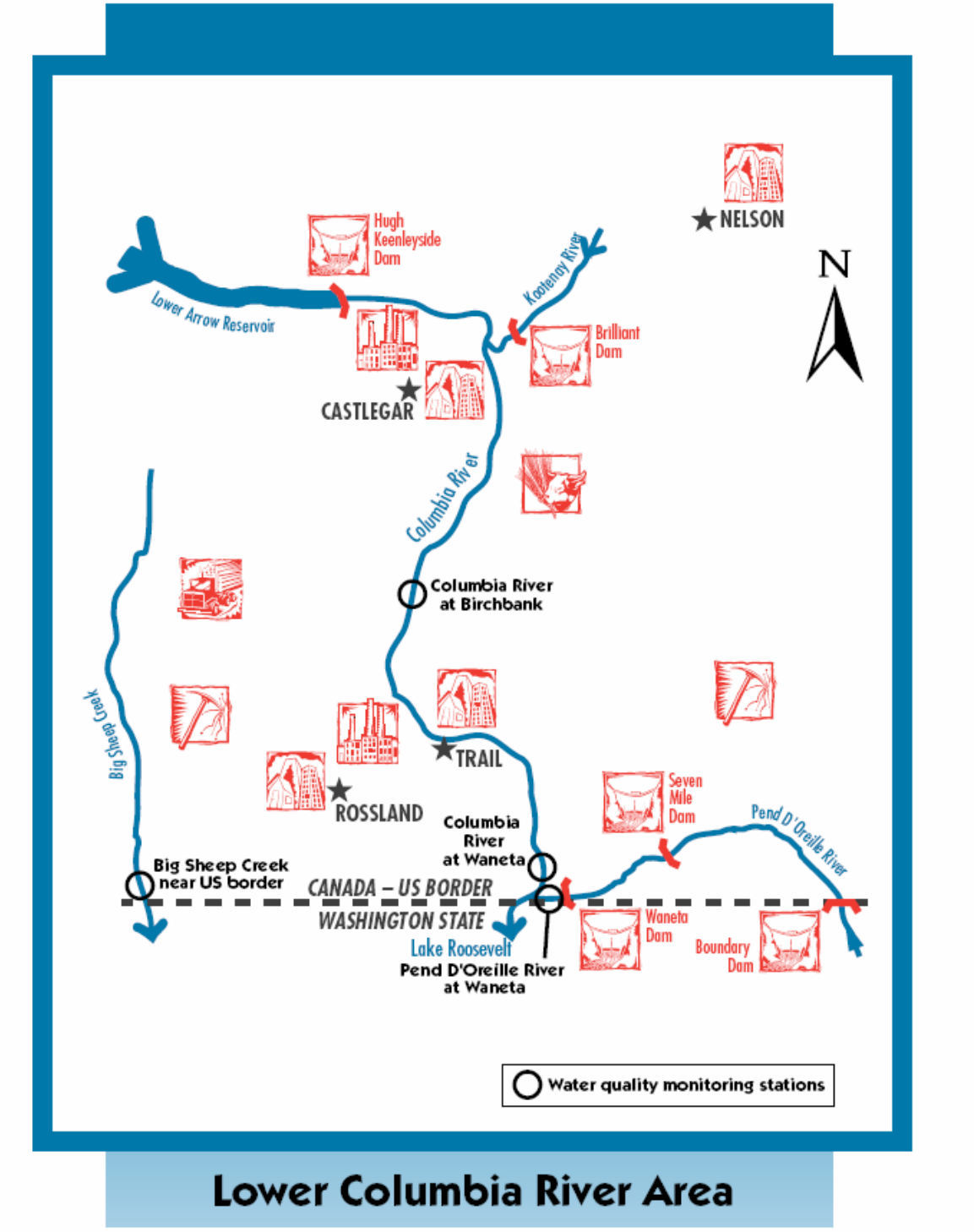
- Ten water quality indicators in the Columbia River at Waneta have shown improving (decreasing) trends over time due at least in part to waste abatement at the Cominco operations at Trail:
  - Arsenic – objective always met 1984-2000.
  - Cadmium – objectives were still exceeded in 2000 and continued waste abatement is needed.
  - Chromium – objective met since 1996.
  - Copper – objectives met since 1995.
  - Fluoride – guidelines met since 1986.
  - Lead – objectives met since 1993, and US standard met since 1997.
  - Phosphorus – levels declined during 1987-95, with little or no change during 1996-2000. (There are no objectives or guidelines for phosphorus in streams.)
  - Silver – guidelines met during 1998-2000.
  - Thallium – objectives and US standards met in 1996-2000, except for two spills in 1998 and 1999.
  - Zinc – objectives met since 1997.
- Aluminum and iron decreased over time at Birchbank and Waneta, possibly due to trapping by upstream dam and reservoirs, but also due to the use of more sensitive measurement methods for iron.
- Fecal coliforms did not change during 1990-2000 and probably met the objective.
- pH met its objectives in the vast majority of samples and the water was well buffered against acidic inputs.
- Turbidity was relatively low due to the settling of suspended sediment in the lakes and reservoirs on the Columbia and Kootenay rivers, and did not change over time, but treatment to remove turbidity was still needed prior to drinking water use.

- Total gas pressure

RECOMMENDATIONS

- Monitoring of the Columbia River at Waneta should continue for the present suite of water quality indicators because it is a transboundary waterbody, flowing into Washington State, with important fisheries and water supply values and human activities that continue to threaten water quality.
- Implement more sensitive analyses for cadmium, when the methods become available, to enable a more accurate comparison to water quality objectives.
- Implement analyses of dissolved aluminum to permit comparison to guidelines for drinking water and aquatic life.
- Terminate analyses for fluoride and sulphate due to the lack of concerns.
- Consider measuring dissolved oxygen for comparison to the objectives.

FIGURE 1 MAP OF THE COLUMBIA RIVER BASIN



AUTHORS

Pommen, L.W.	Water, Air and Climate Change Branch, Ministry of Water, Land and Air Protection, Victoria, B.C.

CONTRIBUTORS

Beatty, J.	Environmental Protection, Ministry of Water, Land and Air Protection, Nelson, B.C.
McDonald, L.E.	Environmental Protection, Ministry of Water, Land and Air Protection, Cranbrook, B.C.
Roome, R.	Environmental Protection, Ministry of Water, Land and Air Protection, Nelson, B.C.
Ryan, A.	Aquatic Sciences Section, Environmental Conservation Branch, Environment Canada, Vancouver, B.C.
Swain, L.G.	Water, Air and Climate Change Branch, Ministry of Water, Land and Air Protection, Victoria, B.C.

TABLE OF CONTENTS

LIST OF FIGURES

Page

LIST OF FIGURES (CONT'D)

Page

1. INTRODUCTION

The Columbia River at Waneta water quality monitoring station is located about 16 km downstream (south) from Trail, B.C., 1.5 km upstream from the Pend d'Oreille River, and 2.5 km upstream from the US border (Figure 1). The drainage area of the Columbia River at Waneta is about 88,800 km^2, while the drainage area at the US border is 155,000 km^2 with the inflow of the Pend d'Oreille River. The designated water uses of this reach of the Columbia are drinking water (with partial treatment and disinfection), aquatic life, wildlife, livestock, irrigation and primary-contact recreation. Major influences on water quality at Waneta have included:

- The Cominco Ltd. lead-zinc smelter and former fertilizer plant (closed in ?) at Trail.
- The Celgar pulp mill at Castlegar.
- The Hugh Keenleyside Dam on the Columbia River at Castlegar (completed in 1967).
- The Libby Dam on the Kootenay River in Montana (completed in 1972).
- The Mica Dam on the Columbia River (completed in 1976).
- The Revelstoke Dam on the Columbia River at Revelstoke (completed in 1983).
- Treated municipal sewage discharges from the Nelson, Castlegar and Trail areas.

Flow in the Columbia River at Birchbank, about 25 km upstream from the Waneta station, has been monitored since 1937. The drainage area at Birchbank is 88,100 km^2, or about 99% of the drainage area at Waneta, and thus the flows at Birchbank are a good approximation of the flows at Waneta. The flow data are stored on the Water Survey of Canada database under station number BC08NE049. Twenty-two years (1979-2000) of flow data are plotted in Figure 2.

The collection of water quality data at Waneta began in 1979 and the data are stored on the Province's Environmental Monitoring System (EMS) under site number 0200559, and on Environment Canada's ENVIRODAT database under station number BC08NE0001. Since 1985, Canada and B.C. have jointly operated the station as a federal-provincial station. Water quality data have been collected weekly since 1983. Up to twenty-two years (1979-2000) of water quality data were used in this report. The data for the current suite of water quality indicators are plotted in Figures 3 to 41. These are the water quality indicators that were recommended by a previous assessment (Ministry of Environment, Lands and Parks and Environment Canada, 1999) and that have been monitored up to the present. Water quality data have also been collected at Birchbank, which serves as a reference station upstream from Trail for the Waneta station. The Birchbank data are referenced in this report, and assessed in a separate report in this series (Ministry of Water, Lands and Air Protection and Environment Canada, 2002).

2. WATER QUALITY ASSESSMENT

The status and trends of water quality were assessed by plotting the water quality indicators over time and comparing the values to the Province's water quality objectives for this reach of the Columbia (Ministry of Environment, Lands and Parks, 2000a) or to the Province's approved and working water quality guidelines (Ministry of Environment,

Lands and Parks, 2001a & 2001b). The US water quality standards for the Columbia River in Washington State were also used for selected indicators (Washington State 1997). Any levels or changes of the indicators over time that may have been harmful to sensitive water uses, such as drinking water, aquatic life, wildlife, recreation, irrigation and livestock, are described below in alphabetical order.

Water quality indicators that were plotted but not discussed because they easily met all water quality objectives or guidelines and showed no harmful trends were: barium, boron, calcium, cobalt, conductivity, hardness, lithium, magnesium, molybdenum, nickel, nitrogen, selenium, sulphate, uranium, and vanadium.

Alkalinity, total (Figure 3) was monitored during 1980-2000. The water was well buffered against acidic inputs, with all values well above the 20 mg/L guideline above which water has a low sensitivity to acids. There was a minor increasing trend over time, which was not seen at the Birchbank reference station, but the change is not environmentally significant.

Aluminum, total (Figure 4) was monitored during 1990-2000, and there was a declining trend over this time, which was also noted at Birchbank. The cause of this trend is not known, but it probably made the water more suitable for aquatic life and drinking water. The guidelines for these water uses are expressed as dissolved aluminum, and are not directly comparable to the total aluminum values, which would overestimate the dissolved fraction. Dissolved aluminum should be measured to permit comparison to the guidelines.

Arsenic, total (Figure 5) was monitored during 1984-2000 and all values were below the 0.005 mg/L objective. There was a minor decreasing trend over time, which was also noted at Birchbank, and thus may be due to changes in measurement techniques, as well as due to waste abatement at the Cominco smelter at Trail.

Cadmium, total (Figure 8) was monitored during 1980-2000, but the data prior to 1991 were excluded owing contamination from preservative vials during 1986-90 and high detection limits (0.01, 0.001 and 0.0005 mg/L). Only data with a detection limit of 0.0001 mg/L, which is still above the objectives (0.00003-0.00005 mg/L), were included. Nevertheless, there were 56 values (10%) above the 0.0001 mg/L detection limit and thus above the objectives during 1991-2000, mostly prior to 1994. There was a declining trend during 1991-94 due to waste abatement at the Cominco smelter at Trail. However, the data must be used with caution because all of the values were within 5 times the detection limit and thus below the limit of quantification (Clark & Whitfield 1994). The maximum value of 0.0005 mg/L was well below the drinking water guideline of 0.005 mg/L.

Cadmium, extractable (Figure 9) was monitored during 1996-2000 with a detection limit of 0.000005 mg/L. Figure 9 shows that there was a declining trend during this time due to waste abatement at the Cominco smelter at Trail. However, the objectives (30-day mean of 0.00003-0.00005 mg/L) were often exceeded during 1996-2000, although the extent of the exceedances diminished over time. Figure 9 also shows that the short-term

objective (0.00005 mg/L) was always met at Birchbank, but that the long-term objective level (0.00003 mg/L) was occasionally exceeded, although the sampling frequency was insufficient to determine whether the 30-day mean objective was exceeded. There is a need for continued waste abatement at Cominco and the detection limit should be lowered to at least 1/10th of the lowest objective, when the analytical methods are available.

Carbon, dissolved organic (Figure 11) was monitored during 1997-2000. Two values (4.8 & 14.7 mg/L), which comprise 1.2% of the values, exceeded the drinking water guideline for raw water that will be chlorinated. The record is too short to comment on trends.

Chromium, total was monitored during 1991-2000, and **extractable chromium** was monitored during 1996-2000 (Figure 12). Total chromium had a declining trend during 1991-96 and the 0.001 mg/L objective has been met since mid 1996. Extractable chromium also met the objective during 1996-2000 and exhibited a declining trend during this period. The declining trends may be due in part to waste abatement at Cominco, but similar trends were also noted at Birchbank, and thus the trends may be due in part to changes in the measurement methods.

Coliforms, fecal (Figure 14) were monitored during 1987-2000. There was a decrease in fecal coliform levels during 1987-89 and then little or no change during 1990-2000. The reason for the 1987-89 decrease is not known. The objective (30-day 90th percentile of 100/100 mL) was probably met during 1990-2000, although the sampling frequency (5-in-30 days) was less than the 10-in-30 days needed for rigorous calculation of the 90th percentile.

Colour, true (Figure 15) was monitored mainly during 1997-2000. The aesthetic guideline for drinking water (15 true colour units) was exceeded only once (0.5% of values), in 1998. The record is too short to comment on trends.

Copper, total was monitored during 1991-2000 and **extractable copper** was monitored during 1996-2000 (Figure 17). There was a declining trend in both forms of copper over time due to waste abatement at Cominco at Trail. The maximum objective (0.007 mg/L) was exceeded four times (0.7% of values; the maximum of 0.0582 mg/L in 1994 was not shown to improve the scale of the plot), all during 1991-95, and the average objective (0.002 mg/L) was often exceeded during this time. However, since mid-1995, the maximum objective was met, and although values occasionally exceeded 0.002 mg/L, the 30-day average objective was met (Figure 18).

Fluoride, dissolved (Figure 19) was monitored during 1978-2000. There was a declining trend over time due to waste abatement at Cominco at Trail. The drinking water guideline (1 mg/L) was exceeded once in 1981 (0.1% of values) and the aquatic life guideline (0.3 mg/L) was exceeded 15 times (1.7% of values), with all but one of these during 1978-86. The one exceedance in 2000 may be an error, since the adjacent values are 10 times lower.

Iron, total (Figure 21) was monitored during 1984-2000, and there was an apparent decreasing trend during this time. A similar decrease was noted at Birchbank, which was due in part to declining detection limits, but also may have been due to trapping by upstream dams and reservoirs. The 0.3 mg/L guideline for drinking water and aquatic life was exceeded by 1.3% of the values.

Lead, total (Figure 22) was monitored during 1991-2000 with a detection limit of 0.0002 mg/L, while **extractable lead** was monitored during 1996-2000 with a detection limit of 0.00001 mg/L. There was a decreasing trend in total and extractable lead over time due to waste abatement at Cominco. The maximum objective of 0.0379 mg/L was never exceeded, while the average objective of 0.0048 mg/L has not been exceeded since 1993. The US average standard of 0.0012 mg/L has not been exceeded since 1997.

Manganese, total (Figure 25) was monitored during 1981-2000. There was an apparent declining trend over time due to declining detection limits. One value exceeded the aesthetic guideline for drinking water of 0.05 mg/L, but levels were well below the irrigation (0.2 mg/L) and aquatic life (0.7 mg/L) guidelines.

pH (Figure 29) was monitored during 1979-2000 and ranged from 6.2 to 8.7 pH units. There was no apparent change over time and the vast majority of the values were within the objective range of 6.5 to 8.5 pH units.

Phosphorus, total dissolved was monitored during 1987-2000. Figure 30 shows a dramatic downward trend during 1987-95 due to abatement of Cominco's fertilizer plant discharge and then no change during 1996-2000.

Phosphorus, total was monitored during 1979-2000. Like dissolved phosphorus, Figure 31 shows a dramatic downward trend during 1979-95 due to abatement at the Cominco fertilizer plant, followed by a slight downward trend until 2000 (Figure 32).

Silver, extractable was monitored 292 times during 1996-2000 with a detection limit of 0.000005 mg/L (Figure 34). One value on November 26, 1996 exceeded the maximum aquatic life guideline (0.0001 mg/L), and the average aquatic life guideline (0.00005 mg/L) was also exceeded by six values on that day. Extractable silver levels at Birchbank, upstream from Cominco, were low and always met the guidelines during 1996-2000. There was an apparent decrease in peak silver values over time at Waneta, which was probably due to waste abatement at Cominco, and the guidelines were met during 1998-2000. (Total silver levels were also measured at Birchbank and Waneta, but the detection limits at or above the maximum guideline and thus the data are not reliable.)

Temperature, water (Figure 36) was monitored during 1980-2000. Water temperature often (19% of all values) exceeded 15 degrees C during summer, which is the aesthetic guideline for drinking water, but the lower limit for swimming. The summer water temperatures occasionally exceeded the optimum upper temperatures for the fish species

known to inhabit the Columbia River (e.g., 1.3 % of values exceeded 19 degrees Celsius). There was no apparent change in water temperature over time.

Thallium, extractable (Figure 37) was monitored 304 times during 1996-2000. Two values (0.7% of values) in April 1998 and April 1999 exceeded the average objective (0.0008 mg/L), the US standard (0.0017 mg/L) and the US drinking water maximum contaminant level (0.002 mg/L). The values at Birchbank were always very low and met all objectives and standards. The peak values at Waneta were due to spills at Cominco, and there was a decreasing trend in mean thallium levels over time at Waneta due to waste abatement at Cominco.

Turbidity (Figure 38) was monitored 968 times during 1980-2000 and is an optical measure of the amount of suspended sediment in water. Turbidity was relatively low with a maximum of 18 NTU, due to the settling out of suspended sediments in upstream reservoirs and lakes on the Kootenay and Columbia rivers. Nevertheless, the drinking water health guideline of 1 NTU was often exceeded (13% of values), while the aesthetic drinking water guideline of 5 NTU was rarely exceeded (0.3% of values), indicating that water treatment to remove turbidity (e.g., filtration) would be needed before using the river for drinking water. There was no apparent change in turbidity over time, and the levels were similar at Birchbank and Waneta.

Zinc, total (Figure 41) was monitored during 1991-2000, and **extractable zinc** was measured during 1996-2000. There was a decreasing trend in both zinc forms over time due to waste abatement at Cominco. The maximum objective (0.033 mg/L) has been met since 1991, and the 30-day average objective has been met since 1997. The US standard (4-day average of 0.058 mg/L) was always met during 1991-2000. The levels at Birchbank always met the objectives during 1991-2000.

REFERENCES

Clark, M.J.R. and P.H. Whitfield. 1994. Conflicting Perspectives About Detection Limits and About the Censoring on Environmental Data. Water Resources Bulletin (30) 6, p.1063-1079.

McKean, C.J.P. and B.W. Huggins. 1989. pH Determination and Measurement. Ministry of Environment, Water Management Branch, B.C.

Ministry of Environment, Lands and Parks and Environment Canada. 1999. State of Water Quality of Columbia River at Waneta, 1979-1996.

Ministry of Environment, Lands and Parks. 2000a. Water Quality Assessment and Objectives for the Lower Columbia River: Birchbank to the International Border.

Ministry of Environment, Lands and Parks and Environment Canada. 2000b. Water Quality Trends in Selected British Columbia Waterbodies.

Ministry of Environment, Lands and Parks. 2001a. British Columbia Approved Water Quality Guidelines (Criteria). 1998 Edition updated August 24, 2001.

Ministry of Environment, Lands and Parks. 2001b. A Compendium of Working Water Quality Guidelines for British Columbia. 1998 Edition updated August 23, 2001.

Ministry of Water, Land and Air Protection and Environment Canada. 2002. Water Quality Assessment of the Columbia River at Birchbank, 1983-2000.

Washington State Dept. of Ecology. 1997. Water Quality Standards for Surface Waters of the State of Washington. Chapter 173-201A WAC, p. 1-18, 11/18/97.

FIGURE 2 FLOW AT THE COLUMBIA RIVER AT BIRCHBANK

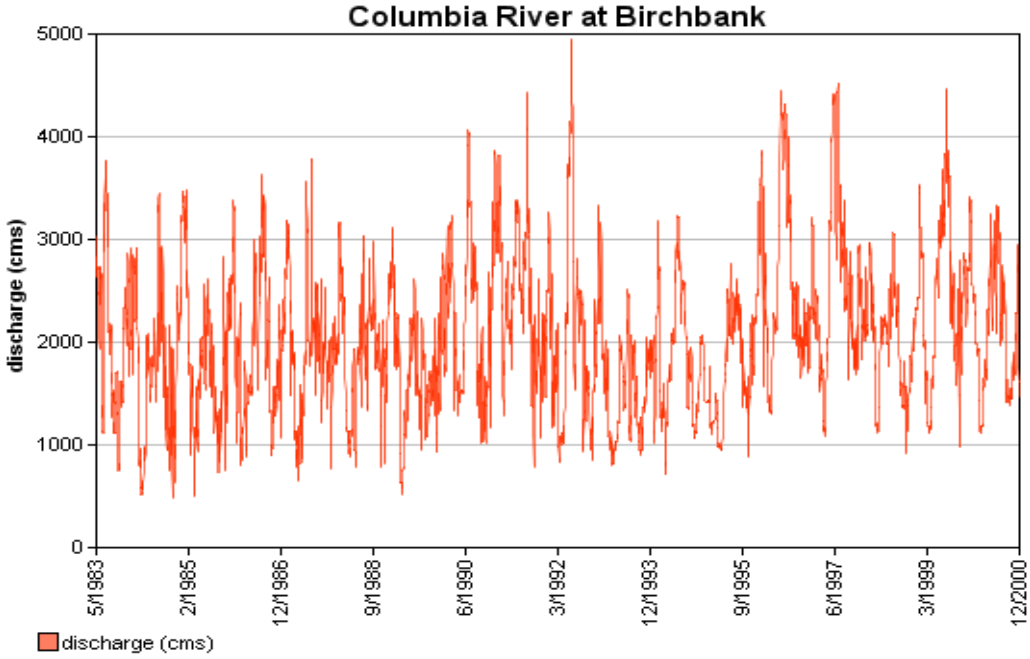


Figure 3 Columbia River at Waneta - Alkalinity, Total

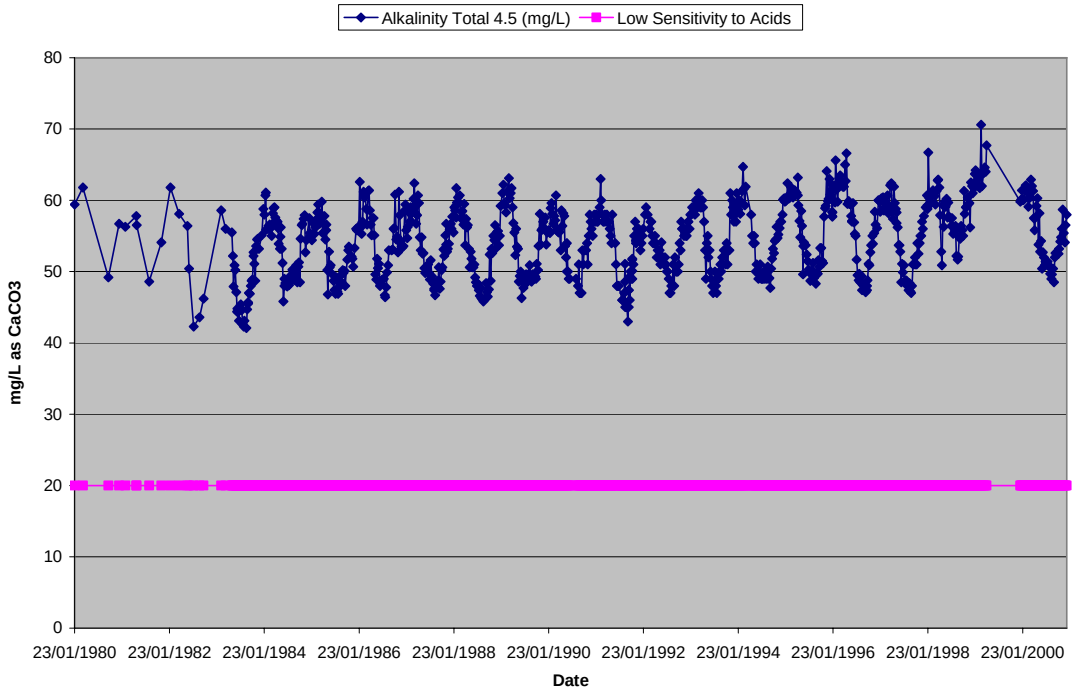


Figure 4 Columbia River at Waneta - Aluminum, Total

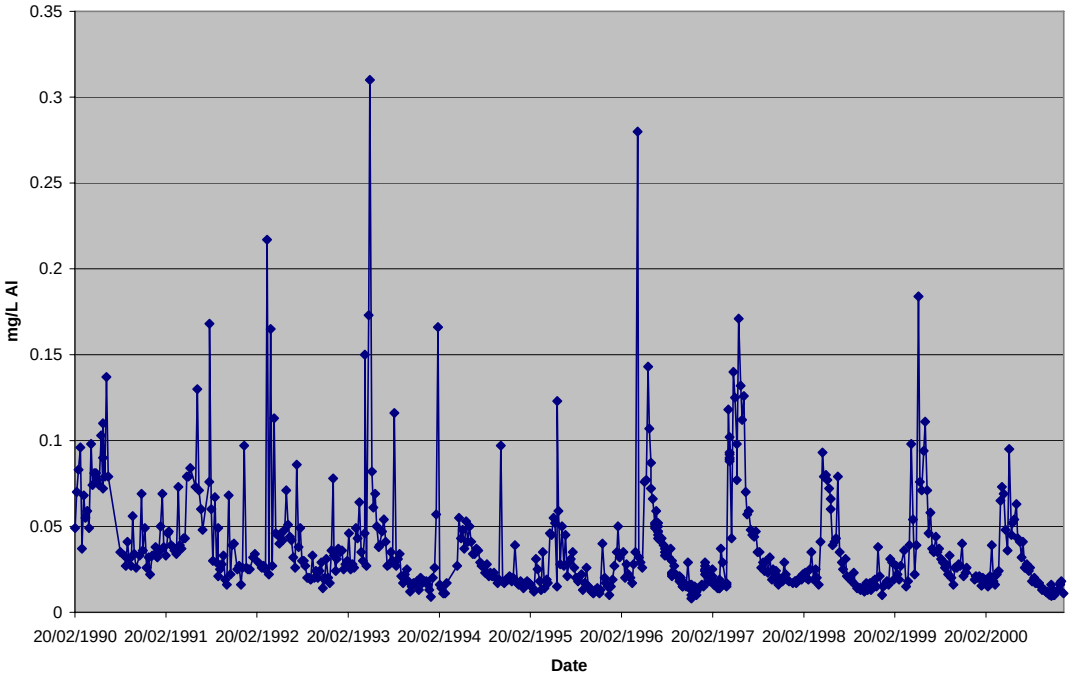


Figure 5 Columbia River at Waneta - Arsenic, Total

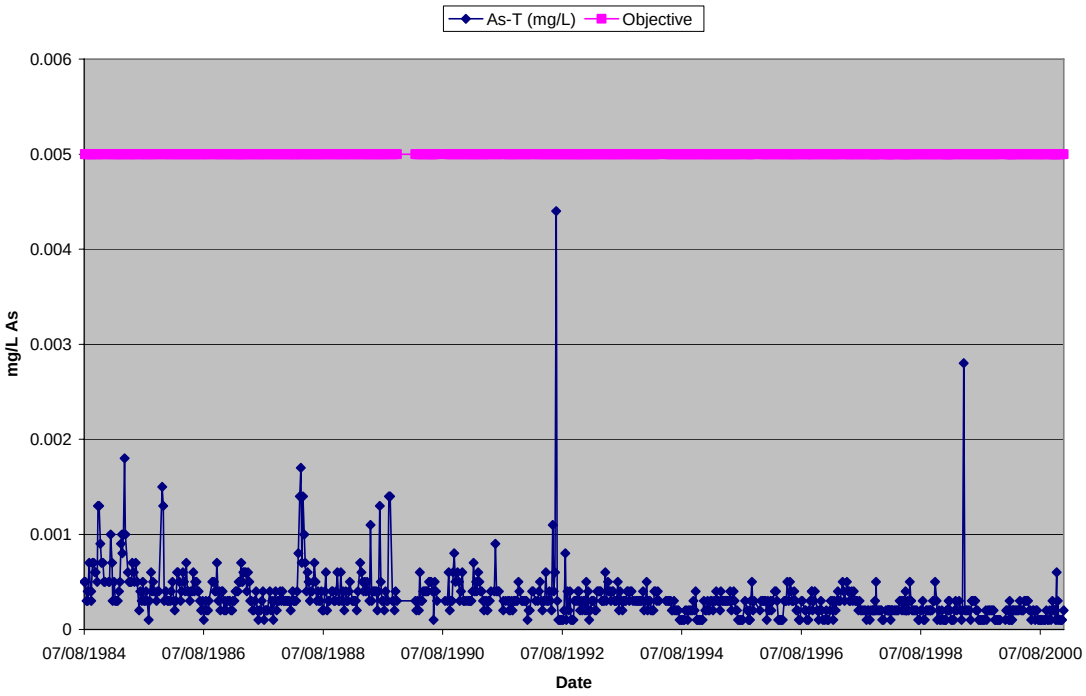


Figure 6 Columbia River at Waneta - Barium

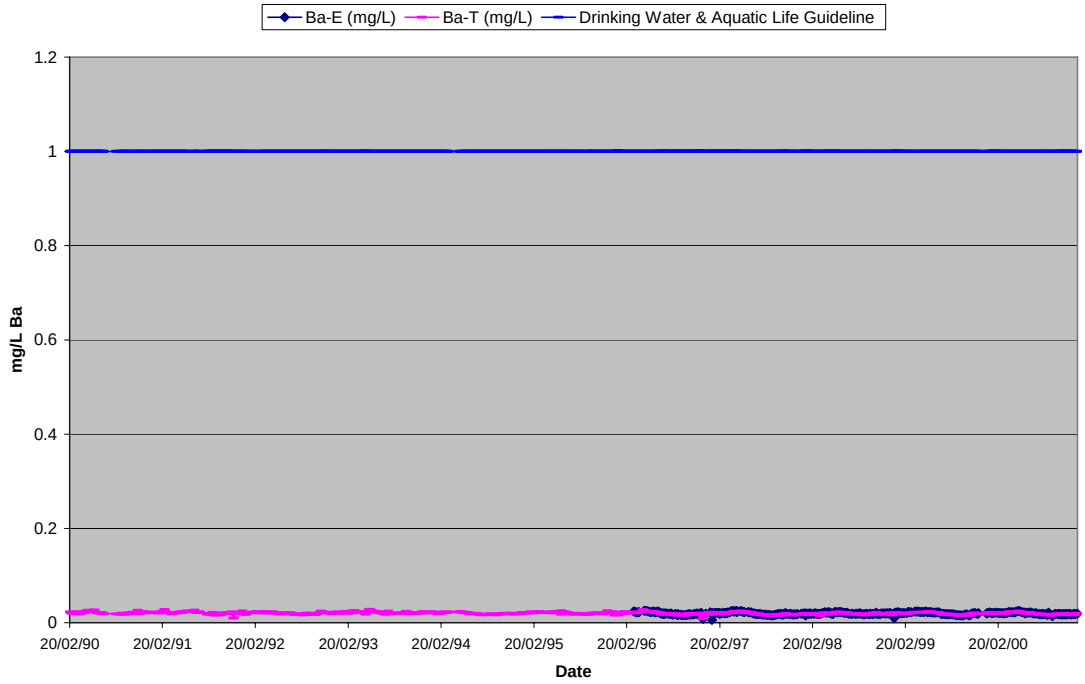
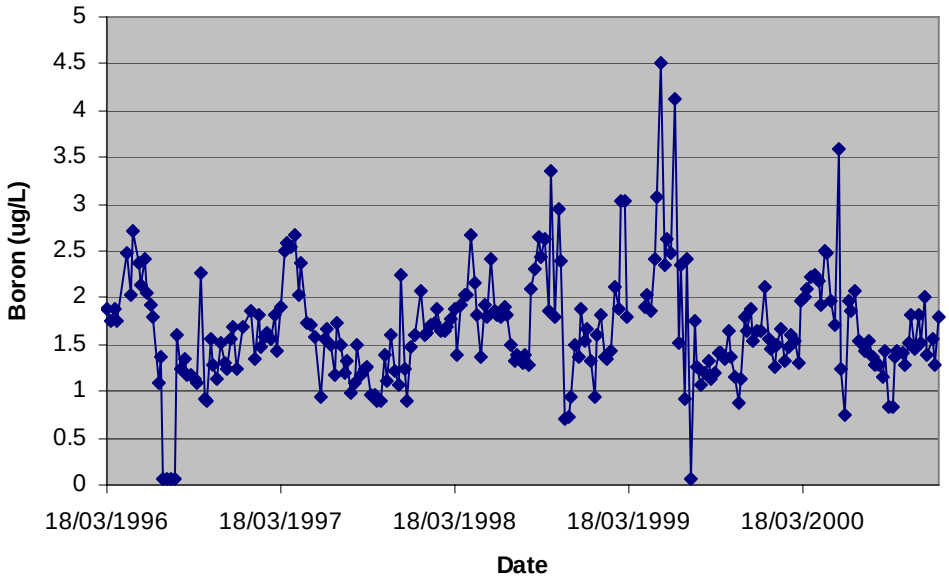


Figure 7 Columbia River at Waneta - Extractable Boron



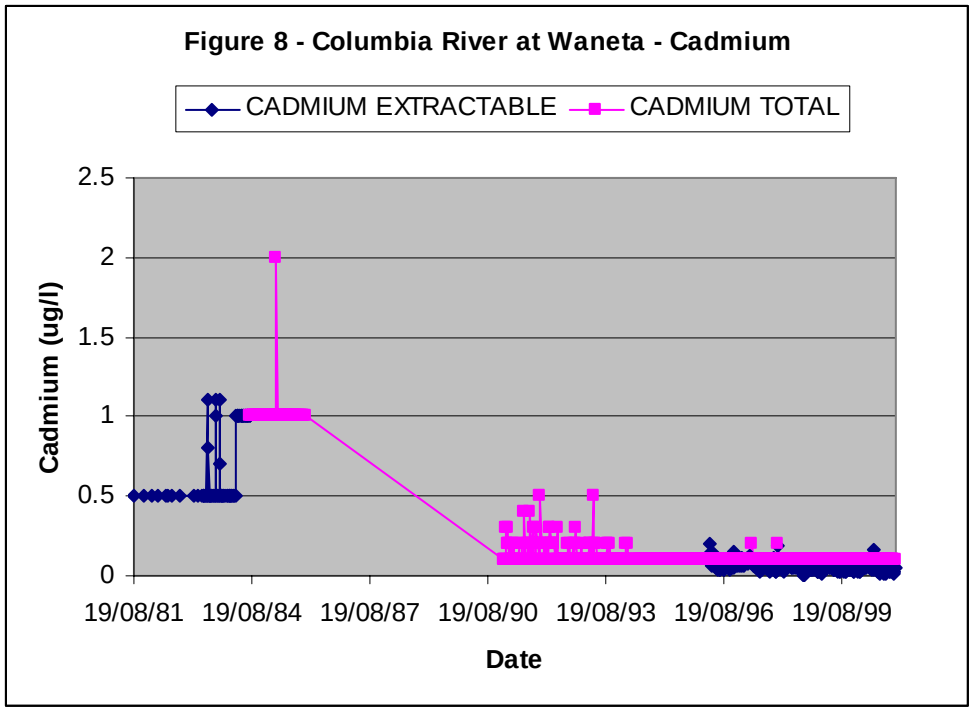
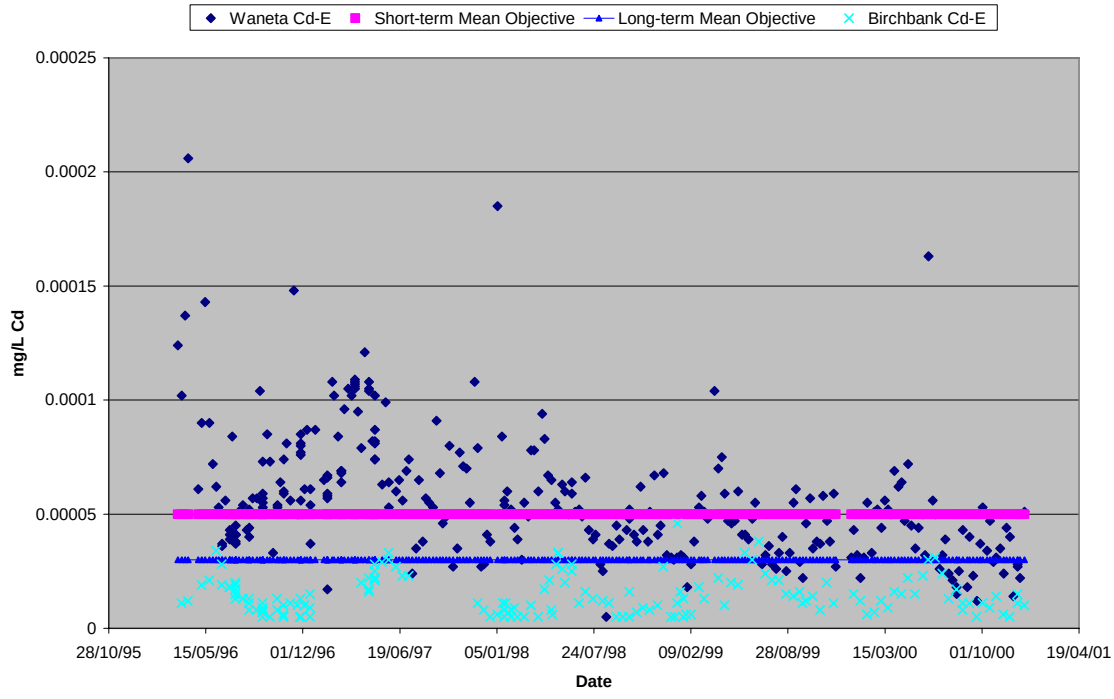


Figure 9 Columbia River at Waneta and Birchbank - Cadmium, Extractable



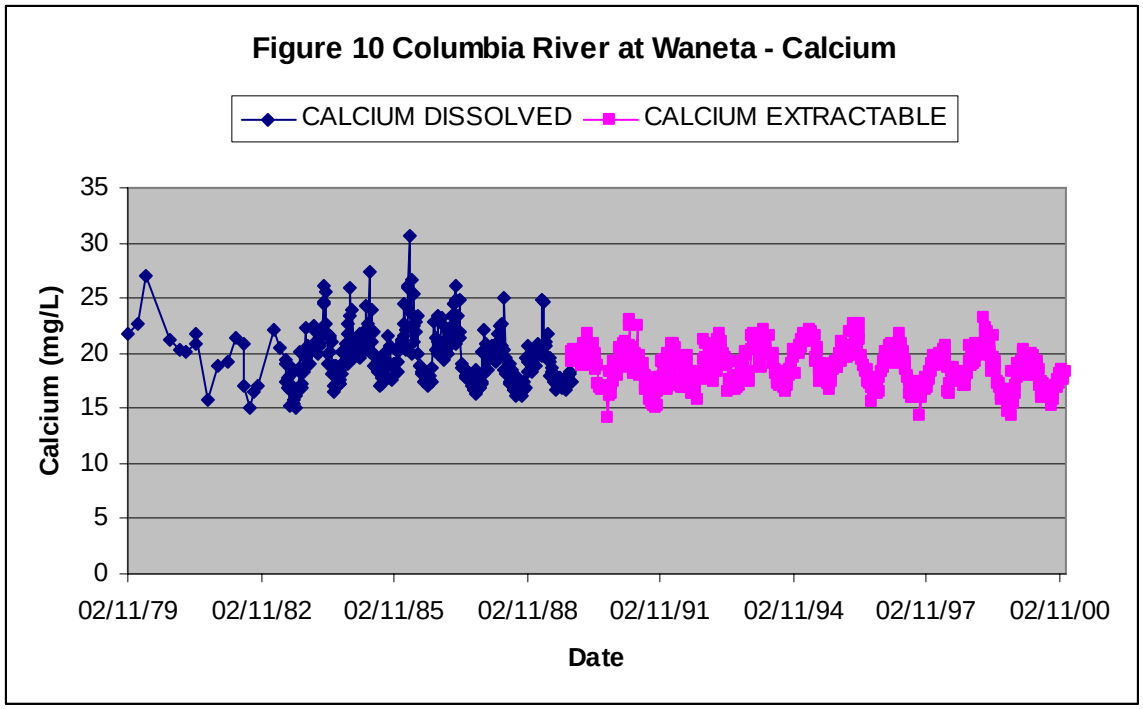
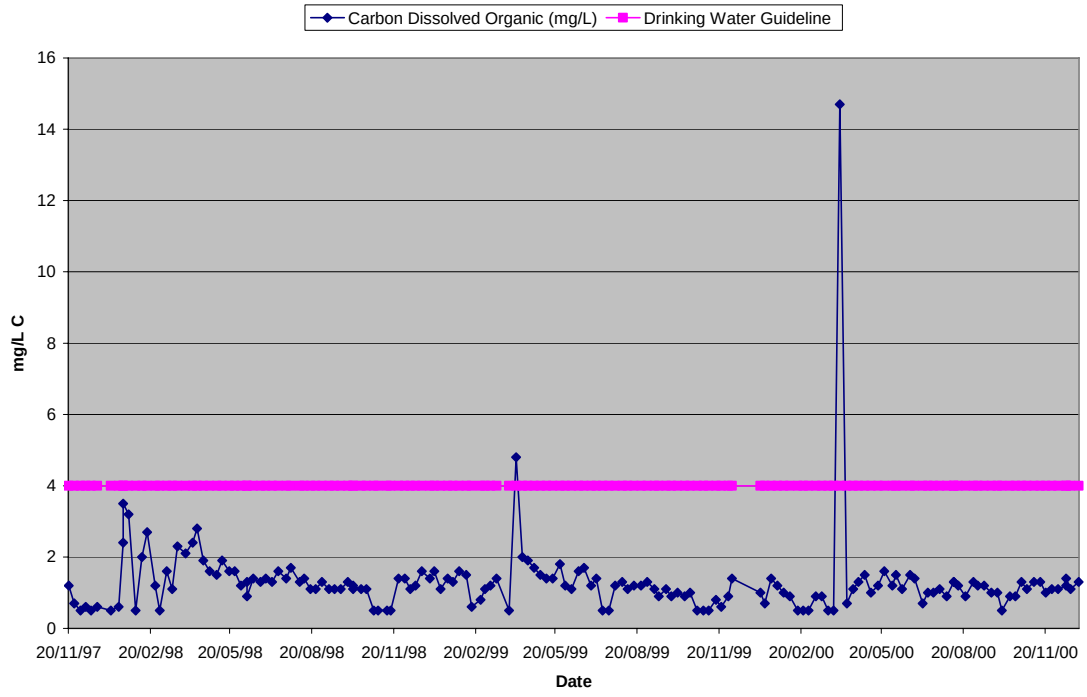


Figure 11 Columbia River at Waneta - Carbon, Dissolved Organic



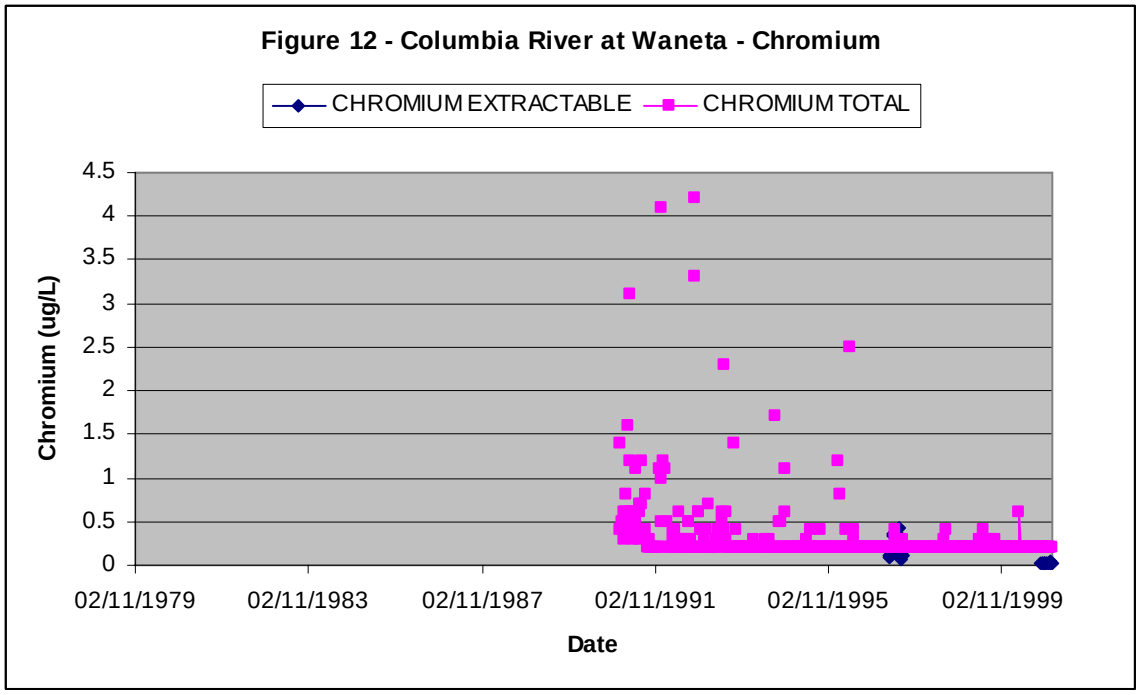


Figure 13 Columbia River at Waneta - Cobalt

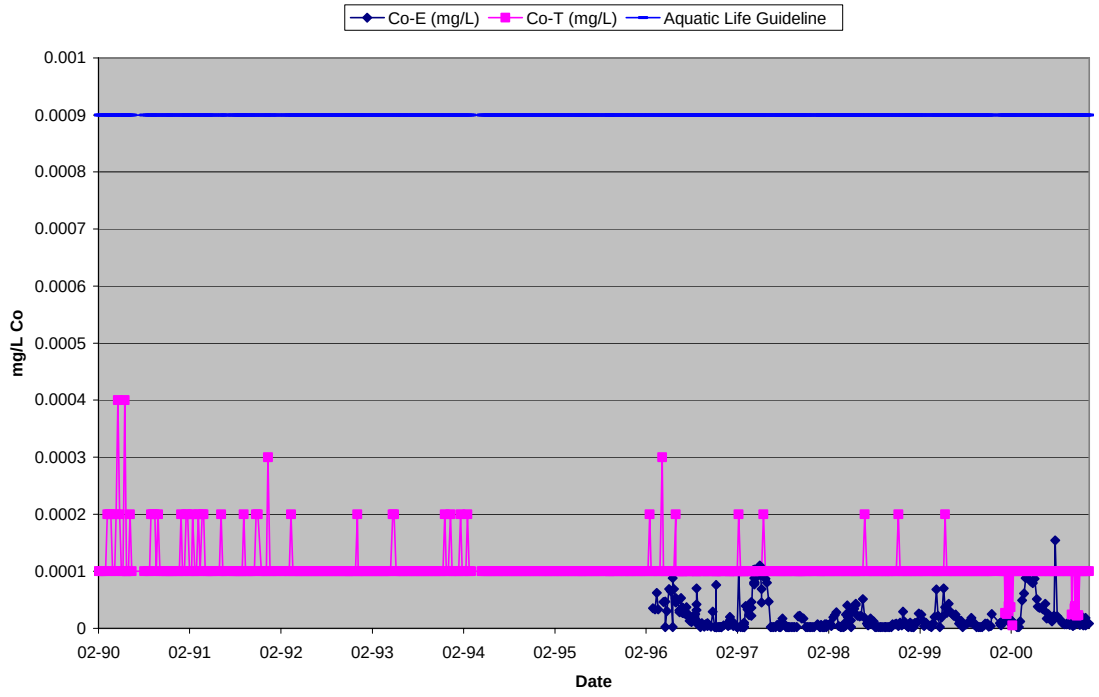


Figure 14 Columbia River at Waneta - Coliforms

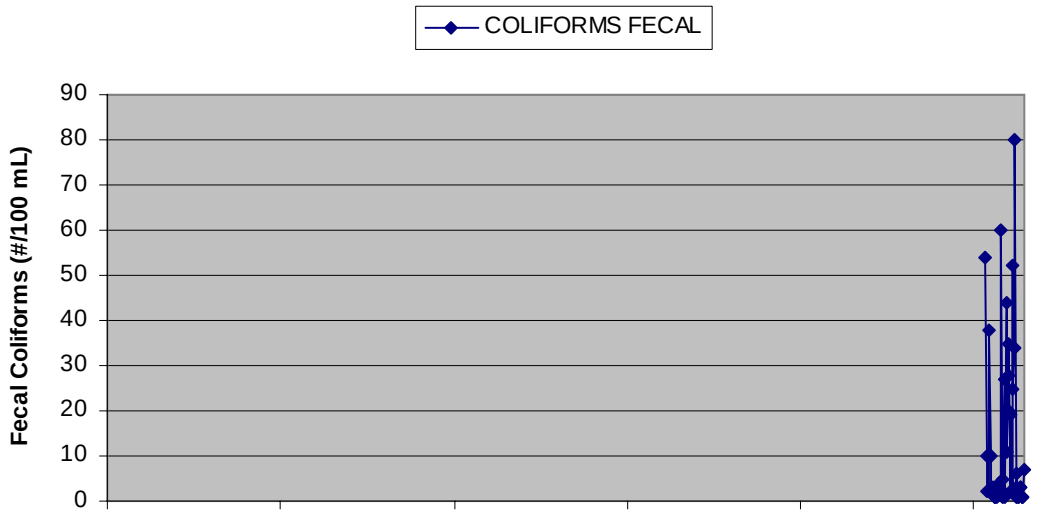


Figure 15 Columbia River at Waneta - Colour

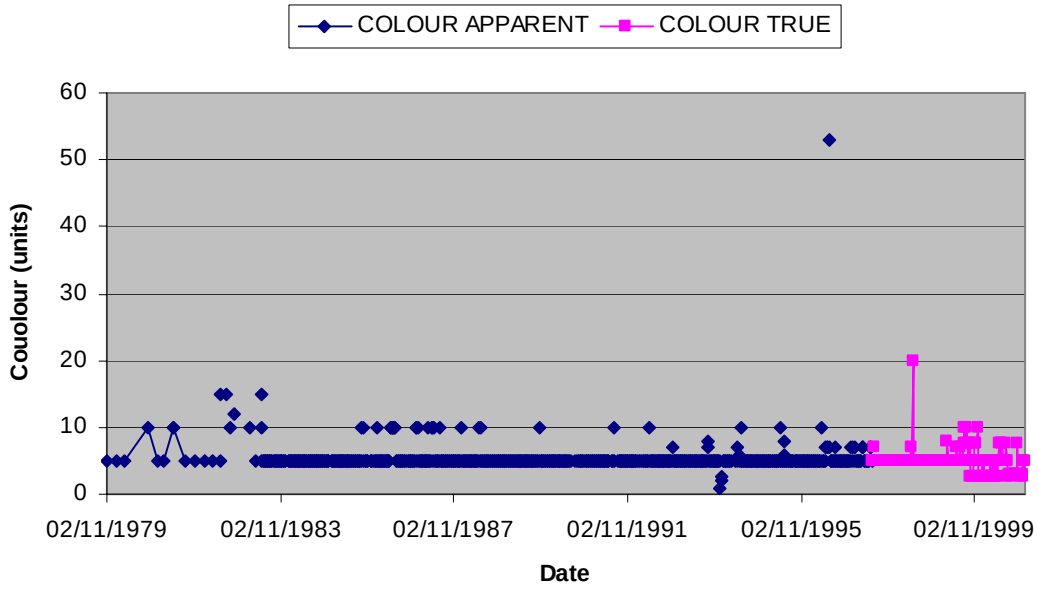


Figure 16 Columbia River at Waneta - Conductance, Specific

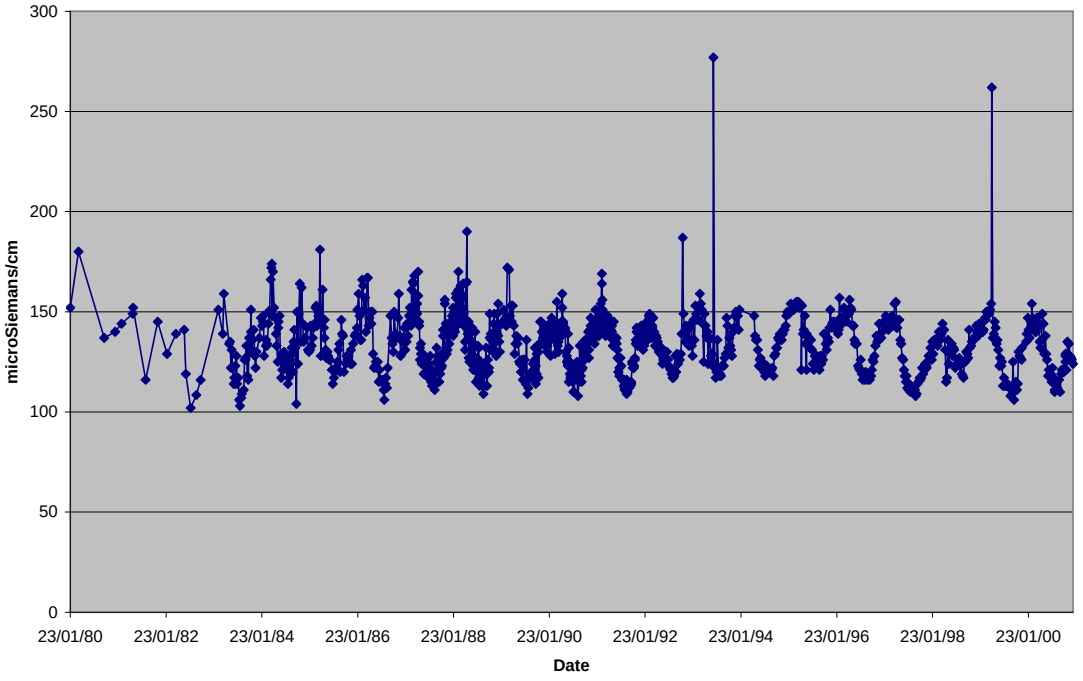


Figure 17 Columbia River at Waneta - Copper

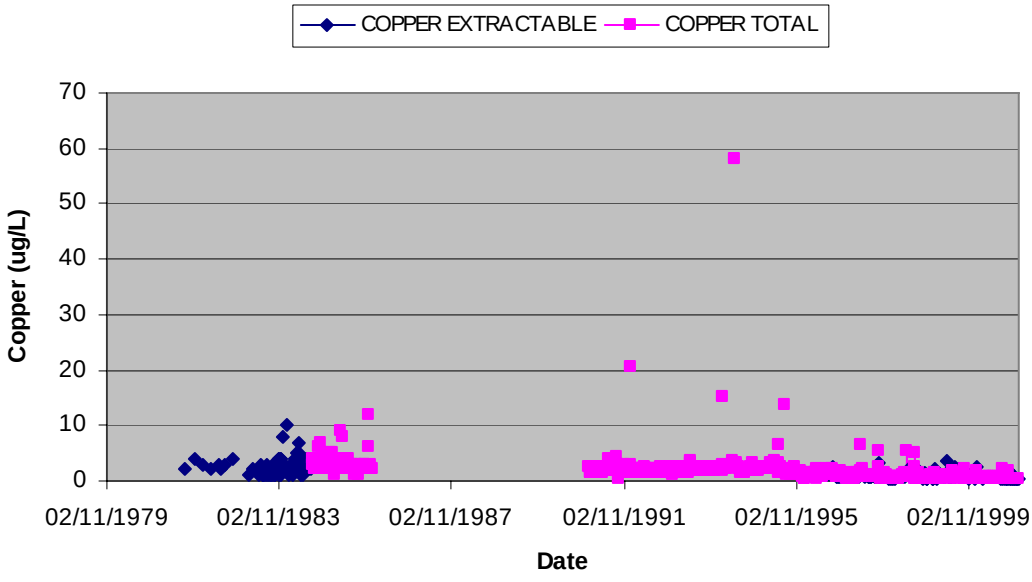


Figure 18 Columbia River at Waneta - Copper, 1996-2000

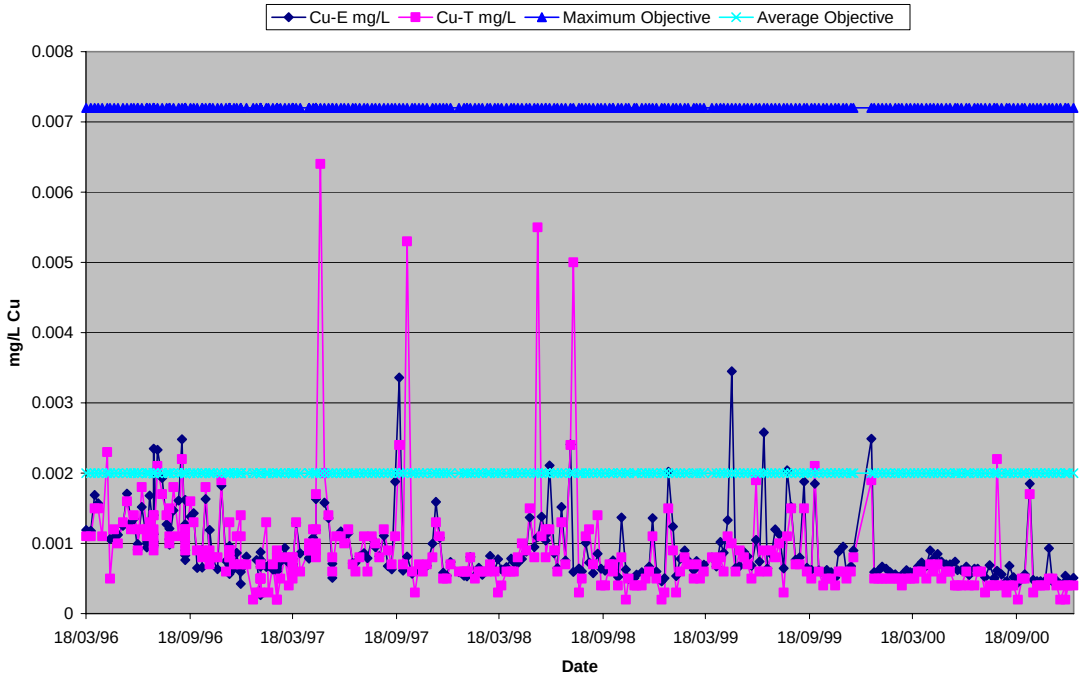


Figure 19 Columbia River at Waneta - Fluoride

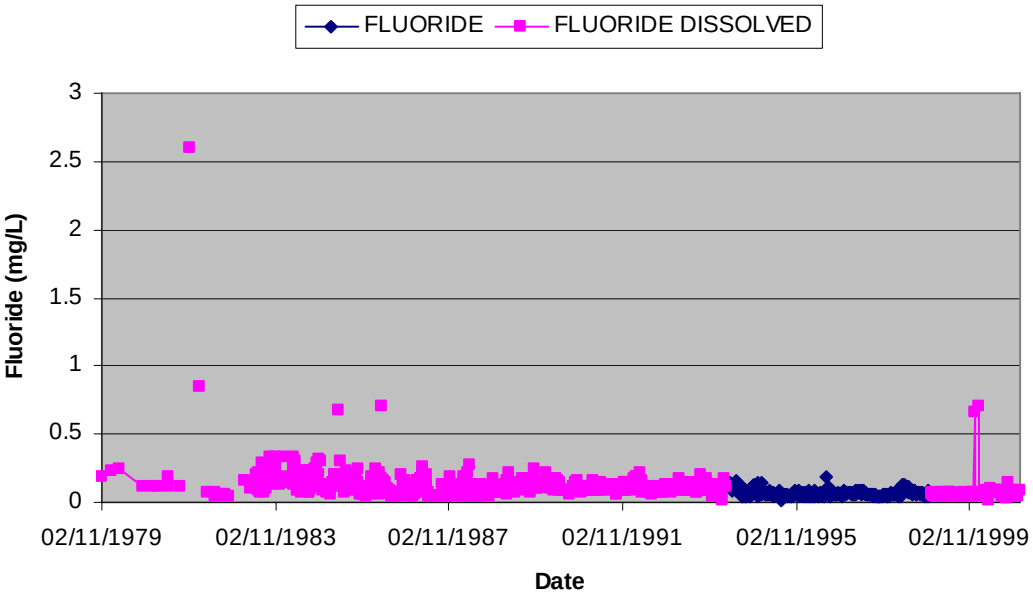


Figure 20 Columbia River at Waneta - Hardness

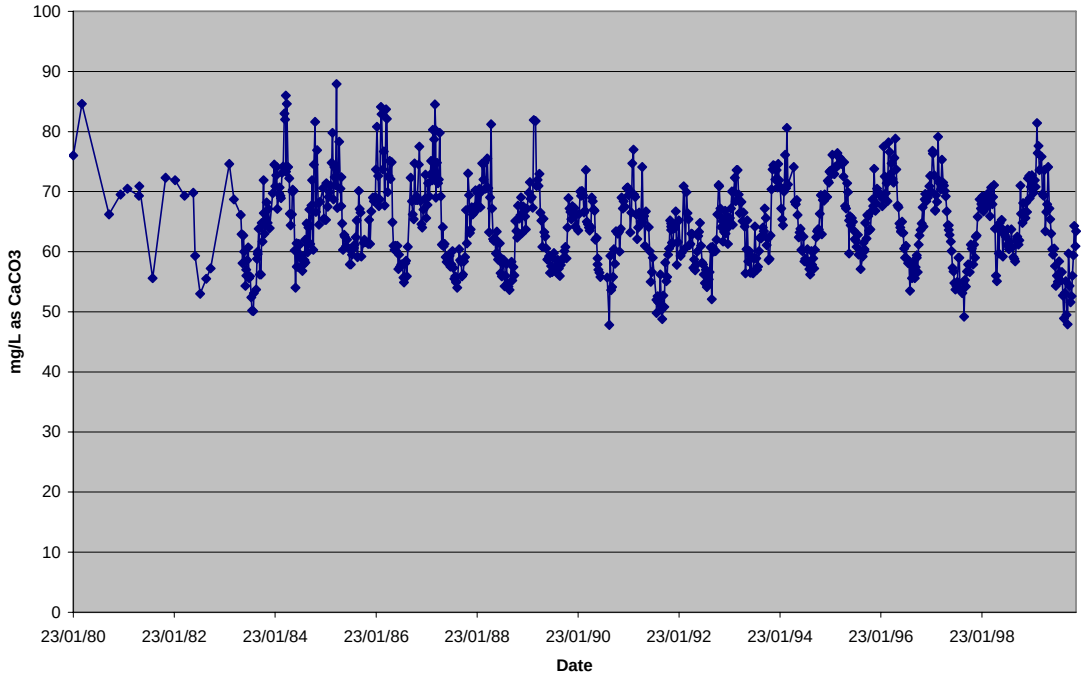


Figure 21 Columbia River at Waneta - Iron, Total

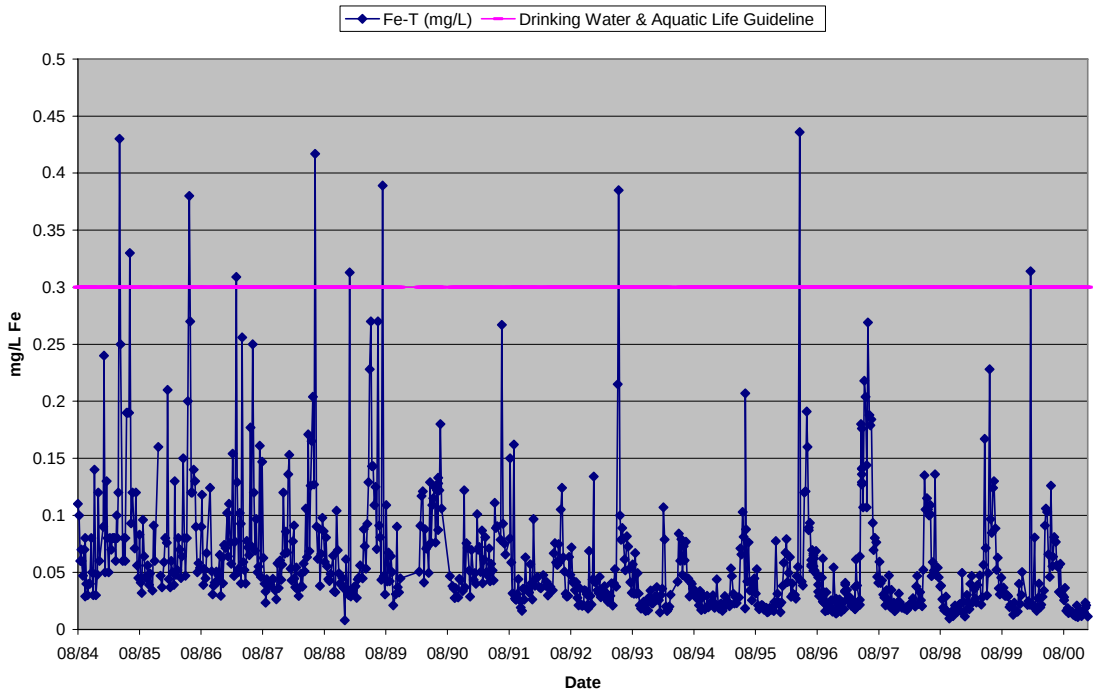


Figure 22 Columbia River at Waneta - Lead

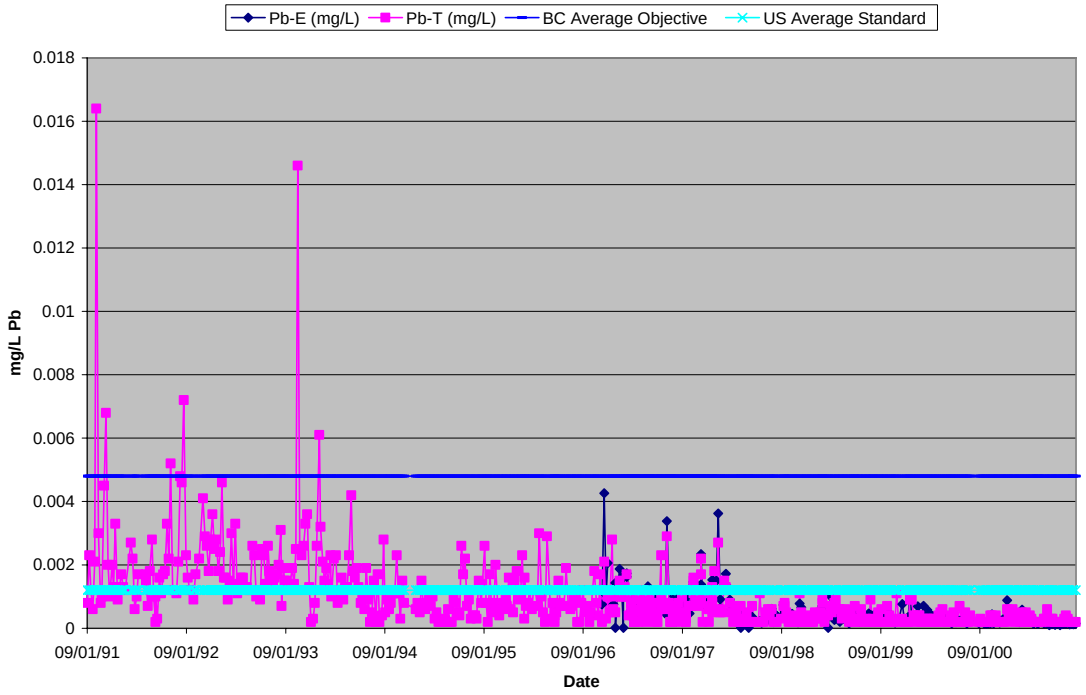


Figure 23 Columbia River at Waneta - Lithium

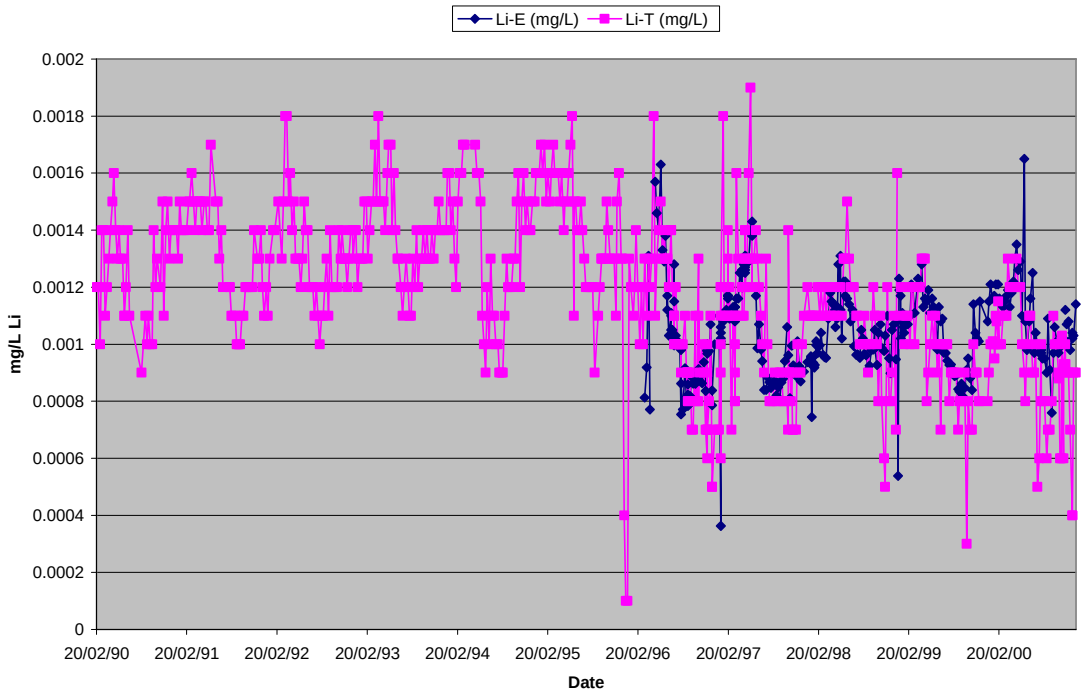


Figure 24 Columbia River at Waneta - Magnesium

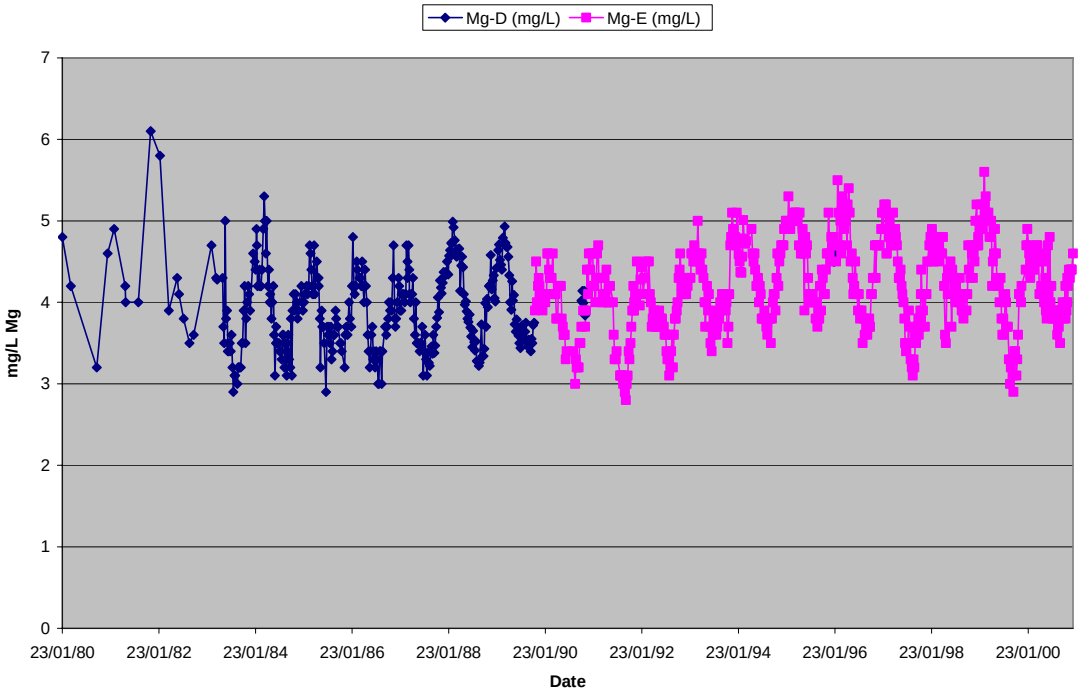


Figure 25 Columbia River at Waneta - Manganese

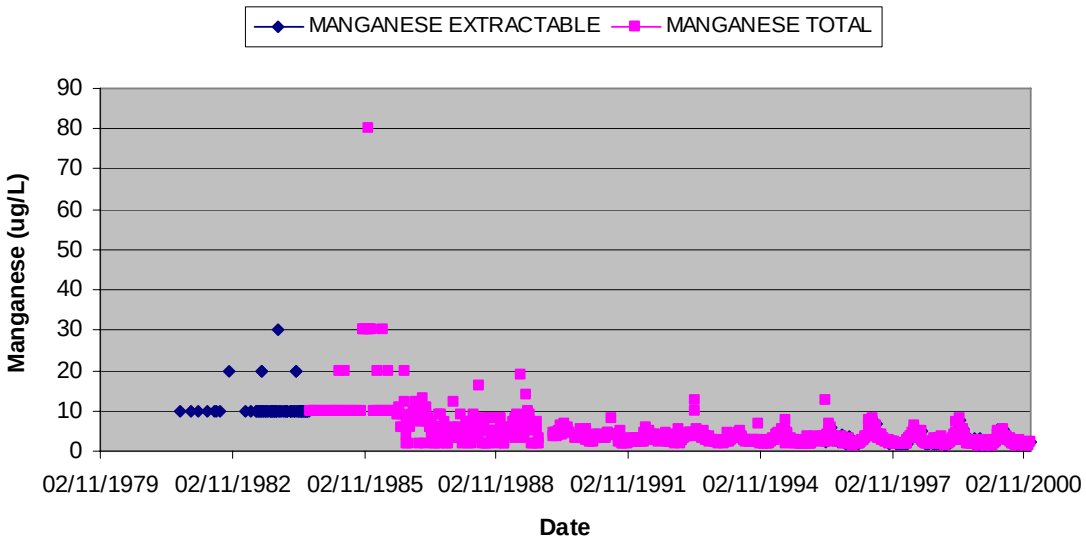


Figure 26 Columbia River at Waneta - Molybdenum

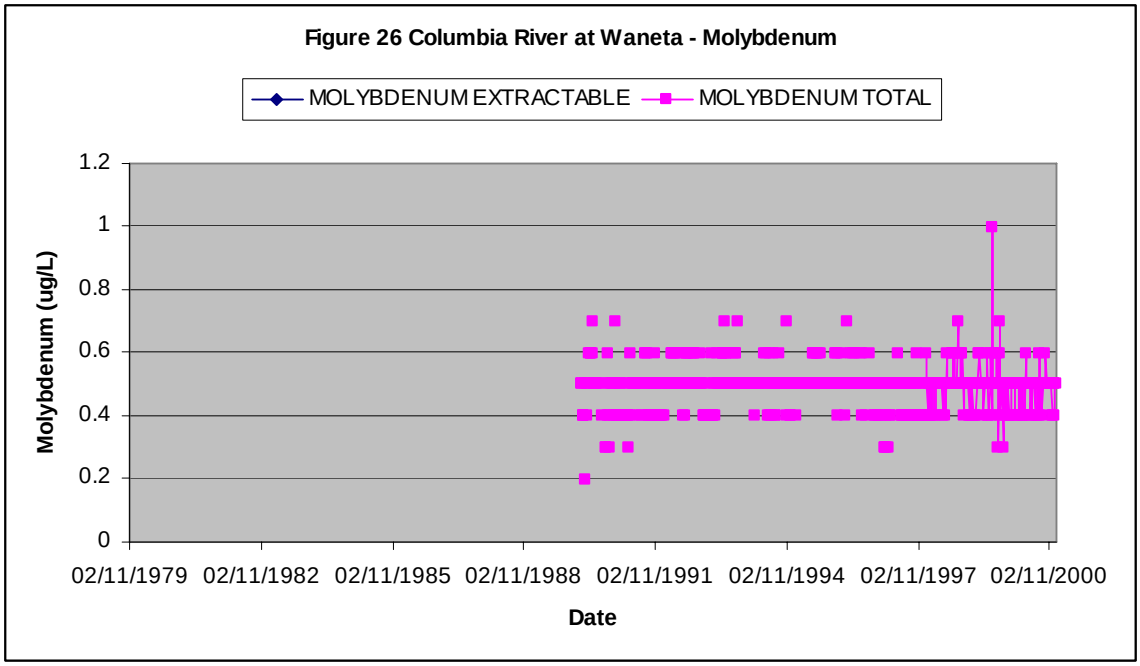


Figure 27 Columbia River at Waneta - Nickel

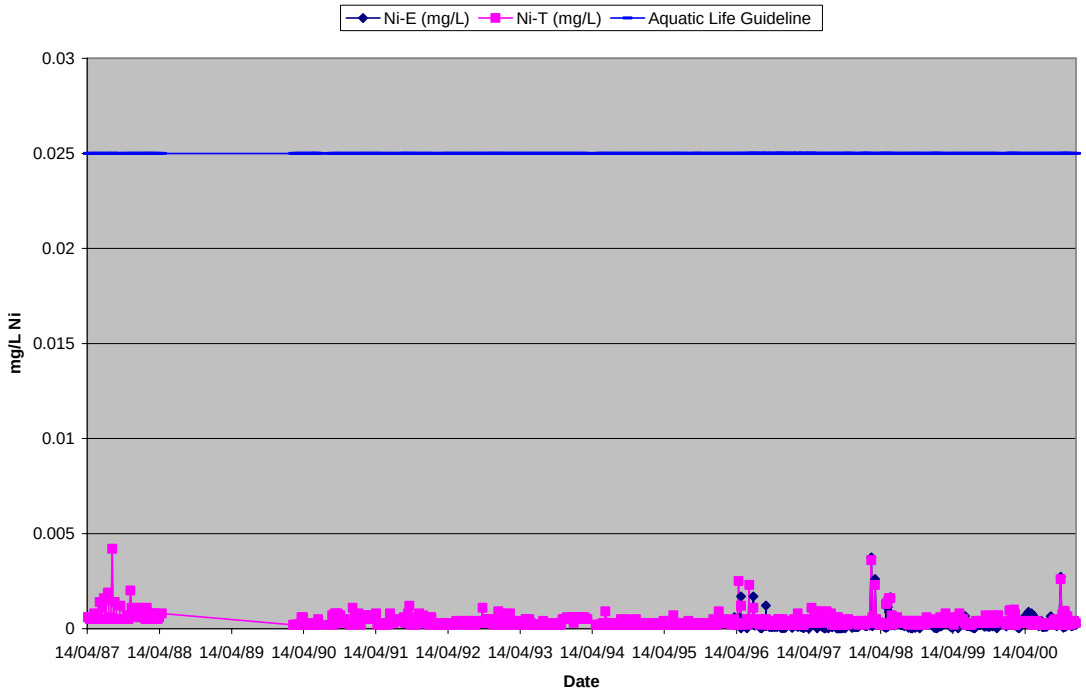


Figure 28 Columbia River at Waneta - Total Dissolved Nitrogen

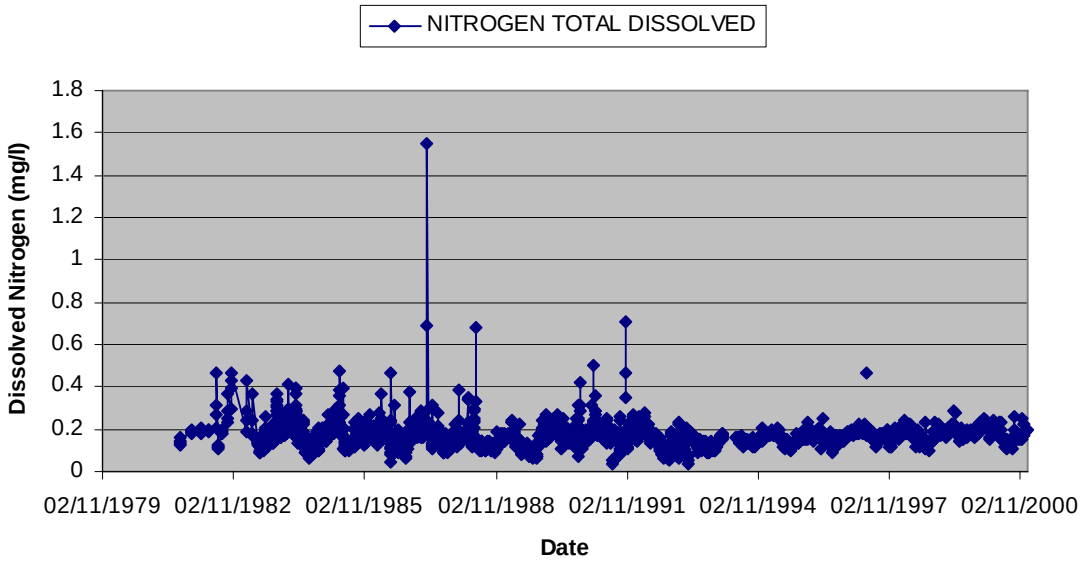


Figure 29 Columbia River at Waneta - pH

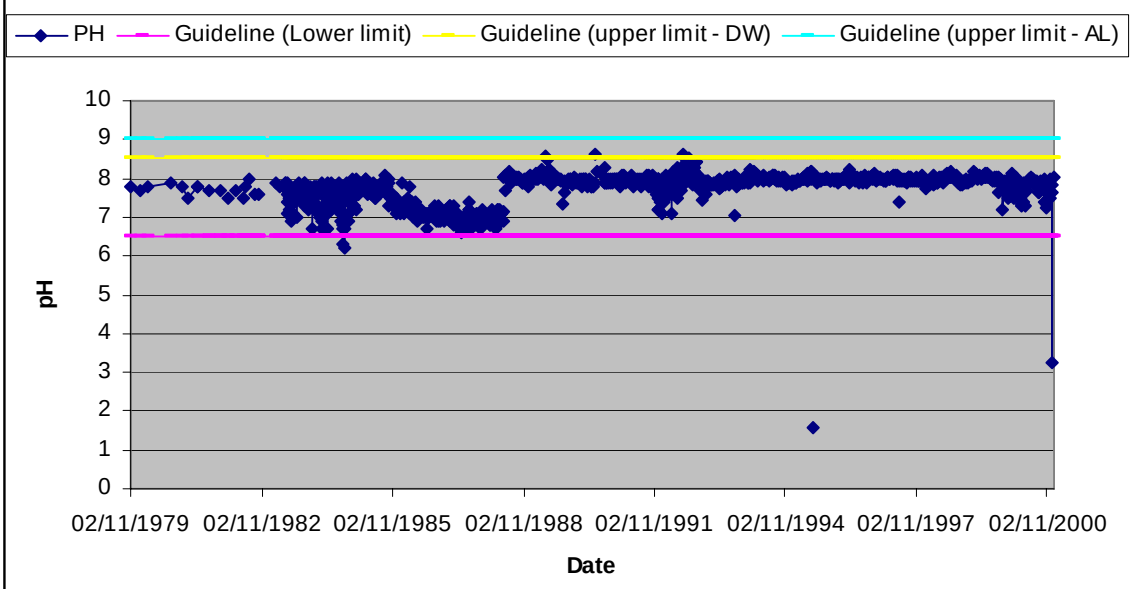


Figure 30 Columbia River at Waneta - Total Dissolved Phosphorus

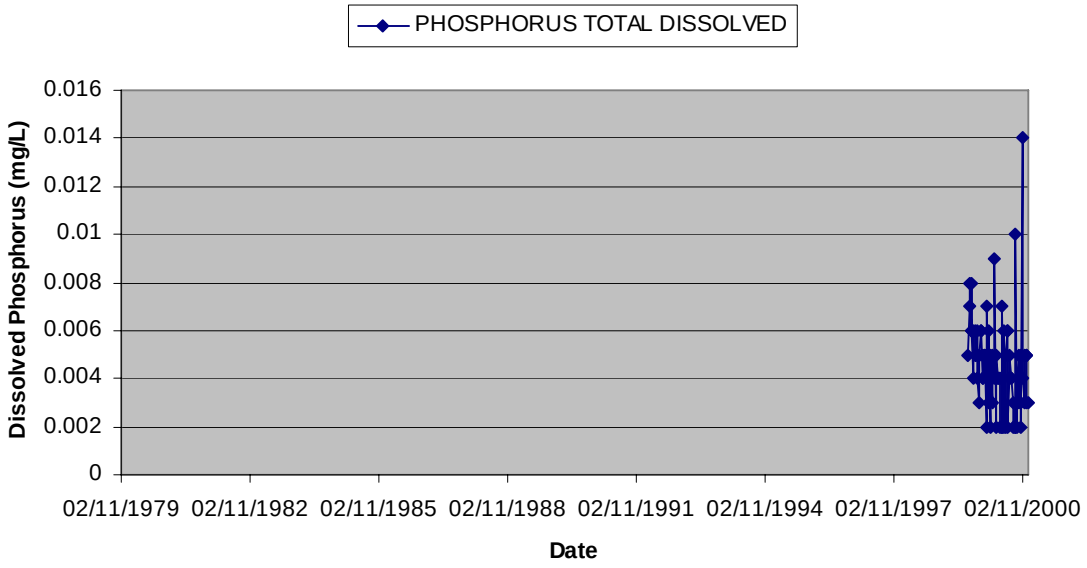


Figure 31 - Columbia River at Waneta - Total Phosphorus

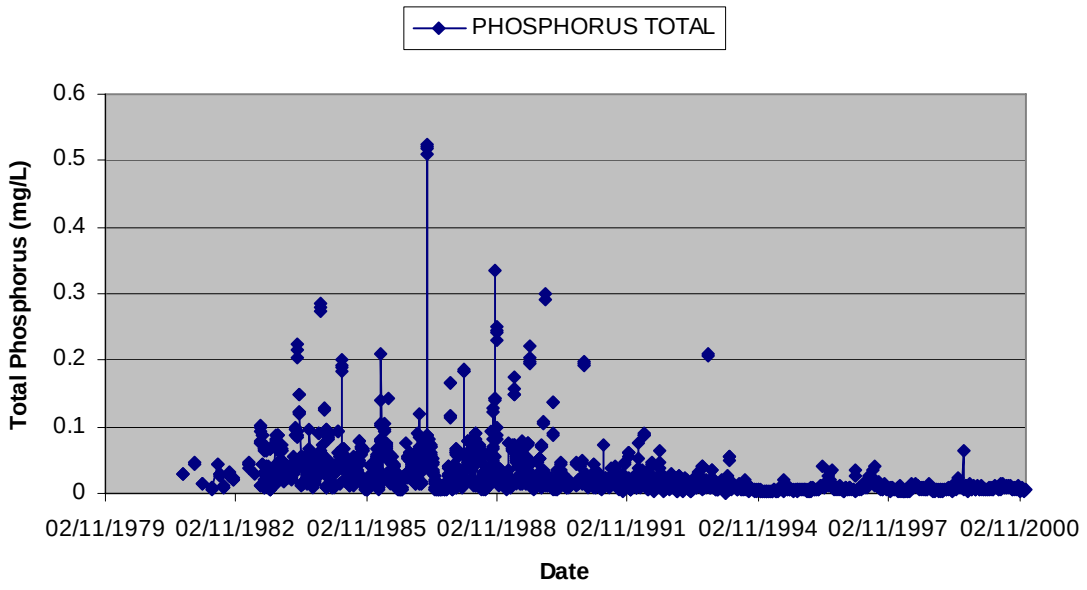


Figure 32 Columbia River at Waneta - Total Phosphorus Fed Data 1996-2000

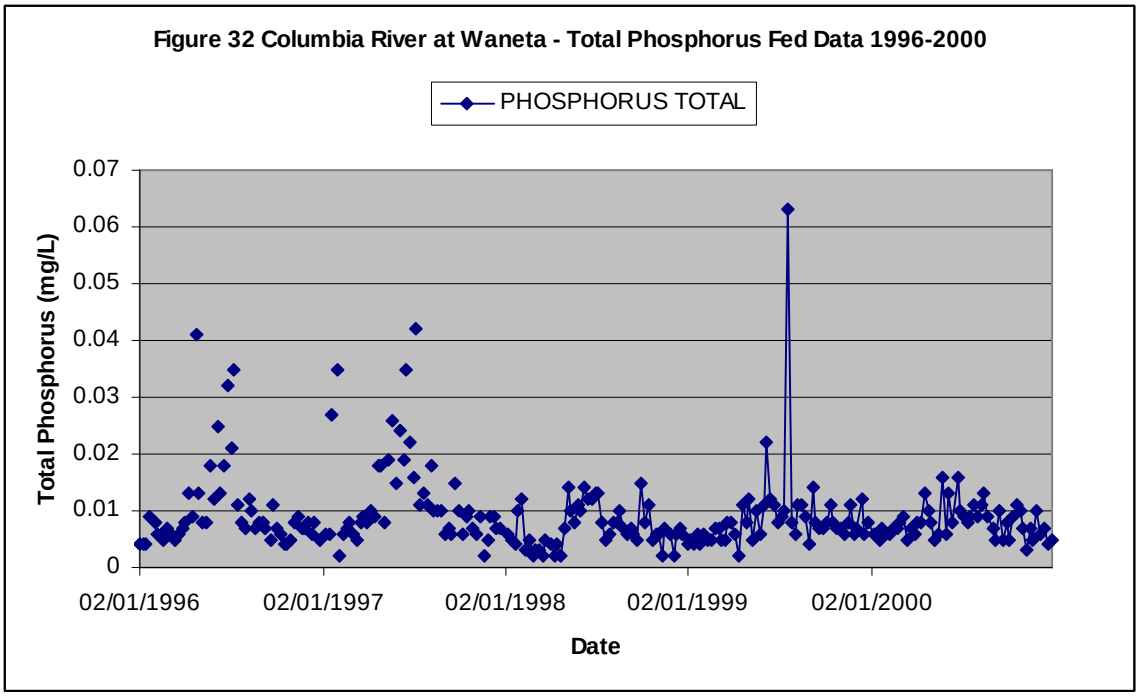


Figure 33 Columbia River at Waneta - Selenium, Total

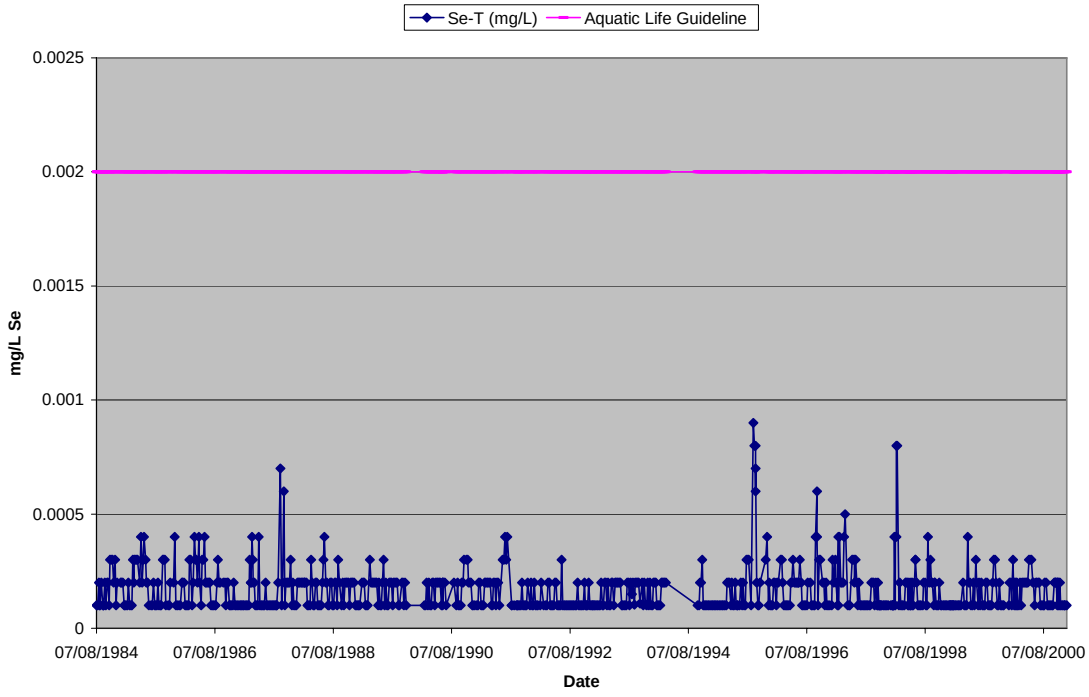


Figure 34 Columbia River at Waneta - Silver, Extractable

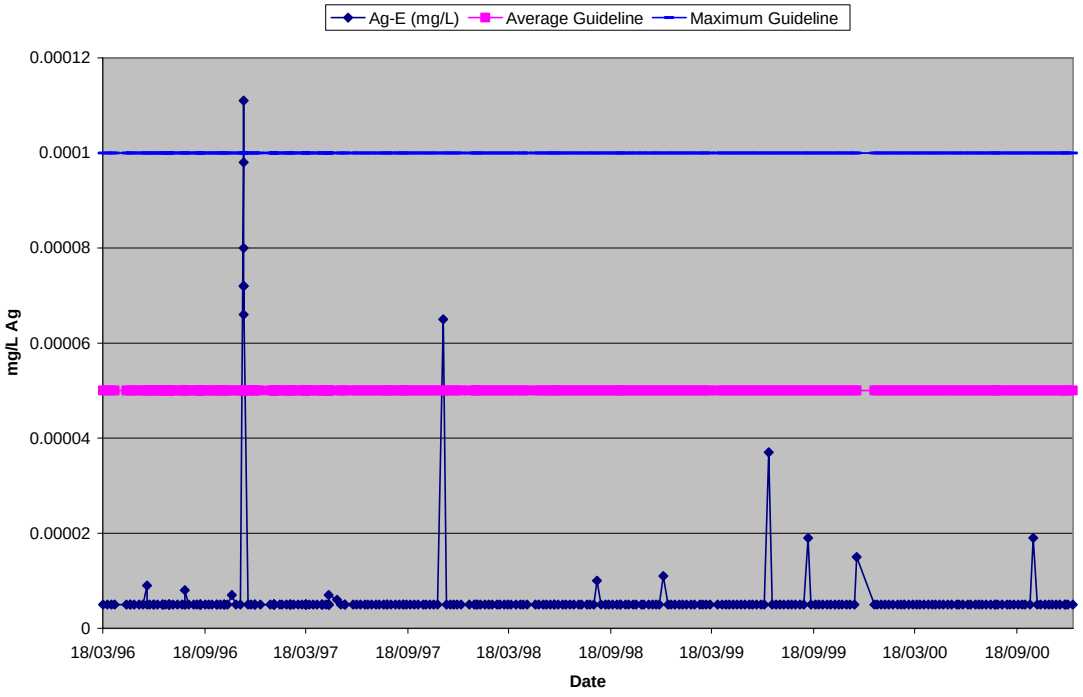


Figure 35 Columbia River at Waneta - Sulphate

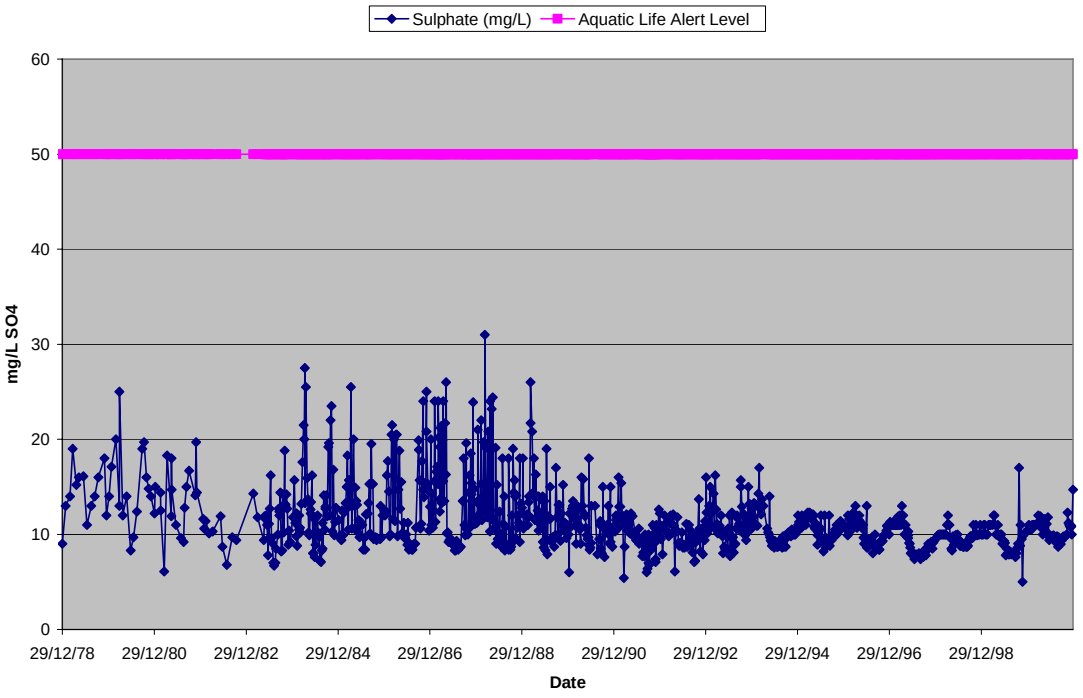


Figure 36 Columbia River at Waneta - Temperature, Water

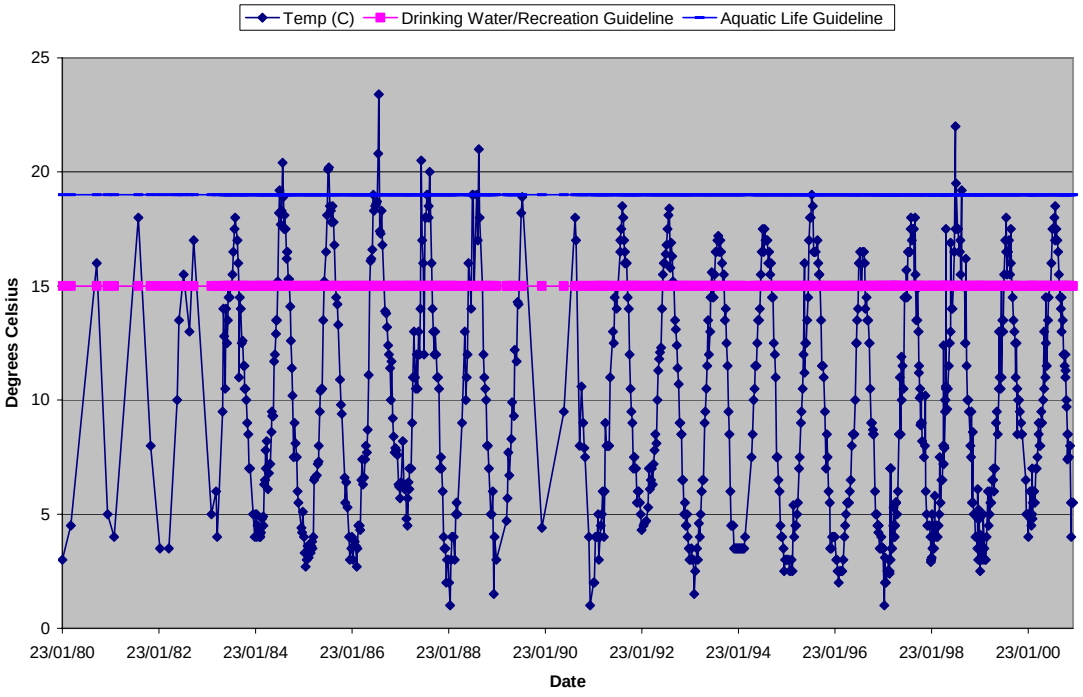


Figure 37 Columbia River at Waneta - Thallium, Extractable

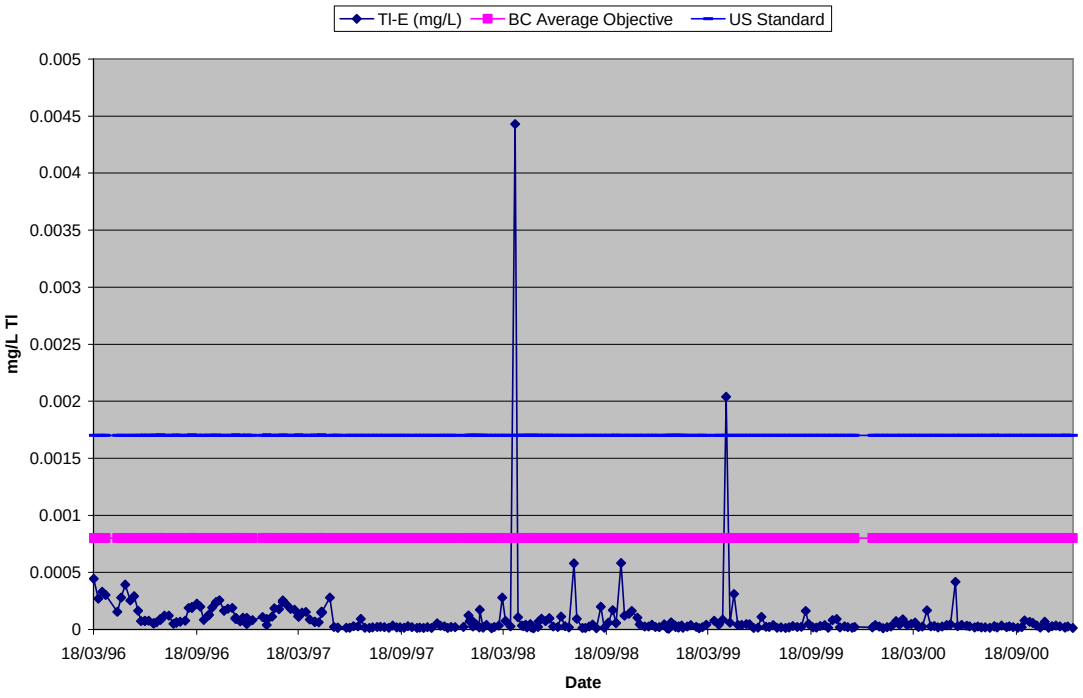


Figure 38 Columbia River at Waneta - Turbidity

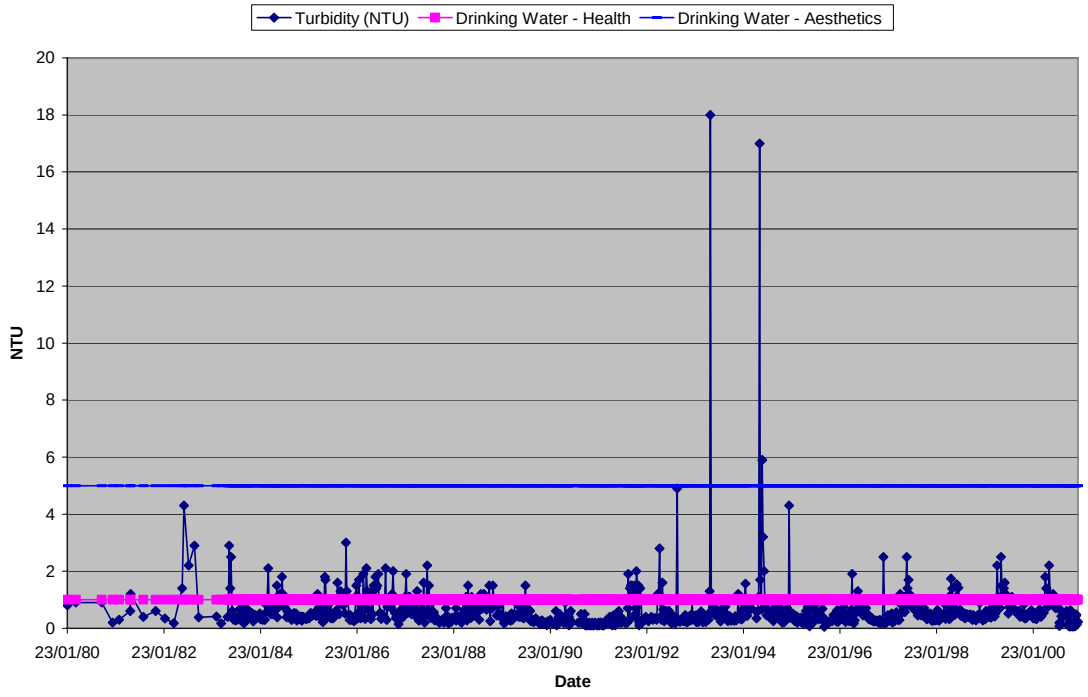


Figure 39 Columbia River at Waneta - Uranium

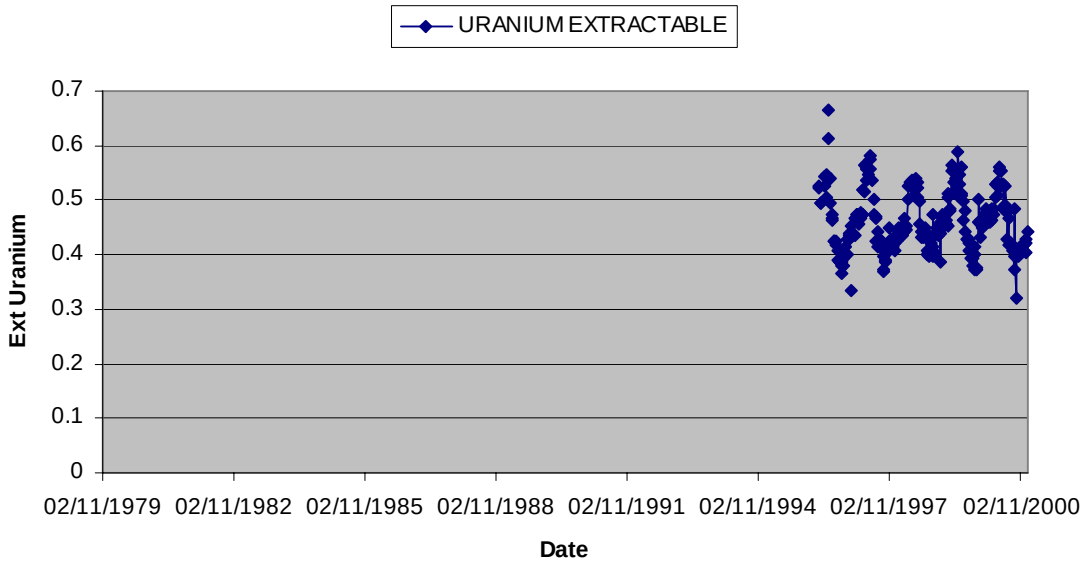


Figure 40 Columbia River at Waneta - Vandium

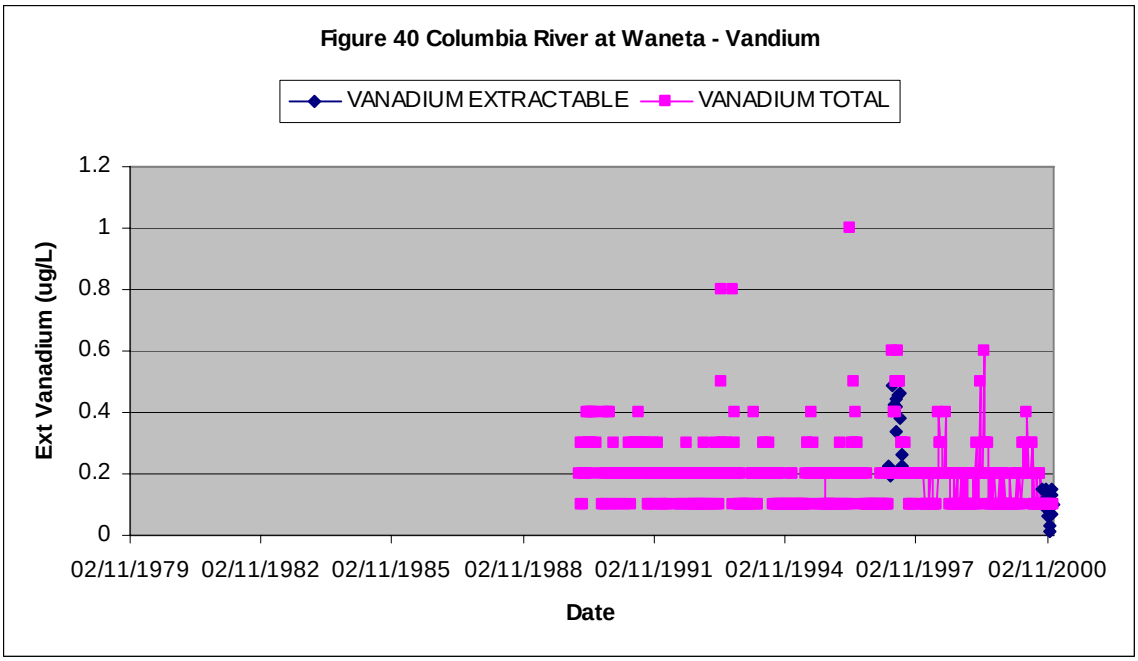


Figure 41 Columbia River at Waneta - Zinc